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TECHNICAL FACULTY
"MIHAJLO PUPIN"
ZRENJANIN

ITROCONFERENCE[11]

INFORMATION TECHNOLOGY AND EDUCATION DEVELOPMENT

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INFORMATION TECHNOLOGY AND EDUCATION DEVELOPMENT

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With this publication, the CD with all papers from the International Conference on Information Technology and Development of Education, ITRO 2020 is also published.

INTRODUCTION

For the first time the conference „Information Technology and Development of Education – ITRO 2020“ has been held on line, due to the covid-19 pandemic circumstances. The main goal of the conference was scientific discussion and interchange of information and experiences about the implementation of IT solutions in educational technology and the impact of different kinds of crises on children's access to quality education. Thematic fields of the conference are aligned with general trends in education, especially in technical sciences.

At the conference, within the poster session and at the plenary presentation, problems and, conditions were presented in the following areas: Theoretical and methodological issues of modern teaching, Personalization and learning styles, Social networks and their impact on education, Safety and security of children on the Internet, Curriculum of modern teaching, Methodological issues of teaching natural and technical sciences, Lifelong learning and professional development of teachers, E-learning, Management in education, Development and impact of information technology on teaching, Information and communication infrastructure in the teaching process, Improving the competencies of teachers and students. A significant number of papers were related to the implementation of teaching in the context of the COVID 19 pandemic.

At the end of the conference, and based on the papers of our participants, we conclude that the main focus points of this moment in education, which in one of the papers is called the "digital revolution", are the following:

- intensive work on increasing the level of responsibility of all participants in education,
- intensive work on the digitization of teaching content in order to overcome barriers and problems, of which one is certainly the dominant which is students motivation,
- intensive work on increasing competencies and professional support to teachers in the circumstances of a pandemic, different type of crisis and state of emergency,
- necessity of lifelong learning mechanisms,
- encouraging the research of attributes and relatively simple but sufficiently efficient approaches to assessing the metrics of the usability of educational technologies,
- encouraging the media to play a more active role in presenting the situation in the field of education professionally and objectively.

The ITRO Organizing Committee would like to thank the authors of papers, reviewers and participants in the Conference who have contributed to its tradition and successful realization.

We hope that next year our planet Earth will recover and that we will see each other live at the next conference.

We especially want to pay tribute to our late colleague professor Ivan Tasić PhD, as one of the founders of the ITRO conference. Our team thus suffered an irreparable loss, and his name will forever remain on the pages of the conference proceedings.

Chairman of the Organizing Committee

Ph.D Dragana Glušac

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The Influence of Teacher Communication Satisfaction on the Teaching Process and Student Development

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Abstract - The aim of this paper is to examine the direction and intensity of the impact of teacher communication satisfaction on the teaching process, personal and ethical development of students. The research was conducted through a questionnaire, and the respondents were teachers in primary schools in Serbia. A total of 406 valid questionnaires were collected, from 62 primary schools. The main conclusions of the research are: 1. Descriptive statistics show high average grades of the dimensions of communication satisfaction, teaching process and student development. 2. Satisfaction with teacher communication has a significant and positive impact on the quality of the teaching process and personal and ethical development of students. 3. Satisfaction with teacher communication has the greatest impact on the dimensions of TP1 - Teaching Planning and TP2 - Preparation, which also have the lowest average grades, so it is clear that satisfaction with communication can significantly contribute to raising the quality of these very important dimensions of the teaching process. 4. Principals need to pay significant attention to the development of quality communication in the team and, thus, satisfaction with the communication of teachers. This will certainly contribute to improving the quality of the teaching process, personal and ethical development of students.

I. INTRODUCTION

The teaching process, that is, the quality of the teaching process is a very old, probably the central topic of decades of pedagogical research. The quality of the teaching process, in modern pedagogical research, is seen through conceptual, empirical and normative properties. For example, the reference (Fenstermacher, Richardson, 2005) deals with the analysis of the concept, goals and tasks of teaching, teacher work and student achievement, on the example of schools in Australia. The results emphasize that good teaching does not necessarily indicate quality and successful learning. Practically, the quality of the learned material is influenced by numerous other factors over which the teacher, through his work in the classroom, has no influence. The research (Mcinnis, 2000) deals with the topics of changes in teaching and their impact on the scope of teachers' work, as well as obstacles in these processes. The results indicate that the scope of work of teachers and work tasks reach a critical point, where only essential reforms can be adequate in efforts to improve the quality of teaching processes.

Teacher job satisfaction is the subject of more research in the field of education, for example (Shann, 1998; Hoerr, 2013; Wolk, 2008; Ho, Au, 2006; Ladebo, 2005). Common to these references is that they indicate the importance of job satisfaction of teachers and its impact on the teaching process and the overall effectiveness of the school.

However, when it comes to the impact of communication and satisfaction with teachers' communication on the results of the teaching process, it is not possible to talk about a large number of researches that deal with this topic. The significance of this issue can mostly be seen indirectly. For example, references (Martinez-Maldonado, Goodyear, Carvalho, Thompson, Hernandez-Leo, Dimitriadis, Prieto, Wardak, 2017; Roberts, MacCann, Matthews, Zeidner, 2010) indicate the general importance of communication in educational organizations. Furthermore, communication is important in the process of teacher training (Asensio-Pérez, Dimitriadis, Pozzi, Hernández-Leo, Prieto, Persico, Villagrá-Sobrino, 2017). Similarly, the reference (Boynton Hauerwas, Skawinski, Ryan, 2017) identifies the importance of communication in international and intercultural schools, while the reference (Sayer, De Saintonge, Evans, Wood, 2002) confirms the importance of communication to support students and increase academic success. Finally, changes in education inevitably imply the need for teacher advancement. Teachers need to learn, and the school needs to inspire and support teachers in the learning process (Wiggins, McTighe, 2006). This also indirectly indicates the importance of communication in schools.

It should be borne in mind that communication satisfaction, in general, affects a number of organizational outcomes and performance. For

example, communication satisfaction has a positive effect on employee productivity (Clampitt, Downs, 1993; Pincus, 1986; Opiz, Hinner, 2003; Sprague, Del Brocco, 2002), employee job satisfaction and organizational commitment (Varona, 1996; Orpen, 1997; Nakra, 2006; Carriere, Bourque 2009; Kang, 2010; Pincus, Knipp, Rayfield, 1990; Burke, Wilcox, 1969), but also overall organizational effectiveness and organizational performance (Gray, Laidlaw, 2004; Snyder, Morris, 1984; García-Morales, Matías-Reche, Verdú-Jover, 2011; Andersen, 2001; Nelson, Coxhead, 1997).

Based on the above, it can be concluded that satisfaction with teacher communication certainly has a significant impact on the teaching process, but this topic has not been given much attention in previous research. Consequently, the aim of this paper is to examine the impact of teacher job satisfaction on the teaching process and personal and ethical development of students in primary schools in Serbia. Teachers in schools in Serbia are often dissatisfied with their work, and especially with their income. At the same time, there is not much room for the situation to improve significantly in the near future, so we should look for additional opportunities to increase the overall level of job satisfaction of teachers. One possibility is to improve communication in schools, and in that way to positively influence the satisfaction of teachers' communication, and then the teaching process and student development.

II. THEORY AND HYPOTHESES

Communication in an organization takes place between individuals or groups, which may be at the same or different hierarchical levels in the organization. Communication in organizations has four basic functions: control, motivation, emotional expression, and information (Scot, Mitchell, 1976). In general, it is very difficult to find an aspect of management activities that does not involve communication. In case of poor and incomplete communication, serious problems can arise in the organization (Ivancevich, Matteson, 2002).

Communication is not just about providing meaning, but that meaning must also be understood (Robbins, Judge, 2009). Ideally, a thought or idea is conveyed so that the mental image received by the recipient of the message is equal to the mental image of the sender of the message. It seems simple, but in fact, perfect communication is very difficult to achieve in real conditions.

A special place in organizational behavior is occupied by satisfaction with communication, as the degree to which employees have a positive attitude towards the overall way of communication in the organization. Thus, according to (Reeding, 1972), communication satisfaction represents the overall degree of satisfaction that employees experience in their communication environment. Satisfaction with communication is especially important for this research, because it is placed in relation to the dimensions of the teaching process, personal and ethical development of students.

Numerous authors, for example (Downs, Hazen, 1977; Clampitt, Downs, 1993), agree that communication satisfaction is a complex concept and difficult to assess unambiguously. Therefore, the assessment of satisfaction with communication requires a multidimensional approach, where the assessment is performed according to a number of categories (dimensions). Therefore, the survey of communication satisfaction in organizations is most often done through appropriate instruments, which have a number of dimensions. This is also the case in this research.

Based on the previous statements, the following hypotheses can be made:

H1: Dimensions of teacher communication satisfaction have statistically significant correlations with dimensions of teaching process quality, in primary schools in Serbia.

H2: The dimensions of satisfaction with teacher communication have statistically significant correlations with the dimensions of personal and ethical development of students, in primary schools in Serbia.

H3: Dimensions of satisfaction with teacher communication have a statistically significant predictive effect on the dimensions of the quality of the teaching process, in primary schools in Serbia.

H4: Dimensions of teacher communication satisfaction have a statistically significant predictive effect on the dimensions of personal and ethical development of students, in primary schools in Serbia.

III. RESEARCH METHODOLOGY

A. Research instruments

Satisfaction with communication. A questionnaire called The Communication Satisfaction Questionnaire (CSQ) was used to measure communication satisfaction (Downs and Hazen, 1977). The questionnaire has 40 items arranged in eight dimensions, but seven dimensions were used in this paper, the names of which can be seen in Table 1. All items were rated on a ten-point Likert scale.

Teaching process, personal and ethical development of students. To measure the quality of

the teaching process, personal and ethical development of students, a questionnaire from the Manual for evaluation and self-evaluation of school work, the Ministry of Education and Sports of the Republic of Serbia in cooperation with the British Council Serbia and Montenegro (Bojanić et al., 2005) was used. The questionnaire for measuring the quality of the teaching process has 80 items arranged in ten dimensions. The questionnaire for measuring the personal and ethical development of students has 30 items arranged in two dimensions. All items were graded on a four-point Likert scale. Names of all dimensions can be seen in Table 1.

B. Data on the procedure and sample of the research

The research was conducted in primary schools in Serbia. Surveys through interviews with respondents were used. The respondents were teachers. A total of 406 valid questionnaires were collected, from 62 primary schools.

IV. RESEARCH RESULTS

A. Results of descriptive statistics

The results of the descriptive statistics are given in Table 1. This table shows: dimension names, abbreviations for each dimension, mean values of all dimensions, and Cronbach's alpha for each dimension. Cronbach's alpha values range from $\alpha = 0.739$ to $\alpha = 0.949$.

Table 1. Results of descriptive statistics

Dimensions and items	abbreviation	N	Min	Max	**Mean**	Std. Deviation	α
Organizational perspective	CS1	406	1.00	10.00	**7.03**	2.125	.889
Communication with superiors	CS2	406	1.40	10.00	**8.14**	2.060	.949
Communication climate	CS3	406	1.00	10.00	**7.31**	2.154	.947
Personal feedback	CS4	406	1.40	10.00	**7.16**	2.226	.931
Horizontal and informal communication	CS5	405	1.33	10.00	**7.18**	1.995	.878
Media quality	CS6	406	1.00	10.00	**7.24**	2.061	.871
Organizational integration	CS7	406	1.40	10.00	**7.49**	2.025	.894
Teaching planning	TP1	406	1.00	4.00	**3.54**	.419	.820
Preparation of classes	TP2	406	1.62	4.00	**3.60**	.400	.888
Communication and cooperation	TP3	406	2.13	4.00	**3.86**	.279	.875
Rationality and organization	TP4	406	2.25	4.00	**3.69**	.351	.856
Encouraging students	TP5	406	2.00	4.00	**3.77**	.322	.880
Correlation and application of knowledge	TP6	406	2.20	4.00	**3.65**	.406	.739
Student responsibility	TP7	406	2.00	4.00	**3.63**	.415	.800
Way of learning	TP8	406	2.29	4.00	**3.74**	.351	.857
Monitoring and evaluation	TP9	406	2.36	4.00	**3.77**	.316	.885
Reporting	TP10	406	1.60	4.00	**3.64**	.468	.862
Personal development of students	SPD	406	2.13	4.00	**3.7309**	.322	.882
Ethical development of students	SED	406	2.33	4.00	**3.6525**	.372	.888

B. Results of correlation analysis

The correlation analysis between the dimensions of communication satisfaction and the quality of the teaching process is given in Table 2, and the correlation analysis between the dimensions of communication satisfaction and personal and ethical development of students is given in Table 3.

Table 2. Correlations between communication satisfaction and the quality of the teaching process

	TP1	TP2	TP3	TP4	TP5	TP6	TP7	TP8	TP9	TP10
CS1	.466**	.322**	.214**	.288**	.299**	.169**	.255**	.179**	.277**	.354**
CS2	.422**	.275**	.245**	.278**	.290**	.154**	.263**	.185**	.282**	.340**
CS3	.489**	.338**	.262**	.335**	.328**	.174**	.306**	.240**	.318**	.360**
CS4	.473**	.331**	.202**	.286**	.287**	.161**	.258**	.169**	.259**	.338**
CS5	.476**	.335**	.244**	.308**	.312**	.159**	.283**	.203**	.306**	.357**
CS6	.494**	.360**	.231**	.343**	.336**	.213**	.317**	.232**	.321**	.383**
CS7	.512**	.361**	.305**	.352**	.361**	.205**	.291**	.249**	.350**	.344**

*p<0.05; **p<0.01

Table 3. Correlations between communication satisfaction and personal and ethical development of students

	SPD	SED
CS1	.342**	.457**
CS2	.352**	.474**
CS3	.367**	.496**
CS4	.339**	.458**
CS5	.376**	.502**
CS6	.412**	.495**
CS7	.389**	.493**

*p<0.05; **p<0.01

C. Results of regression analysis

Linear regression analysis was applied with the aim of examining the predictive effect of communication satisfaction on the quality of the teaching process and personal and ethical development of students. The results are shown in Table 4 and Table 5.

Table 4. Results of regression analysis: predictive effect of communication satisfaction on the teaching process

Dep.	Indep. β							R^2	F	Sig.
	CS1	CS2	CS3	CS4	CS5	CS6	CS7			
TP1	-.166	-.059	.104	.055	.025	.181	.347**	.277	21.712	.000
TP2	-.131	-.127	.001	.048	.069	.227*	.282**	.146	9.596	.000
TP3	-.206	.063	.235	-.205	-.106	-.036	.541**	.120	7.794	.000
TP4	-.203	-.039	.207	-.132	-.090	.237**	.373**	.147	9.782	.000
TP5	-.119	-.004	.126	-.168	-.070	.187	.407**	.144	9.567	.000
TP6	-.062	-.028	-.010	-.116	-.115	.270*	.261*	.058	3.466	.000
TP7	-.170	.032	.205	-.116	-.027	.276**	.124	.113	7.254	.001
TP8	-.221	-.025	.313*	-.235	-.156	.174	.383**	.096	6.001	.000
TP9	-.161	.009	.150	.259*	-.129	.191	.433**	.145	9.620	.000
TP10	.095	.098	.038	-.111	.070	.281*	-.060	.155	10.400	.000

Table 5. Results of regression analysis: predictive effect of communication satisfaction on students' personal and ethical development

Dep.	Indep. β							R^2	F	Sig.
	CS1	CS2	CS3	CS4	CS5	CS6	CS7			
SPD	-.140	.053	-.056	-.154	.116	.395**	.210	.187	13.011	0.00
SED	-.116	.133	.104	-.072	.171	.201*	.135	.281	22.184	.000

V. DISCUSSION OF RESULTS

A. Discussion of the results of descriptive statistics

The results of descriptive statistics (Table 1) show that, of the dimensions of communication satisfaction, by far the highest average score has the dimension CS2 - Communication with superiors. Some of the items that make up this dimension are: The manager is ready to listen to me if I have any objections, the manager has confidence in me, the manager supports me, the manager is ready to accept new ideas. It is obvious that primary school principals show a high level of understanding, trust and support towards their teachers. Dimension CS7 - Organizational integration also has a high average grade. Some of the items that make up this dimension are: Employee reward information is public, Information about the requirements of my job is accurate and complete (work assignments are clearly presented), Communication between departments is active (necessary information is exchanged), Information about with the advancement in my business they are complete and timely. It is certain that working relations are efficient, teachers know what they need to do, communication is active, and the conditions for promotion and rewarding are transparent. All these results can be considered very good and encouraging.

The lowest average score, of the dimensions of communication satisfaction, has the dimension CS1 - Organizational Perspective. This dimension consists of items related to the general business of the organization, for example: Information about the goals and policies of the organization is complete and timely, Information about the successes and failures of the organization is available to employees, Information about changes in the organization is complete and timely, Information on the measures taken by the state, which relate to the work of the organization, is complete and timely.

According to this result, teachers have a somewhat lower insight into the goals and policies of the school, organizational changes, as well as measures taken by the state in connection with the

work of schools. The CS4 - Personal Feedback dimension also has a low average score. Feedback falls within the realm of what directors can undoubtedly, and without too much effort, do to advance this aspect of communication. Regardless of the fact that some dimensions have lower average grades, in general, it can be stated that the dimensions of communication satisfaction have grades that are significantly above average. This is, of course, a good result.

Of the dimensions of the quality of the teaching process, the highest average grade has the dimension TP3 - Communication and Cooperation. Some of the items that make up this dimension are: I try to express myself clearly and correctly in class, I check if students have correctly understood the questions and instructions, I encourage students to express their opinions and observations, I address each student with respect, I encourage solidarity and responsibility in group work. Teachers, obviously, very conscientiously and with quality realize the immediate process of teaching in the classroom, making an effort to explain the material to all students, check whether everyone understood what was presented and encourage students to actively participate in class. Accordingly, high average grades also occur in the dimensions of the teaching process TP5 - Encouraging students and TP9 - Monitoring and assessment. Therefore, class work, encouragement, monitoring and assessment of students are at a high level.

On the other hand, from the dimension of the quality of the teaching process, the lowest average grade has the dimension TP1 - Teaching Planning. Some of the items that make up this dimension are: Members of professional councils cooperate in planning, Curricula are time-coordinated processing of topics common to several subjects, My plans provide different methods of work in the function of effective acquisition of knowledge and development of abilities and skills of students, Written tests are time-aligned with checks from other subjects. Dimension TP2 - Preparation of teaching also has a low average grade. Some of the items that make up this dimension are: I use professional literature for preparation, I use the Internet and other sources for preparation, I exchange good preparations with colleagues, I prepare assignments for work of different difficulty, I plan the use of teaching aids.

These results suggest that teachers should pay more attention to the planning and preparation of classes, especially better cooperation with teachers of other subjects and greater use of current professional literature. We should not lose sight of the fact that the average grades of all dimensions of the teaching process are very high and that these proposals do not represent criticism, but proposals and the possibility to raise the level of the teaching process even more.

Dimensions of SPD - Personal development of students and SED - Ethical development of students also have high average grades. These grades are close to most average grades, which occur in the dimensions of the teaching process. Therefore, it can be said that in this segment there is a good approach of teachers and a favorable climate in schools.

B. Discussion of the results of correlation analysis

Table 2 shows the results of the correlation analysis between the dimensions of communication satisfaction and the dimensions of the teaching process. It can be seen that all correlations are statistically significant, strong and positive. Therefore, hypothesis H1 was confirmed. Practically, this confirms that all dimensions of communication satisfaction affect the teaching process, the only question is where that influence is stronger.

Of the dimensions of communication satisfaction, the strongest positive influence on the dimensions of the teaching process have the dimensions CS7 - Organizational integration, followed by CS6 - Media quality. CS7 - Organizational integration includes items such as: Information on rewarding employees is public, Information regarding the requirements of my job is accurate and complete (work tasks are clearly presented), Communication between departments is active (necessary information is exchanged), Information in the progress of my work is complete and timely. CS6 - Media quality includes items such as: Written instructions and reports are clear and short, In case of urgency the necessary information is transmitted quickly, Meetings are well organized, with a clear goal and short, The amount of information in the organization is appropriate. It is obvious that short, clear and timely information regarding work, promotion, rewards, school goals, have the greatest impact on the quality of the teaching process. In general, the teaching process has a positive and strong impact on everything related to strategic and operational activities in the school, which can be considered a logical result.

Of the dimensions of communication satisfaction, the weakest influence on the dimensions of the teaching process has the dimension CS2 - Communication with superiors, and then the dimension CS4 - Personal feedback. It should be borne in mind that these dimensions have a positive and strong impact on the teaching process, only this impact is somewhat weaker than with other dimensions of communication satisfaction. Definitely, quality communication with superiors

and feedback contribute to the quality of the teaching process, but that impact is somewhat smaller. This can be explained by the fact that these dimensions restrict and hinder the teacher to provide the maximum in the immediate teaching process, than if, for example, he did not receive certain information about work, rewarding school goals, or is generally dissatisfied with the way meetings are organized. . Such organizational events have a more direct effect on the teaching process, so the quality of the teaching process itself is more sensitive to any positive or negative phenomenon in that context.

Of the dimensions of the teaching process, under the strongest influence of the dimensions of satisfaction with communication, there are dimensions TP1 - Teaching Planning, TP10 - Reporting and TP2 - Teaching Preparation. These are the dimensions that are related to the activities that take place mostly outside the classroom and the time of classes. In the class itself, the elements of organizational behavior, as well as the satisfaction with communication, do not have such an impact because the class largely depends on the teacher himself, his abilities, expertise, pedagogical approach, etc. On the other hand, communication and satisfaction with communication can initiate the exchange of information between teachers and the harmonization of teaching contents of different subjects, encourage greater use of professional literature and the achievement of prescribed goals. Also, if we keep in mind that the dimensions TP1 - Teaching Planning and TP2 - Teaching Preparation have the lowest average grades of all dimensions of the teaching process (descriptive statistics, Table 1), then it is clear that communication and communication satisfaction in schools certainly have great importance for the improvement of these, the least evaluated dimensions of the teaching process.

Of the dimensions of the teaching process, under the weakest influence of the dimensions of satisfaction with communication are the dimensions TP8 - Learning, TP3 - Communication and cooperation and TP6 - Correlation and application of knowledge. Here, a phenomenon opposite to the previous one occurs: the stated dimensions refer to the immediate work and activities in class. As a result, these dimensions largely depend on the teachers themselves, and less on the various elements of organizational behavior, and thus satisfaction with communication. At the same time, we should not forget that these influences are also statistically significant and positive, only somewhat weaker. This phenomenon is consistent with the previously described results for the dimensions of the teaching process on which there is the strongest influence of the dimensions of communication satisfaction. Thus, the strongest influence of communication satisfaction on the dimensions of the teaching process occurs on the dimensions that include activities outside the classroom, while the weakest influence on the dimensions of the teaching process exists with dimensions that relate to teaching activities during class.

Table 3 shows the results of the correlation analysis between the dimensions of communication satisfaction and the dimensions of personal and ethical development of students. It can be seen that all correlations are statistically significant and positive. Based on that, hypothesis H2 was confirmed. Practically, this shows that all dimensions of communication satisfaction affect the personal and ethical development of students, and it is only necessary to consider where this influence is stronger.

From the dimensions of communication satisfaction, the dimensions of personal and ethical development of students are most strongly influenced by CS6 - Media Quality, and then CS7 - Organizational Integration. These dimensions of communication satisfaction indicate a high level of information, transparency, orderliness and organization of processes in schools. It is obvious that such a highly organized and organized system is most conducive to creating an atmosphere in the school that contributes to the personal and ethical development of students. The smallest influence on the dimensions of personal and ethical development of students has the dimension CS4 - Personal feedback, followed by the dimension CS1 - Organizational perspective. According to these results, the students themselves and their personal and ethical development have the least impact on how the work of teachers and knowledge of business aspects of school work are evaluated. It is noticeable that the dimensions of communication satisfaction have a greater impact on the dimension of SED - Ethical development of students, than on the dimension of SPD - Personal development of students.

C. Discussion of the results of regression analysis

Table 4 shows the results of regression analysis in which the dimensions of communication satisfaction are independent variables, while the dimensions of the teaching process are dependent variables. All values of the corrected determination index R2 have statistically significant values. Based on these results, it can be concluded that the dimensions of communication satisfaction have a predictive effect on the dimensions of the teaching process, so hypothesis H3 is confirmed. The highest values of R2 occur in the dimensions TP1 - Teaching planning, TP10 - Reporting and TP2 - Preparation of

teaching, and the lowest in the dimensions TP6 - Correlation and application of knowledge, TP8 - Learning and TP7 - Student responsibility. These results are mostly consistent with the results of correlation analysis.

When we look at the predictive effect of certain dimensions of communication satisfaction, we see that the strongest effect has the dimensions CS7 - Organizational Integration, and then CS6 - Media Quality, which is fully in line with the results of correlation analysis. Other dimensions of communication satisfaction have a very weak predictive effect, which in some dimensions is slightly negative. This is especially true for dimensions CS1 - Organizational Perspective and CS4 - Personal Feedback.

Table 5 gives the results of regression analysis in which the dimensions of communication satisfaction are independent variables, while the dimensions of personal and ethical development of students are dependent variables. The values of the corrected determination index R2 have statistically significant values. Therefore, there is a predictive effect of the dimensions of communication satisfaction on the dimensions of personal and ethical development of students, which confirms hypothesis X4. At the same time, the dimension SED - Ethical development of students has a higher index of determination R2, compared to the dimension SPD - Personal development of students. In addition, the value of R2 for the dimension SED - Ethical development of students is the highest if the values of this index are observed in the dimensions of the teaching process (Table 4). It can be concluded that the dimensions of communication satisfaction have the greatest predictive effect and the strongest influence on the dimension of SED - Ethical development of students. This result is consistent with the results of the correlation analysis.

A limitation of this research can be considered the fact that the research was conducted in primary schools in Serbia, so the results, in the first place, apply to primary schools in Serbia. It can be assumed that the results would be similar in secondary schools in Serbia, as well as in primary and secondary schools in the surrounding countries, such as Montenegro, Bosnia and Herzegovina, Macedonia and the like. Also, similar research can be done periodically.

VI. CONCLUSION

The research confirmed all four hypotheses. Therefore, satisfaction with teacher communication has an impact on the quality of the teaching process and personal and ethical development of students in primary schools in Serbia. Descriptive statistics show high average scores on the dimensions of communication satisfaction, teaching process and student development. Of the dimensions of communication satisfaction, the highest average score has the dimension CS2 - Communication with a superior, followed by the dimension CS7 - Organizational integration. Dimensions CS1 - Organizational Perspective and CS4 - Personal Feedback have the lowest average score.

All dimensions of communication satisfaction have a statistically significant and positive effect on the teaching process. The strongest positive influence on the dimensions of the teaching process have the dimensions CS7 - Organizational integration, followed by CS6 - Media quality. The weakest influence on the dimensions of the teaching process has the dimension CS2 - Communication with superiors, and then the dimension CS4 - Personal feedback.

Of the dimensions of the teaching process, under the strongest influence of the dimensions of satisfaction with communication, there are dimensions TP1 - Teaching Planning, TP10 - Reporting and TP2 - Teaching Preparation. At the same time, the dimensions TP1 - Teaching Planning and TP2 - Teaching Preparation have the lowest average grades of all dimensions of the teaching process (descriptive statistics, Table 1). This result indicates that the satisfaction with communication in schools can significantly contribute to raising the quality of these very important dimensions of the teaching process. Of the dimensions of the teaching process, under the weakest influence of the dimensions of satisfaction with communication are the dimensions TP8 - Learning, TP3 - Communication and cooperation and TP6 - Correlation and application of knowledge.

All dimensions of communication satisfaction have a statistically significant and positive effect on students' personal and ethical development, with the impact on the SED - Student Ethical Development dimension being greater than on the SPD - Student Personal Development dimension.

Concrete proposals for improving the quality of the teaching process, personal and ethical development of students, are aimed at primary school principals because they are leaders in their organizations and many dimensions in the field of organizational behavior depend on them the most. First of all, primary school principals need to be aware of their important and key role in improving various aspects of organizational behavior in schools. As part of this, principals need to pay significant attention to the development of quality communication in the team and, thus, satisfaction

with teacher communication. This will certainly contribute to improving the quality of the teaching process, personal and ethical development of students. It is also important that the implementation of this proposal does not require special financial investments, as well as excessive engagement of the director.

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Student's Success Prediction in the Secondary Level of Education Using a Linear Regression Model

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Abstract - The paper presents research about the use of linear regression model for the analysis of the interrelation of the grades by subject in 1st semester to a final grade of class (after 2nd semester) in secondary school education level. The authors used linear regression to create equations for description relation between grades as independent variables and rating (final grade) as a dependent variable. Final grade calculates as an average of all subjects' grade. The research was based on the set of data related to the success of Persian-Bosnian College students, Bosnia and Herzegovina. This research should help educational institutions to predict students' success, i.e., the final grade of semesters of 1st and 2nd class based on subjects' grades in 1st semester of 1st class. Based on this pre-diction, educational institutions can make the teaching processes more efficient and be more attractive for future students.

I. INTRODUCTION

The secondary level of the education system in Bosnia and Herzegovina aims to prepare students for entry into the labor market or higher education. The primary quality indicator is students' success and school management policy to help students to achieve better success [1].

Management of secondary schools is under a considerable challenge to prepare students for entry into a highly competitive, dynamic, high-tech, complex, and interdisciplinary global labor market and higher education environment. They can respond to that challenge by equipping their students with appropriate knowledge, skills, and competences [2]. One of the significant changes in the education market of Bosnia and Herzegovina is the continuous activity of high school managers to achieve a better position in the education market. The market struggle is caused not only by competition between public and private schools but also by the presence of a lot of organizations that offer various informal programs. Although this type of education cannot be compared with formal education, it is a fact and, as such, must be considered [4]. For example, these organizations offer a comprehensive list of short-term specialized courses to citizens [5-6]. Such learning delivery platforms put pressure on institutions providing formal education to upgrade their curriculum continually and finally define a more flexible educational process. The goal is to maintain systems' standards concerning learning outcomes.

Regression analysis is a statistical technique for investigating and modeling the relationship between variables and is used to build a prediction model, i.e., the best fitted model with minimum squared errors of the fitted values and further applied to data for continuous value predictions.

In the process of the curricula development and implementation, the decisions what is to be taught, for what reasons, and how learning should look like are crucial for the success of curricula. In order to ensure successful achievement of planned learning outcomes, the curricula have to be carefully designed and implemented.

The way parts of the curricula are designed, their complexity and volume, and their sequence within curricula are defined by the Ministry of education, which is a competent state institution.

That is why the authors raised the question: is it possible by using linear regression analysis to determine equations for describing the relation between grades by courses (subjects) of 1st semester of 1st class and final grade of another semester of 1st and 2nd class.

The educational process is divided into two parts. 1st and 2nd classes make the first part and subjects are the same for all students in both classes. 3rd and 4th classes are considered as a second part, and subjects depend on students' choice. Research is performed using data from 1st and 2nd class only.

The research aims to determine the degree of impact of successes achieved in 1st semester of 1st class to the success achieved on a later semester during the 1st and 2nd class.

II. METHODOLOGY

Within the research, the set of data related to the success of students of Persian-Bosnian College is used. The final grade of every semester is the average of subjects' grades. There is not any kind (especially not mathematical equation for calculating) relation between subjects' grades of 1st semester of 1st class and final grade of other semesters.

Aims of research are to:

a) define the relation between grades from 1st semester of 1st class and final grade of 2nd semester of 1st class and final grade of 1st and 2nd semester of 2nd class

b) using linear regression model create an equation for description relation between grades as predictors (independent variables) and final grade as a response (dependent variable)

The research consists of 4 cases. Aim of all cases is to determine the linear regression model between subjects' grades of 1st semester of 1st class and final grades of all other semesters. The analysis was performed on 1st, and 2nd class because curricula are the same and consist of the same subjects (courses). This paper presents linear regression equation for subjects' grades of 1st semester of 1st class versus 1st semester of 2nd class.

If schools' management has early information about the potential worst success of students (lower grades), it can organize the additional support for students to help them successfully pass the courses recognized as potentially challenging for most of them.

The analysis was performed in R programming language using packages: RSQLite and dplyr [7], [8].

Accuracy, precision, recall, and F-measure are parameters used within research to determine the models' efficiency. Accuracy is the necessary parameter, but for more reliable results of efficiency, it is advisable to use other parameters. In order to determine the values of the efficiency parameters, it is necessary to create a confusion matrix [9]. The general form of the confusion matrix is given in Table 1.

TABLE I. The general form of confusion matrix [9]

		Actual	
		T	N
Predicted	T	True positive (TP)	False positive (FP)
	N	False negative (FN)	True negative (TN)

Using the marks from the confusion matrix, the parameters can be represented by the following expressions.

$$accuracy = \frac{TP + TN}{TP + FN + FP + TN} (1)$$

Accuracy represents the percentage of correctly classified instances in the data set.

$$precision = P = \frac{TP}{TP + FP} (2)$$

Precision (also called positive predictive value) is the number of positive predictions divided by a total number of positive class values predicted.

$$recall = R = \frac{TP}{TP + FN} (3)$$

Recall (also called the true positive rate, the sensitivity) is the number of positive predictions divided by the number of positive class values in the test data.

$$F - measure = \frac{2 \cdot R \cdot P}{R + P} (4)$$

F-measure (also F-score or F1 score) is a measure of a test's accuracy. That is, the harmonic mean (average) of the precision and recall, and F-measure is the best when precision (P) and recall (R) are balanced [18].

III. RESULTS

Figure 1 shows the process flow. The process is starting with data preprocessing. After the pivot table is created, and the missing value is imputed, the appropriate table from the database is connected, and data is attached to the data frame. The Data frame is divided to train and test data. Using a training dataset linear regression model is created. The created model is evaluated, and if the model is good enough, it is used for prediction on test data. Prediction results are evaluated by creating confusion matrix and calculating accuracy, precision, recall, and F-measure.

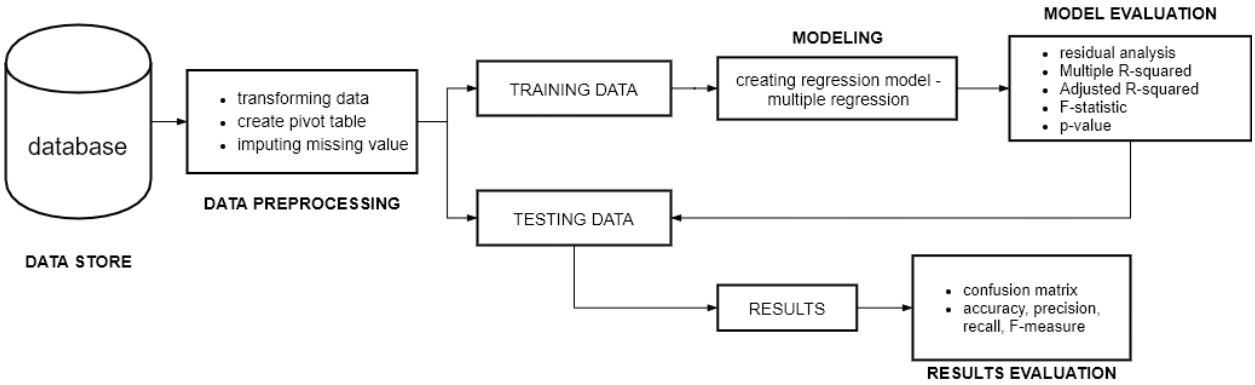

Figure 1: Diagram process flow

IV. CASE STUDY

All subjects of 1st semester of 1 class as predictors

Aim of case study is to define the linear regression model between the final grade of 1st semester of 2nd class and grades by subjects of 1st semester of 1st class.

New data frame c2s1 (class_2_semester_1) is created using data frame class_2_rating. The new data frame is consisted of grades by the subject of 1st semester of 1st class and 1st semester of 2nd class final grade.

There is not subject with p-values smaller than 0.1, and they will not be performed next iteration with a new linear regression model consist of these subjects' grades as predictors.

It was created diagnostic plot of model. The red line on the bottom-left plot is relatively flat in range 1-4 of fitted values. Generally, the red line in the bottom right plot is partially flat regarding the dashed line. On the plot exists two Cook's distance values (0.5, 1), but there is no point which lies outside of Cook's distance, so this is very good fit regression.

Regression equation - all subjects' grades of 1st semester of 1 classes predictor

class_2_sem_1 ≈ -0.009362 + 0.090047s3_a + 0.126428s5_a + 0.393115s6_a-0.226720s11_a + 0.273442s12_a - 0.191545s13_a - 0.063349s14_a - 0.119358s15_a-0.102640s16_a + 0.110209s19_a + 0.075932s623_a + 0.226710s773_a + 0.344334s5021_a

Prediction is performed on test dataset, i.e. data frame prediction_c2s1_a. Quality of prediction is checked by confusion matrix.

TABLE II: Accuracy, precision, recall, and F-measure for case study

Accuracy	Precision	Recall	F-measure
0.7	0.7777778	0.875	0.8235294

All parameters (accuracy, precision, recall and F-measure) have high values, so the model is rated as very good.

V. EXPERIMENTAL RESULTS DISCUSSION - PROOF OF HYPOTHESIS

This research is based on Statistical Learning. Experimental results show success in proof of concept and proof of the hypothesis. Aim of all cases is to define linear regression model final grade of semesters of 1st and 2nd class against grades by subjects of 1st semester of 1st class.

All models' residuals are small. Medians of all models are close to 0. Distinctions 3Q and 1Q are low (≈ 0.01), and the absolute value of distinction 1Q and 3Q to the median are low (lower than 0.01). F-statistics are predominantly excellent. P-values of all models are lower than 0.1. The degrees of freedom are relatively small. Multiple R-squared and adjusted R-squared are close to 0.

The diagnostic plot checks models of quality for all cases for training and confusion matrix for the testing phase.

The diagnostic plot consists of 4 plots: residuals vs. fitted values, standardized residuals, square root of standardized residuals, and standardized residuals vs. leverage. Fitted values are grade in the range of 1 to 5.

The first plot is residuals versus fitted values plot. The red line on the plot is a smooth curve regarding residuals, and the dotted gray line is the regression line. The analyzed case red line has a low deviation

in the range of 1 to 4. In the range of 4 to 5 red line has a high deviation.

The second plot or Normal Q-Q plot shows the normal of residuals. If all residuals lie close to the gray dash line, residuals are normally distributed. The analyzed case residuals lie close to the gray dash line.

The third plot is used to measure the square root of the standardized residuals against the fitted value. If the red line is relatively flat, the assumption is correct. The analyzed case red lines are not so flat, but values are in the range of size 1 or lower, so it is concluded that assumptions are correct.

The fourth plot shows standardized residuals versus leverage. The leverage is a measurement of how each data point influences the regression. The last plot contains the Cook distance line, too. Cook's distance is a measure of how influential an instance is to the computation of a regression. The case analyzed mostly have not points which are outside Cook's distance.

Accuracy, precision, recall, and F-measure values of all cases, except case 4, are high.

The important factor of research is dataset size. Dataset has 126 rows, so training dataset in all cases have 88 rows. Even the number of rows is low, linear regression models in most cases have relatively high to very high prediction. The assumption is that greater dataset size can lead to a better model, i.e., better pre-diction.

VI. CONCLUSION

In this paper, results prove that linear regression can be trained to provide a platform for predicting the success of students based on their grades achieved on 1st semester of 1st class, i.e., at the beginning of secondary schooling. If we consider that each learning outcome builds over several different subjects, linear regression can also be used to check the definition of learning outcomes in a given curriculum.

Research is limited to predicting student success in first and second class in high school. The generalization to other classes and types of schools is not possible. According to the high school curriculum, all students in the first and second classes of high school attend the same subjects. In the third and fourth classes, students study in separate programs. Other types of schools educate students for different kinds of professions. For example, one school educates students for electricians, civil and mechanical technicians, and education of each profession types realize by the separate curriculum. In this case, the research plan for predicting students' success of each profession type should be set up differently.

Future research can be related to predicting students' success of third or fourth class in high school based on success in the first semester of the first class. Also, future research will expand the current model with other prediction methods as well as additional datasets from the different educational institutions on the current level and on other educational levels.

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Guidelines for Development of Edutainment Video Games

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Abstract – Learning through play is an effective and attractive educational strategy, especially with younger students. Edutainment media is a teaching tool that aims to teach while simultaneously amusing the students. Edutainment content followed the invention of every new type of multimedia, including video games (EVG) and has been used as an auxiliary teaching tool ever since. However, it could be argued that the entertainment aspect was often overlooked, leading to a negative reputation for edutainment content in general. Analysis of existing edutainment media can be used to form guidelines that would prevent future content from falling into the same pitfalls and amuse, as well as educate.

I. EDUTAINMENT

Edutainment arguably predates the inception of multimedia, with learning through play as a concept being observed in prehistoric humans as well as in the animal kingdom [1]. The word "edutainment" itself has been officially coined relatively recently with the earliest documented use dating back to Walt Disney in 1954[2].

Edutainment encompasses media designed to possess the allure of entertainment while attempting to convey educational content. Since the early 1990s there was a surge in edutainment-centric video games. EVG titles have since been successfully used for teaching children mathematics, geography, history, etc. for decades, and some of them have grown into multi-million dollar franchises [3].

A. Edutainment Target Audience

Primarily aimed at children, EVGs focus on learning through exploratory activities, not traditional school-based teaching methods that often fail to make learning fun [4]. Stated objectives in edutainment often have very little to do with the actual objectives since activities driven by exploration, discovery and adventure in an interactive environment are more appealing to children than learning in a formal classroom setting[5].

B. Questionable EVG quality

Some EVGs arguably fail to either motivate or educated the players [6], with Karl Royle stating that

Figure 1. Carmen Sandiego™ is arguably the most famous edutainment multimedia franchise

"Such efforts have failed either because games designed to educate do not engage their intended audience, or because truly engaging games do not provide enough educational value"[7].

One major issue of current approaches is the lack of design rules to ensure their effectiveness, which have found challenges with using leisure games effectively in learning contexts, particularly in terms of setting and assessing specified learning objectives. Attempts at a bait-and-switch approach may initially get the players' attention, but it almost guaranteed that they will not only quickly loose interest, but also be put off from playing the game, again [8].

Differences in teaching approaches between different age groups are often ignored in EVGs, as players' demands grow along with them [9]. Certain teaching methods are also not equally effective across different age groups [10].

Some EVGs also decide on a genre inappropriate for the game's subject matter [11].

Analyzing existing edutainment content does show certain trends that could be used to form

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guidelines to avoid common pitfalls in the future [12].

II. METHODS OF LEARNING

Children learn the most easily through observation [13] or cognitive osmosis, meaning that they'll make a conclusion about the rules that apply in a given context from a series of presented situations. EVGs allow players to infer what rules apply within the world of the game based on the actions they took within situations they found themselves in.

A. General Learning Model in EVGs

General learning model (GLM) attempts to explain the relationship between exposure to media and the internal processes that form long term cognitive attitudes.

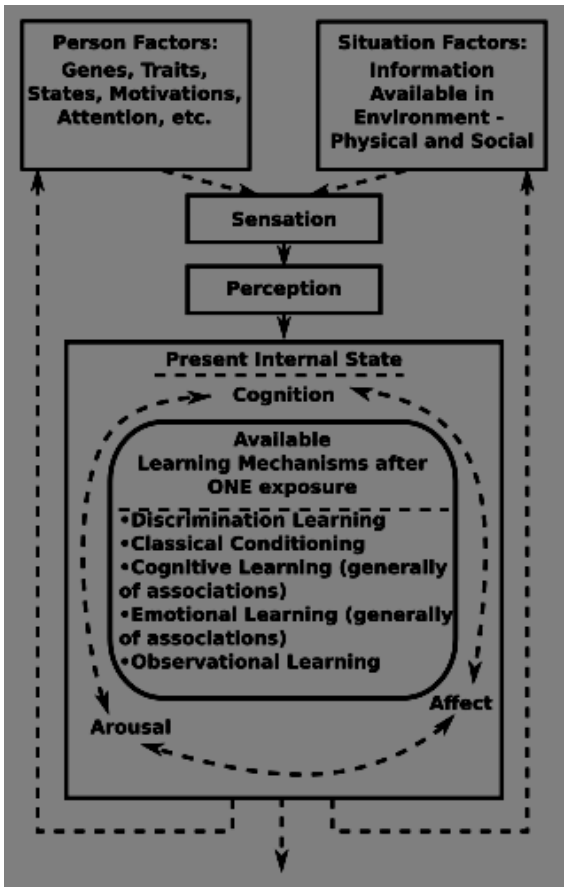

Figure 2. General Learning Model flowchart

An important aspect of GLM is that it takes into consideration learning on multiple levels of consciousness.

There are three basic reactions in the brain during gameplay [14]:

- The received visual, audible and other stimuli are processed instinctively and emotionally.
- The stimuli are compared to memories of previous experiences.
- The frontal cortex will be activated and an attempt will be made to logically explain to the player what happened based on the previous two reactions.

Short term memory is formed based on those three steps of observations. Long term memory is formed through repetition of the situation that forms the short term memory through trial and error. Finally, the brain gradually shapes long term memories into applicable knowledge.

Repeated stimulation of the same brain structure can cause conditioned responses to form.

Association is important because if players notice two or more concepts simultaneously and repeatedly, they will consider them connected in some way, even if they can't explain exactly how [15].

B. Learning Through Observation

The players start off observing other people's behavior and not knowing exactly how specific tasks are done [16]. The observer then takes over the command and starts actually playing the game.

Depending on the players' previous level of experience, the first few seconds or minutes of the game can draw them into the game, or make them completely loose interest in it.

EVGs' primary advantage over other forms of edutainment multimedia is that they provide immediate feedback to the players depending on their actions [17].

Edutainment is rarely a replacement for classical learning, but it can nevertheless be a very useful tool for getting younger children interested in subjects they would otherwise avoid, as well as for instilling prior knowledge for classical future teaching [18].

III. GAMEDEV GUIDELINES

A. Video Games in General

Most general video game development (gamedev) guidelines apply to EVGs. Some of the relevant factors include:

- Bushnell's law that states "All the best games are easy to learn and difficult to master" applies to the entertaining aspect of the EVG's gameplay mechanics [19].
- Player's reactions to success and failure can differ greatly depending on whether they're depicted realistically or comically stylized. Realism should be avoided in certain situations, especially if the game is trying to

get the players to think and act in a way they're not accustomed to [20].

- Graphics influence the players' experience and the amount of risk they're willing to take. The more abstract they are, the more risk the player is willing to take [21].
- The game's narrative has to be immersive in order to keep players' attention [8].
- A threat from a villain, whether it be humanoid, or abstract is important for initially getting the player's attention [22].
- The goal of the game should be clearly defined and ultimately simple [23].
- The player will feel certain negative emotions after making a mistake, more so if it's effects are irreversible, and especially if they perceive the mistake as the game's fault and not their own [24].
- If the players' actions lead to them advancing through the game, they will feel positive emotions, unless they consider the positive result was achieved too easily [24].
- Whether the game is single player or multiplayer also influences the players decision making. Peer pressure is an important factor [25].

B. EVG Specific Guidelines

- The game's genre should be pertinent to the subject it is supposed to be teaching, if possible [26].
- If aimed at younger players, the game's graphics and sound design should be child friendly. Symbolic 2D graphics are preferable, except in specific cases where orientation in 3D space in an integral part of the subject matter [27].
- Goals the game expects the player to achieve must be appealing to the target demographic and age group [24].
- Interface, gameplay mechanics, as well as difficulty levels should be age appropriate [24].
- Implementation of reward and punishment system discussed in chapter II is relatively easy in EVGs, with actions the developers wanted the player to take being rewarded, and actions the developers did not want them to take being punished.
- Educational aspect should be indirect and possibly subconscious. If players notice sudden interruption of the gameplay abruptly stops so the educational aspect can be focused

Figure 1. The Sims™ is not classified as an edutainment title, but it does possess certain characteristics of the genre.

on, they will feel frustration and possibly loose interest in playing the game any further [28].

- Educational aspect must not overshadow the entertaining aspect of the game, otherwise the player will loose interest in playing the game [12].
- Knowledge transfer in EVGs can be relatively quick and easy, while application of knowledge gained through such means takes a certain period of time to adapt [24].

C. EVGs and Simulations

Simulations, while usually considered a separate genre often overlap with edutainment as well as video games made purely for the purposes of entertainment. While titles like The Sims™ are not advertised as educational per se, it has been observed that they teach the players' skills like multi-tasking, architecture, design, etc [29].

Educational potential of games not specifically designed to educate remains largely unexplored [30].

IV. Conclusion

Over a century of research has shown that there isn't enough conclusive evidence that knowledge learned through play can be applied in the real world without additional classical teaching and training. Edutainment, however, still remains a powerful auxiliary teaching tool that can make classical teaching methods easier and more effective [14].

Long term results can only be ascertained when the students learn about the subject matter in a more classical fashion, especially if their results are compared to those of students who weren't provided

with edutainment content earlier in life. Nevertheless, some immediate positive effects edutainment has had in areas where there is trouble garnering the students' interest in a particular subject and imparting some basic knowledge of it have been demonstrated by several studies[6].

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Fourier Analysis Through Examples Using Wolfram Mathematica

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Abstract - The representation of a function in the form of a series is fairly common practice in mathematics. Fourier series is an expansion of a periodic function $f(x)$ in which base set is the set of sine and cosine functions. In attempt to define the Fourier series of a nonperiodic functions is obtained the Fourier transform, as a continuous representation. In this paper we provide the Fourier series on several functions, define on $[-\pi,\pi]$, $[-l,l]$, or $[a,b]$. Also, through examples we discuss whether the Fourier transform of some function exist or not, and we consider some properties, such as linearity; Fourier transform of the operator for modulation, translation and time-frequency shift. Then using the mathematical package Wolfram Mathematica, we visually present the results that we obtain for Fourier series and Fourier transform, which in fact is real and complex function, respectively.

I. INTRODUCTION

Fourier analysis deals with analysis of a functions in terms of and in relation with Fourier series expansion and Fourier transform. The idea of expanding a function in the form of series, in which the base is the set of sine and cosine functions, was given by French physicist Joseph Fourier in 1807 as a result of necessity to solve practical problems in physics, such as heat-flow problems, wave propagation and diffusion. The Fourier series expansion first was given for a periodic function, then in an attempt to define it of a nonperiodic functions is obtained the Fourier transform, as a continuous representation. Even more, the Fourier transform can be considerate as a ready-made tool, which has application in several areas, such as mathematics for solving differential equation; signal and system analysis. More about Fourier analysis one can find in [1,3,4, 6].

In this paper we make a short review of the fundamental results for Fourier series and Fourier transform. Then we provide the Fourier series of continuous function, function with one finite discontinuity and continuous function extended to an odd function (see example 1, 2, 3). The Fourier transform of an odd and even function, and translation and modulation of some function is given in example 4, 5 and 6, respectively. In all examples we visually present the obtained results, using the mathematical package Wolfram Mathematica.

II. PRELIMINARIES

A. *Fourier series expansion*

Let $f(x)$ is 2π-periodic function. If the trigonometric series

$$\frac{a_0}{2}+\sum_{n=1}^{\infty}(a_n\cos nx+b_n\sin nx) \qquad (1)$$

converges uniformly on $(-\pi,\pi)$, and its sum is the function $f(x)$, i.e.

$$f(x)=\frac{a_0}{2}+\sum_{n=1}^{\infty}(a_n\cos nx+b_n\sin nx),\ x\in(-\pi,\pi),$$

then for coefficients a_0, a_n and b_n hold

$$a_0=\frac{1}{\pi}\int_{-\pi}^{\pi}f(x)dx,\qquad a_n=\frac{1}{\pi}\int_{-\pi}^{\pi}f(x)\cos nxdx,$$

$$b_n=\frac{1}{\pi}\int_{-\pi}^{\pi}f(x)\sin nxdx.$$

The coefficients a_0, a_n and b_n are called Fourier coefficients, and the series (1) is Fourier series expansion. The corresponding exponential Fourier series expansion is

$$f(x)=\sum_{n=-\infty}^{\infty}c_n e^{inx},$$

where $c_n=\frac{1}{2\pi}\int_{-\pi}^{\pi}f(x)e^{-inx}dx,\ n\in\mathbb{Z}$.

If $f(x)$ is an even function on interval $(-\pi,\pi)$, then its Fourier series expansion is $\frac{a_0}{2}+\sum_{n=1}^{\infty}a_n\cos nx$, $a_n=\frac{2}{\pi}\int_0^{\pi}f(x)\cos nxdx$, $n=0,1,..$; and if it is an odd function, its Fourier serie expansion is $\sum_{n=1}^{\infty}b_n\sin nx$, $b_n=\frac{2}{\pi}\int_0^{\pi}f(x)\sin nxdx$, $n=1,2,\ldots$.

Dirichlet's Theorem: Let $f(x)$ is defined on $[-\pi,\pi]$. If the function $f(x)$ satisfied the Dirichlet's conditions on $[-\pi,\pi]$, i.e. it has a finite number of isolated maxima and minima, and a finite number of points of finite discontinuity, then the Fourier series expansion of $f(x)$ uniformly converges to $S(x)$ at all points on $[-\pi,\pi]$, for which hold:

1. $S(x)=f(x)$, where $f(x)$ is continuous;
2. At the points of discontinuity hold
$$S(x)=\frac{f(x-0)+f(x+0)}{2};$$
3. At the end points of $(-\pi,\pi)$ hold
$$S(-\pi)=S(\pi)=\frac{f(-\pi+0)+f(\pi-0)}{2}.$$

The same theorem hold if the function $f(x)$ is defined and satisfied the Dirichlet's condition on $(-\pi,\pi)$, $(-\pi,\pi]$, $[-\pi,\pi)$, $[a,b]$, (a,b), $(a,b]$ or $[a,b)$, $a,b\in\mathbb{R}$.

If the function $f(x)$ is defined on $[-l,l]$, and satisfied the Dirichlet's conditions then its Fourier series has the form (1), such that the argument in sine and cosine functions is $\frac{n\pi x}{l}$ instead of nx, and the integration is from $-l$ to l. If a function is defined on $[a,b]$, then $l=\frac{b-a}{2}$.

B. Fourier transform

Let $f(x)$ is periodic function with period l, $l\in\mathbb{R}^+$, which is defined and satisfied Dirichlet's condition on $[-l/2,\ l/2]$. Its exponential Fourier series expansion is

$$f(x)=\sum_{n=-\infty}^{\infty}c_n e^{\frac{2\pi inx}{l}}, \qquad (2)$$

where

$$c_n=\frac{1}{l}\int_{-l/2}^{l/2}f(x)e^{\frac{-2\pi inx}{l}}dx,\ n\in\mathbb{Z}.$$

If we consider the coefficients c_n as a function F from variable $\frac{n}{l}$, i.e.

$$F\left(\frac{n}{l}\right)=\int_{-l/2}^{l/2}f(x)e^{\frac{-2\pi inx}{l}}dx, \qquad (3)$$

then for the Fourier series expansion (2) we obtain

$$f(x)=\sum_{n=-\infty}^{\infty}\frac{1}{l}F\left(\frac{n}{l}\right)e^{\frac{2\pi inx}{l}}. \qquad (4)$$

Now, if l tends to infinity in (3), the range of $f(x)$ will be from $-\infty$ to ∞, and let we redefine n to be the "frequency," which we denote with ω, i.e.

$$F(\omega)=\int_{-\infty}^{\infty}f(x)e^{-2\pi i\omega x}dx. \qquad (5)$$

The function $F:\mathbb{R}\to\mathbb{R}$ is called the Fourier transform of the function $f(x)$, and we will use the notation $\hat{f}$ or $\mathcal{F}$ when we consider it as an operator. The Fourier transform (5) exist whenever $\int_{-\infty}^{\infty}|f(x)|dx<\infty$. When l tends to infinity, the continuous form of (4) is $f(x)=\int_{-\infty}^{\infty}F(\omega)e^{2\pi i\omega x}d\omega$, such called the inverse Fourier transform.

If $f(x)$ is an even function on $(-\infty,\infty)$, it's Fourier transform is $\hat{f}(\omega)=2\int_0^{\infty}f(x)\cos 2\pi x\omega$, and if it is an odd, then $\hat{f}(\omega)=-2i\int_0^{\infty}f(x)\sin 2\pi x\omega$.

The linearity of the Fourier transform is an important property. For $b,a\in\mathbb{R}$, with $T_b f(x)=f(x-b)$ and $M_a f(x)=e^{2\pi iax}f(x)$ we denote the operator for translation and modulation, respectively, and with $T_b M_a$ and $M_a T_b$ the time frequency operators, such that $T_b M_a f(x)=e^{-2\pi iba}M_a T_b f(x)$. Even more, one can prove that $\mathcal{F}(T_b f)=M_{-b}\hat{f}$, $\mathcal{F}(M_a f)=T_a\hat{f}$, $\mathcal{F}(T_b M_a f)=e^{-2\pi iba}T_a M_{-b}\hat{f}$, (see e.g. [1]).

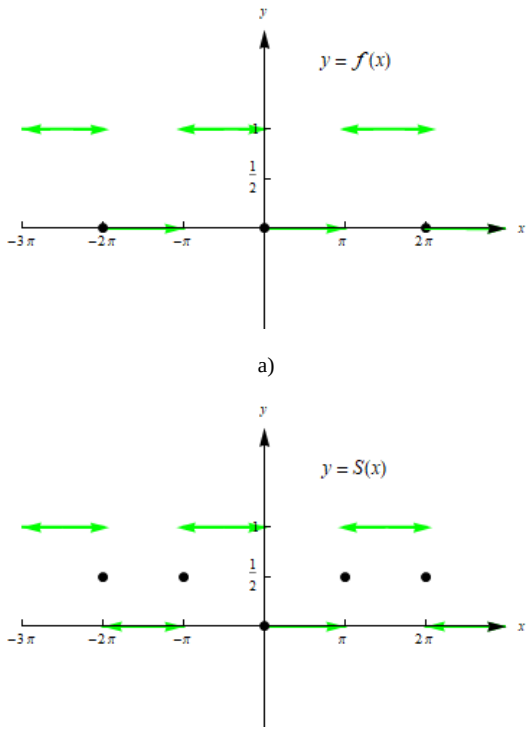
III. MAIN RESULTS

In this section through examples we visually present the Fourier series expansion of continuous function and function with points of discontinuity defined on different interval (see example 1, 2, 3). Also, we provide the Fourier transform of an odd, even function and translation and modulation of some function, (see example 4, 5, 6). In example 7 we consider functions for which Fourier transform does not exist.

Example 1. Let $f(x)=\begin{cases}1, & -\pi<x<0\\ 0, & 0\le x<\pi\end{cases}$ is 2π-periodic function. By Dirichlet's theorem the Fourier series expansion is

$$S(x)=\frac{1}{2}-\frac{2}{\pi}\left(\sin x+\frac{1}{3}\sin 3x+\frac{1}{5}\sin 5x+\cdots\right),$$

equal to $f(x)$ for all $x\in\mathbb{R}\setminus\{k\pi, k\in\mathbb{Z}\}$ (see Fig.1).



a)

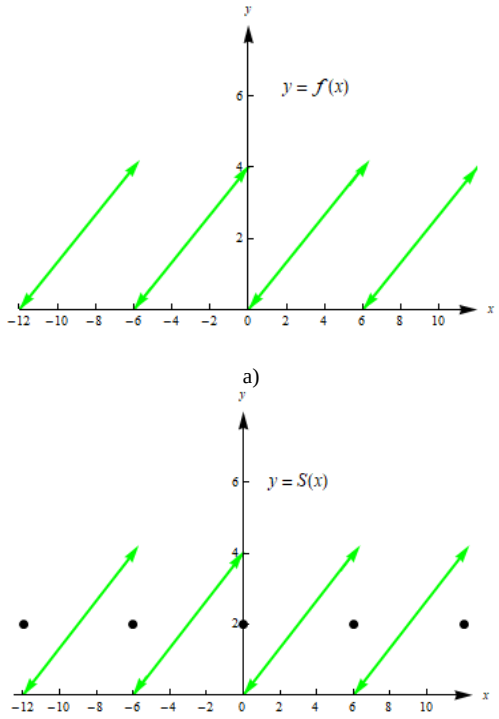
b)

Figure 1. a) Function $f(x)=\begin{cases}1, & -\pi<x<0\\ 0, & 0\le x<\pi\end{cases}$; b) Its Fourier series expansion.

Example 2. Let $f(x)=\frac{2x}{3}$, with period 6 on $(0,6)$. By Dirichlet's theorem the exponential Fourier series expansion is

$$S(x)=\sum_{\substack{n=-\infty\\ n\neq 0}}^{\infty}\frac{-2}{in\pi}e^{\frac{in\pi x}{3}},$$

equal to $f(x)$ for all $x\in\mathbb{R}\setminus\{6k, k\in\mathbb{Z}\}$ (see Fig.2).



a)

b)

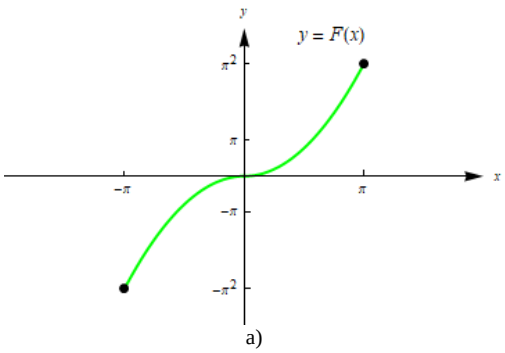
Figure 2. a) Function $f(x)=\frac{2x}{3}$; b) Its Fourier series expansion.

Example 3. Let $f(x)=x^2$ for $x\in[0,\pi]$. We define the odd function $F(x)=\begin{cases}x^2, & x\in[0,\pi]\\ -x^2, & x\in[-\pi,0]\end{cases}$.

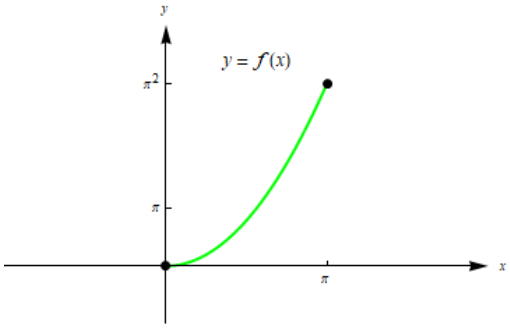
By Dirichlet's theorem the Fourier series expansion of the function $F(x)$ is

$$S(x)=2\pi\sum_{n=1}^{\infty}(-1)^{n+1}\frac{\sin nx}{n}-\frac{8}{\pi}\sum_{n=1}^{\infty}\frac{\sin(2n-1)x}{(2n-1)^3}, \quad (6)$$

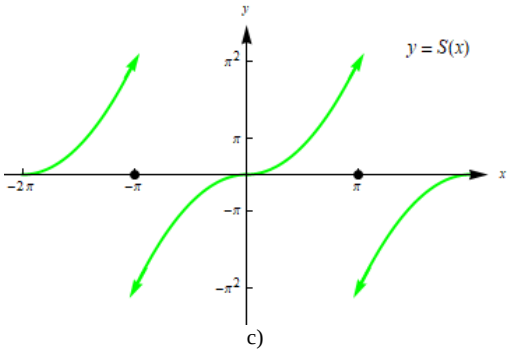
$x\in(-\pi,\pi)$. Because $F(x)$ is extension of $f(x)$, the Fourier series expansion of the function $f(x)$ is the same function in (6), but for $x\in(0,\pi)$ (see Fig.3).



a)



b)



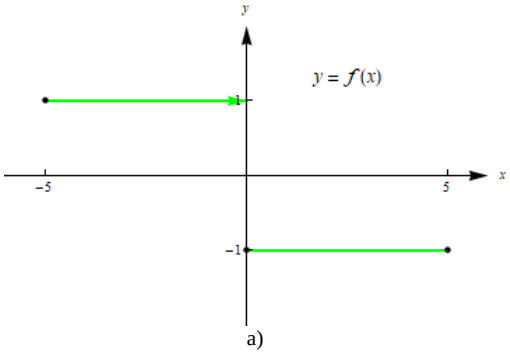
c)

Figure 3. Function a) $f(x) = x^2$; b) $F(x) = \begin{cases} x^2, & x \in [0, \pi] \\ -x^2, & x \in [-\pi, 0] \end{cases}$;
c) Fourier series expansion of $f(x)$ and $F(x)$.

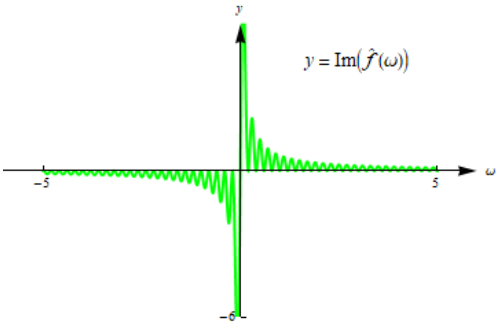
Example 4. The Fourier transform of the function $f(x) = \begin{cases} A, & x \in [-T, 0) \\ -A, & x \in [0, T] \end{cases}$, $A,\ T > 0$ is

$$\hat{f}(\omega) = 2Ai\int_0^T \sin(2\pi\omega x)dx = \frac{Ai}{\pi\omega}\left(1 - \cos(2\pi\omega T)\right).$$

On Fig.4 is given the graphic of the function and the imaginary part of its Fourier transform for $A = 1$ and $T = 5$.



a)



b)

Figure 4. a) Function $f(x) = \begin{cases} 1, & x \in [-5, 0) \\ -1, & x \in [0, 5] \end{cases}$;
b) Imaginary part of its Fourier transform.

Example 5. For the Fourier transform of the function

$$f(x) = \begin{cases} \cos 3x, & -\pi \le x \le \pi \\ 0, & \text{otherwise} \end{cases}$$

we obtain

$$\hat{f}(\omega) = \int_0^{\pi} (\cos(3 + 2\pi\omega)x + \cos(3 - 2\pi\omega)x)dx$$

$$= \frac{\sin(3 + 2\pi\omega)\pi}{3 + 2\pi\omega} + \frac{\sin(3 - 2\pi\omega)\pi}{3 - 2\pi\omega}$$

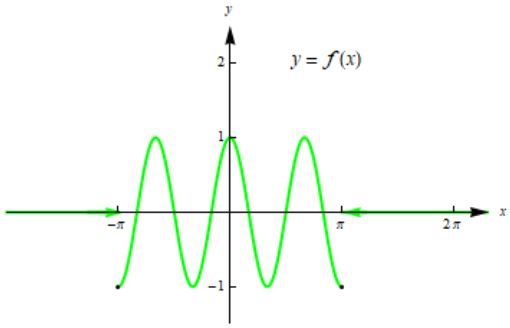
$$= \frac{6\sin 3\pi\cos 2\pi^2\omega - 4\pi\omega\cos 3\pi\sin 2\pi^2\omega}{9 - 4\pi^2\omega^2}$$

$$= \frac{4\pi\omega\sin 2\omega\pi^2}{9 - 4\pi^2\omega^2}.$$

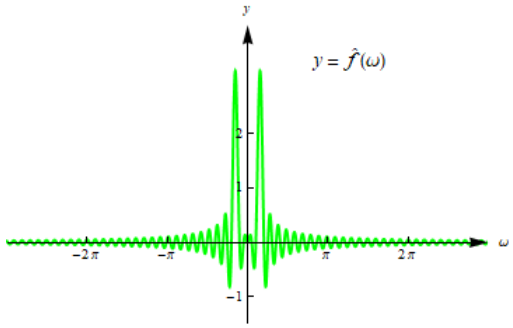
On Fig.5 one can see the graphic of the function and its Fourier transform.

Example 6. Let $f(x) = \begin{cases} 1, & x \in [1, 2] \\ 0, & \text{otherwise} \end{cases}$. The translation and modulation of the function $f(x)$ for $b \in \square$ and $a \in \square$, is defined as $T_b f(x) = \begin{cases} 1, & x \in [1 + b, 2 + b] \\ 0, & \text{otherwise} \end{cases}$ and

$M_a f(x) = \begin{cases} e^{2\pi i x a}, & x \in [1, 2] \\ 0, & \text{otherwise} \end{cases}$, respectively.



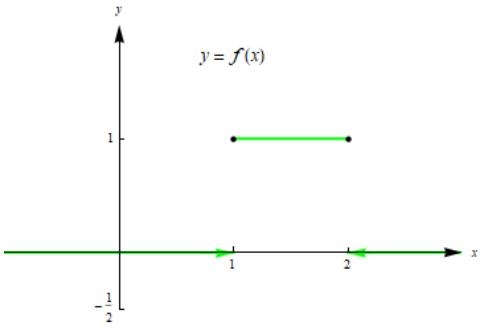
a)



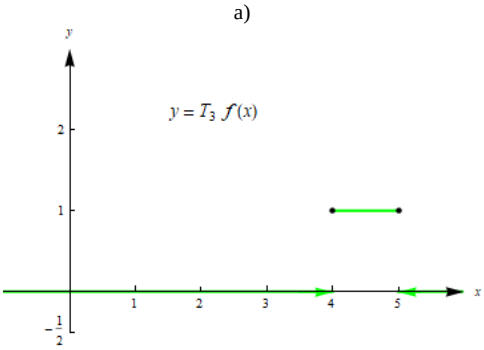
b)

Figure 5. a) Function $f(x) = \begin{cases} \cos 3x, & -\pi \le x \le \pi \\ 0, & \text{otherwise} \end{cases}$; b) Its Fourier transform.

On Fig.6 and 7 one can find the translation for $b = 3$ and $b = -3$, and the real and imaginary part of the modulation for $a = 2$ and $a = 4$ of the function $f(x) = \begin{cases} 1, & x \in [1, 2] \\ 0, & \text{otherwise} \end{cases}$, respectively.



a)



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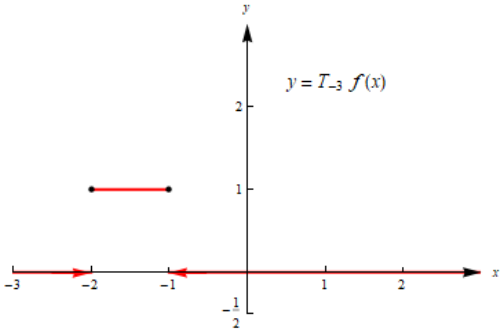
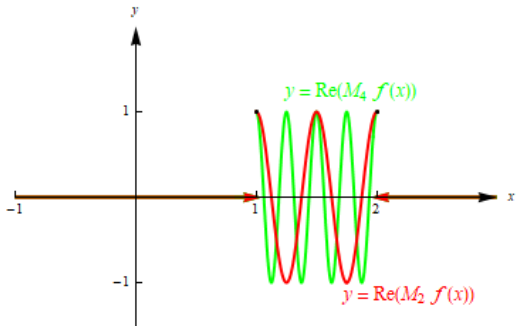


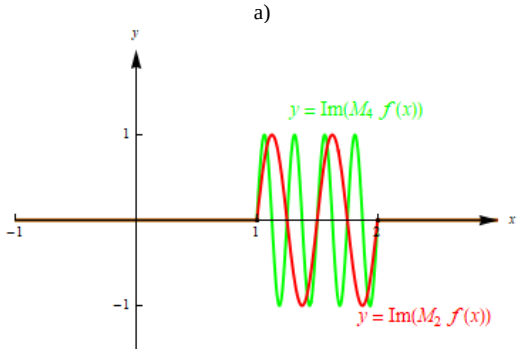
c)

Figure 6. a) Function $f(x) = \begin{cases} 1, & x \in [1, 2] \\ 0, & \text{otherwise} \end{cases}$; Translation of $f(x)$ b) for $b = 3$; c) for $b = -3$.

It is clear that the Fourier transform of functions $f(x)$, $T_b f(x)$, $M_a f(x)$, $b,\ a \in \mathbb{R}$ exist.



a)



b)

Figure 7. a) Real; b) Imaginary part of modulation of the function $f(x) = \begin{cases} 1, & x \in [1, 2] \\ 0, & \text{otherwise} \end{cases}$ for $a = 2$ and $a = 4$.

For the Fourier transform (see Fig. 8) of the function $f(x)$ we obtain

$$\hat{f}(\omega) = \int_1^2 e^{-2\pi i x\omega} dx = -\frac{e^{-4\pi i\omega}}{2\pi i\omega} + \frac{e^{-2\pi i\omega}}{2\pi i\omega}$$

$$= i\frac{e^{-4\pi i\omega} - e^{-2\pi i\omega}}{2\pi\omega}$$

$$= \frac{\cos(3\pi\omega)\sin(\pi\omega)}{\pi\omega} - i\frac{\sin(3\pi\omega)\sin(\pi\omega)}{\pi\omega}.$$

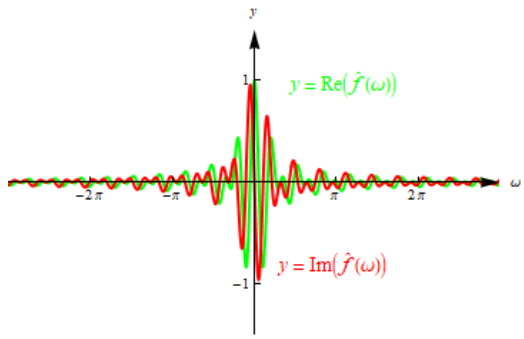


Figure 8. Real and imaginary part of the Fourier transform of the

function $f(x)=\begin{cases}1, & x\in[1,2]\\ 0, & \text{otherwise}\end{cases}$.

For the Fourier transform of translation of $f(x)$ we have

$$\mathcal{F}\,(T_b f)(\omega)=M_{-b}\hat{f}(\omega)=i\frac{e^{-2\pi i\omega(b+2)}-e^{-2\pi i\omega(b+1)}}{2\pi\omega}$$
$$=\frac{\cos(\pi\omega(2b+3))\sin(\pi\omega)}{\pi\omega}$$
$$-i\frac{\sin(\pi\omega(2b+3))\sin(\pi\omega)}{\pi\omega}.$$

On Fig. 9 one can find the real and imaginary part of the Fourier transform of translation for $b=3$ and $b=-3$, such that we use green color for $b=3$ and red color $b=-3$.

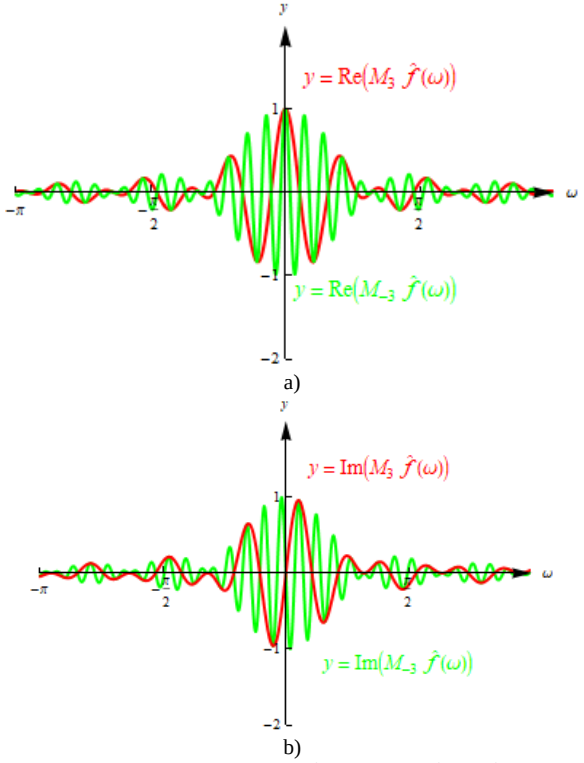


Figure 9. a) Real; b) Imaginary part of Fourier transform of translation of function $f(x)=\begin{cases}1, & x\in[1,2]\\ 0, & \text{otherwise}\end{cases}$.

And, for the Fourier transform of $M_a f(x)$ we obtain

$$\mathcal{F}\,(M_a f)\,(\omega)=T_a\hat{f}(\omega)$$
$$=\frac{\cos(3\pi(\omega-a))\sin(\pi(\omega-a))}{\pi(\omega-a)}$$
$$-i\frac{\sin(3\pi(\omega-a))\sin(\pi(\omega-a))}{\pi(\omega-a)}.$$

The real and imaginary part of the Fourier transform of the modulation for $a=2$ and $a=4$, is given on Fig. 10, such that we use red color for $a=2$ and green color for $a=4$. Let we note that, when the parameter a increase, the graphic of real (resp. imaginary) part of Fourier transform of modulation translates on right, and when a decrease, the graphic of real (resp. imaginary) part of Fourier transform of modulation translates on left (see Fig. 10, a) (resp. Fig. 10, b)) .

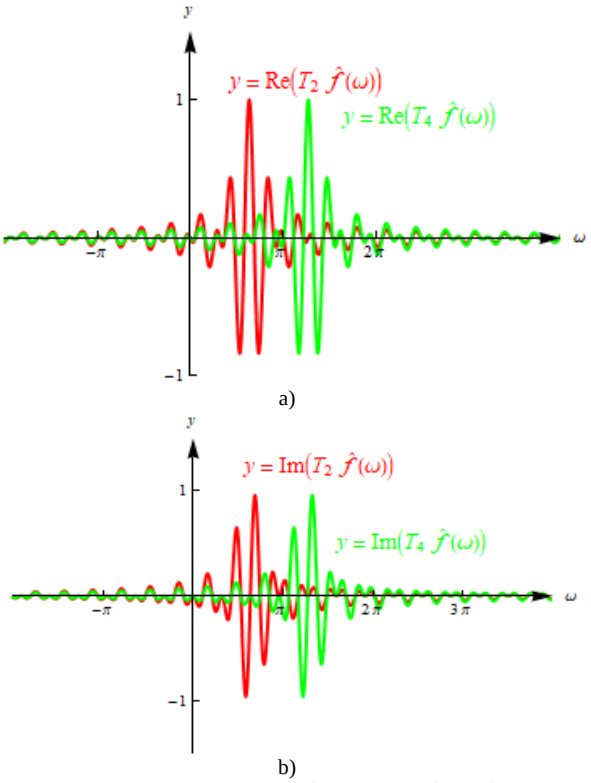


Figure 10. a) Real; b) Imaginary part of Fourier transform of modulation of function $f(x)=\begin{cases}1, & x\in[1,2]\\ 0, & \text{otherwise}\end{cases}$.

Example 7. The Fourier transform of the functions: $f(x)=1$ and $f(x)=x$, $-\infty<x<\infty$; $f(x)=x^n$, $n>1$, $-\infty<x<\infty$; $f(x)=e^{ax}$ and $f(x)=e^{-ax}$, $a>0$, $-\infty<x<\infty$, does not exist because $\int_{-\infty}^{\infty}|f(x)|dx$ is not finite.

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Review: The use of Augmented and Virtual Reality in Education

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Abstract – The COVID-19 pandemic has a severe impact on education all over the world. The closures of educational institutions affected teaching and learning processes and had an impact on students' motivation and engagement. In this context, AR/VR technology can provide assistance to students and support for educators. This paper presents a review of literature on augmented and virtual reality in educational settings in the last 5 years. In total 23 research studies were included in the study. Target group, field of education, reported advantages, limitations and concerns have been investigated and reported. The findings showed that students' learning can benefit both technologies by increasing engagement, motivation, collaboration and learning achievement.

I. INTRODUCTION

The lockdowns in response to COVID-19 have interrupted conventional schooling in almost every country in the world. To keep the children learning, countries have been implementing various digital tools and application. During this period, e-learning platforms have been widely used for providing teaching and learning activities. However, in some areas where practical training is required, online learning platforms are not sufficient for acquiring the required knowledge. One opportunity on the horizon is expanding the use of immersive computing technologies, like augmented, virtual or mixed reality (AR/VR/MR), that create new modes for users to experience digital content.

These technologies are affordable and readily available. They can help us transform our immediate surroundings into learning, work and entertainment spaces. Learning in an AR/VR environment has been found to increase recall [1], to develop muscle memory for specific tasks [2] to increase student learning motivation and contribute to improved academic achievement [3, 4].

In the current COVID-19 scenario, AR/VR technologies are extremely useful in providing remote one-to-one scalable training and education, especially when group training or lectures are no longer viable options. They strive to empower energy of the classroom, energize connection to one another and find new ways to deepen experiences. For both educators and students, AR/VR are quickly proving to have unique benefits, many of which are incredibly well suited to this moment.

A considerable amount of literature has been published in AR/VR applications in educational contexts for a wide variety of learning domains and level of education. The aim of this article is to review literature regarding the use of augmented and virtual reality in educational settings, published in last 5 years. All articles are categorized according to target groups, field of education, reported advantages, limitations and concerns.

II. BACKGROUND

Augmented reality (AR) combines real and virtual world, supplementing the real world with computer-generated virtual objects in real-time [5, 6]. AR acts as a bridge between real world and virtual environment by providing synchronous interaction. It uses pre-determined target points in real world by connecting virtual objects and interpreting the results through certain programs. AR is enriching user's perception of the reality rather than totally replacing it [7], like in the case of the virtual reality.

In virtual reality (VR) the user is completely immersed inside a synthetic environment and can not perceive the real world and the real environment that surrounds him/her (the real world is shut out and the user steps into a digital world).

Mixed reality (MR) brings together real world and digital elements, breaking down basic concepts between real and imaginary. In MR, user can interact with and manipulate both physical and virtual items and environments, using next-generation sensing and imaging technologies. The Milgram's Reality-Virtuality continuum [8] clearly shows the location of MR as well as relation between a real environment, AR and a VR environment (Fig. 1).

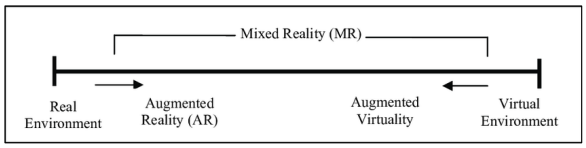

Figure 1. Reality-Virtuality continuum

III. METHOD

In this review study the Arksey and O'Malley's (2005) five-stage framework is utilized. The five stages of this framework are: (1) identifying research questions, (2) identifying relevant studies, (3) study selection, (4) charting the data, (5) summarizing and reporting the results.

A. Identifying research questions

The aim of this review was to explore the literature regarding the use of AR/VR application in educational scenarios. In order to capture the relevant research studies, following research questions were posed to guide the research:

- What technologies are being used?
- Which target groups are covered with the research articles?
- Which fields of education are covered with the research articles?
- What are reported advantages of using AR/VR applications in educational setting?
- What are reported limitations and concerns of using AR/VR applications in educational setting?

B. Identifying relevant studies

To cover a broad range of studies regarding the use of AR/VR in education, the search was performed using the following keywords: "Augmented reality", "AR", "Virtual reality", "VR". The literature source was the Science direct and Eric databases. Relevant papers were considered only papers published in last 5 years (from 2016 to August 2020). This was considered appropriate due to the rapid technology development and the wider use of AR/VR applications in education.

C. Study selection

Twenty-three research studies were selected and included in this review. These articles were selected according to the following inclusion/exclusion criteria.

Inclusion criteria:

- Papers published in the last 5 years;
- Studies that are carried out in formal education context;
- Studies in which an evaluation with end users has been conducted;
- Studies where an AR/VR application is integrated with or applied in teaching-learning process, and learning outcomes are reported.

Exclusion criteria:

- Papers explaining some commercial application, present on market, but not scientifically based;
- Previews of thesis and dissertations, or review papers;
- Papers containing only methodology, platform or framework explaining the approach;
- Papers explaining only the design of AR/VR application;
- Studies that are carried out in informal or non-formal learning contexts.

C. Charting the data

A brief summary of all selected articles is presented in Table 1.

TABLE 1. STUDIES INCLUDED INTO REVIEW

Authors	**Title**	**Application type used in the study**
Harun, Neha Tuli , Archana Mantri	"Experience Fleming's rule in Electromagnetism Using Augmented Reality: Analyzing Impact on Students Learning"	AR
Bhanu Charma, Archana Mantri	"Assimilating Disruptive Technology: A New Approach of Learning Science in Engineering Education"	AR (marker based)
Guido Bozzelli, Antonio Raia, Stefano Ricciardi, Maurizio De Nino, Nicola Barile, Marco Perrella, Marco Tramontano, Alfonsina Pagano, Augusto Palombini	"An integrated VR/AR framework for user-centric interactive experience of cultural heritage: The ArkaeVision project"	AR and VR
Michelle Aebersold, Terri Voepel-Lewis, Leila Cherara, Monica Weber, Christina Khourie , Robert Levine, Alan R. Tait	"Interactive Anatomy-Augmented Virtual Simulation Training"	AR

Jeferson Arango-López, Carlos C. Valdivieso, Cesar A. Collazos, Francisco Luis Gutiérrez Vela, Fernando Moreira	"CREANDO: Tool for creating pervasive games to increase the learning motivation in higher education students"	AR (marker based)
Jared A. Franka , Vikram Kapilaa	"Mixed-reality learning environments: Integrating mobile interfaces with laboratory test-beds"	AR (marker based), MR
Mark Durham, Benjamin Engelb , Thomas Ferrill, Jaron Halford, Tejinder P. Singh, Michael Gladwell	"Digitally Augmented Learning in Implant Dentistry"	VR
Dilara Sahina and Rabia Meryem Yilmazb	"The Effect of Augmented Reality Technology on Middle School Students' Achievements and Attitudes Towards Science Education"	AR
Lissette Lopez-Faican, Javier Jaen	"EmoFindAR: Evaluation of a mobile multiplayer augmented reality game for primary school children"	AR (location based)
Ayman F.A. Foad, MD	"Comparing the use of virtual and conventional light microscopy in practical sessions: Virtual reality in Tabuk University"	VR
Nikolche Vasilevski and James Birt	"Analysing construction student experiences of mobile mixed reality enhanced learning in virtual and augmented reality environment"	AR and VR
Garcia-Bonete, Maria-Jose; Jensen, Maja; Katona, Gergely	"A Practical Guide to Developing Virtual and Augmented Reality Exercises for Teaching Structural Biology"	AR and VR
Sara K. Sweeney, Phyllis Newbill, Todd Ogle & Krista Terry	"Using Augmented Reality and Virtual Environments in Historic Places to Scaffold Historical Empathy"	VR
Stotz, Megan; Columba, Lynn	"Using Augmented Reality to Teach Subitizing with Preschool Students"	AR
Christian Moro Zane Štromberga Athanasios Raikos Allan Stirling	"The effectiveness of virtual and augmented reality in health sciences and medical anatomy"	AR and VR
Cihak, David F.; Moore, Eric J.; Wright, Rachel E.; McMahon, Don D.; Gibbons, Melinda M.; Smith, Cate	"Evaluating Augmented Reality to Complete a Chain Task for Elementary Students with Autism"	AR (marker based)
Baran, Bahar; Yecan, Esra; Kaptan, Burak; Pasayigit, Ozan	"Using Augmented Reality to Teach Fifth Grade Students about Electrical Circuits"	AR
Liou, Wei-Kai; Bhagat, Kaushal Kumar; Chang, Chun-Yen	"Beyond the Flipped Classroom: A Highly Interactive Cloud-Classroom (HIC) Embedded into Basic Materials Science Courses"	AR and VR
Nasser Alalwana, Lim Chengb , Hosam Al-Samarraiec, Reem Yousefd, Ahmed Ibrahim Alzahrania, Samer Muthana Sarsam	Challenges and Prospects of Virtual Reality and Augmented Reality Utilization among Primary School Teachers: A Developing Country Perspective	AR and VR
Sáez-López, José-Manuel; Sevillano-García, M. Luisa; Pascual-Sevillano, M. Ángeles	"Application of the Ubiquitous Game with Augmented Reality in Primary Education"	AR
Taskiran, Ayse	"The Effect of Augmented Reality Games on English as Foreign Language Motivation"	AR
Buchner, Josef; Zumbach, Jörg	"Promoting Intrinsic Motivation with a Mobile Augmented Reality Learning Environment"	AR
Vega Garzón, Juan Carlos; Magrini, Marcio Luiz; Galembeck, Eduardo	"Using Augmented Reality to Teach and Learn Biochemistry"	AR

All articles were categorized according to field of education, reported advantages, limitations and concerns in educational setting.

"Target group" category refers to the level of education of participants in the experiments in which the study of AR/VR in education was carried out, or level of education for which the AR/VR application is intended. The following target group were identified: early childhood, primary school, secondary school, high school and all levels of

education. Fig. 2 shows the results of this classification.

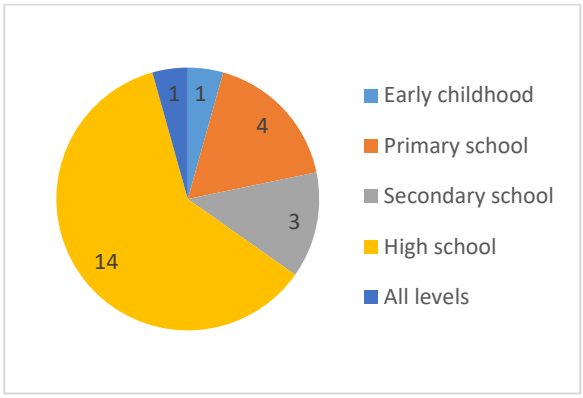

Figure 2. Target groups of reviewed articles.

Results show that AR/VR technology has been mostly carried out in high school education. On the other hand, all other target groups, especially early childhood education, need further research regarding the use of this technology in education.

Regarding "Fields of education", analyses show that "engineering studies" is the most explored field of education, while "math", "chemistry" and "foreign language" are the least explored. Fig. 3 summarizes the results regarding the use of AR/VR by field of education.

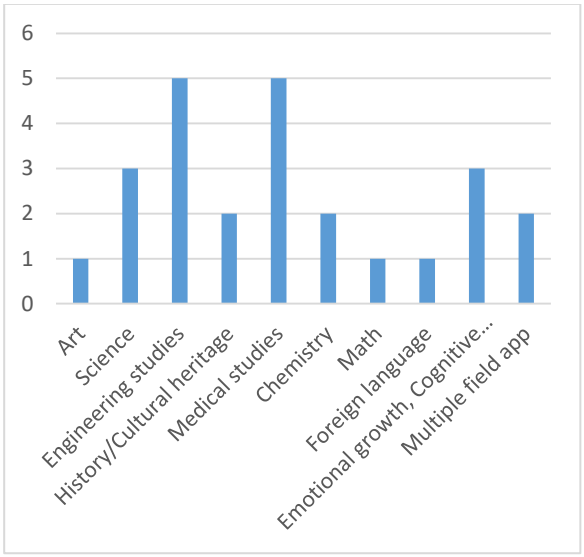

Figure 3. Using AR/VR by field of education.

Another category analyzed in this review is "Reported advantages" of AR/VR in educational settings. Since one study can report more than one advantage, each study can meet more than one sub-category. Table 2 shows the results of the reported advantages identified in the analyzed studies.

TABLE 2. REPORTED ADVANTAGES OF AR/VR IN EDUCATIONAL SETTINGS.

Advantages (sub-categories)	**Number of studies**	**Percentage (%)**
Engagement	5	21,74
Motivation	6	26,09
Interest	5	21,74
Learning Achievement	8	34,78
Improved memory	4	17,39
Enjoyment	9	39,13
Interaction with the objects/environment	4	17,39
Positive Emotion	3	13,04
Perception	3	13,04
Low anxiety	3	13,04
Communication/ collaboration	9	39,13
Cost saving	2	8,70
Ease to use	2	8,70

From the results, it can be seen that the major advantages reported in the studies are: "Communication/collaboration", "Enjoyment" and "Learning achievement". The results show that AR/VR is a promising technology for improving learning achievement and provide new opportunities for students to communicate and collaborate with the teachers and with each other. This technology also helps students enjoy the learning process.

Category "Limitations/Concerns" aims to identify the reported limitations and concerns of AR/VR technology when used in educational settings. It should be noted that not all articles reported limitations. Table 3 summarizes these results.

Studies included in this review outlined several limitations/concerns regarding the use of AR/VR applications in education. The most reported limitation/concerns are "Technical issue", followed by "Small sample size" and "Motion sickness/dizziness".

TABLE 3. REPORTED LIMITATIONS/CONCERNS OF AR/VR IN EDUCATIONAL SETTINGS.

Limitations/Concerns	Number of studies	Percentage (%)
Motion sickness/ dizziness	4	17,39
Small sample size	5	21,74
Technical issues	6	26,09
Short evaluation time	3	13,04
Complexity	1	4,34
Not specified in the study	8	34,78

D. Summarizing and reporting the results

A considerable amount of literature has been published in AR/VR application in various domains. However, the state of current research in AR/VR for education domain is still in its infancy. The research in this field should continue and should be addressed to discover the affordances of AR/VR applications in education.

In total 23 studies were analysed in this review, by using the content analysis method. Analysis shows that AR/VR technology has been mostly carried out in high school education [9, 10, 12, 13, 14, 15, 18, 19, 20, 21, 23, 26, 29, 31], with the highest percentage in medical and engineering studies. This technology enables students better visualization and superior educational interface as compared with their standard training methods [12], improves students' mental map [15], significantly improves their level of content knowledge [14, 15, 18], enhanced engagement, enjoyment, motivation and participation [19, 23, 25], improves students' outcome [9], reduces the subjectivity of assessment process and determine student progress [31]. In primary school AR/VR technology was used to provide emotional growth, cognitive skills and social interaction [17], to promote exploratory behavior and develop a positive attitude [27 and to learn new skills [24]. AR/VR applications positively affects students' achievement throughout the learning process also in secondary education [16]. This innovative technology facilitates students' success making the course and its content more exciting. Moreover, students actively participate in the lessons and ask the teacher more questions, they are more motivated and eager to use this technology [16, 25, 30].

Most of the studies included in this review revealed the fact that the use of AR/VR technology enhances learning achievement, which is in line with the previous studies [32, 33, 34]. This technology promotes active learning and turns passive learners into active learners by engaging them in interactive assignments [26]. It succeeds to provide better learning achievement [16, 28, 30], foster collaboration [17, 29, 31], increase engagement [16, 17, 19, 23] and motivation within the scale interest/enjoyment [10, 19, 23, 30].

Although AR/VR technology in formal education has many advantages and is valuable for desired educational outcomes, there are some technical problems that need to be overcome. Vasilevski and Birt [19] reported negative experiences with the technology, mainly with the control. There were also some concerns about the devices overheating, the discomfort and weight of the headsets [19]. Some participants found that the touchscreen devices were too sensitive and unintuitive to control, while virtual object behaved unrealistically [20]. A potential issue that can have an impact on learning experiences and assessment results when using VR is cybersickness, which can result in motion sickness, dizziness, disorientation, discomfort, headache, fatigue, difficulty concentrating, and problems with vision [11, 19, 23]. This was one of the major concerns reported in the studies. The other important limitation that was pointed out is small sample size (number of participants involved in the evaluation process) [12, 19, 23]. The lack of an appropriate sample size in which AR/VR applications are integrated with teaching-learning processes limits the researchers to generalize their findings. Therefore, future studies need to be conducted with a larger number of participants, in order to confirm the research findings.

IV. CONCLUSION

AR/VR technology has attracted attention in education field with its ability to allow interaction with virtual objects in real environment, thus enabling learning by doing. In a period of world pandemic, when the whole educational process is transferred online, AR/VR technology can create a physical engagement between the learner and their environment. It engages the student's senses and enhances learning by immersing them in a world rich in both information and experience.

The aim of this article is to review literature regarding the use of augmented and virtual reality in educational settings, published in last 5 years. We consider factors such as target groups, field of education, reported advantages and limitations/concerns of using AR/VR technology in education. The findings of this review illustrated a set of studies that provide evidence of increased learning achievement, students' engagement,

motivation, and collaboration through the educational environments that are enriched with AR/VR applications. However, some concerns and limitations regarding these technologies were reported, which need to be minimized and overcome in the future research.

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Implementation of the Unified Information System of Education in Higher Education - Significance and Effects

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Abstract - The paper discusses the expected effects and the importance of implementation of the Unified Information System of Education-UISE to higher education. It is assumed that UISE is established and regulated by the Law on the Fundamentals of the Education System in the education system, which will encompass pre-university education and higher education. It is also assumed that UISE represents one of the most important instruments for achieving higher education reforms, which would lead to its modernization and internationalization. The main effect of introducing of UISE is that the State gets a picture of the entire education system in one place. Other expected effects may include: development of usable records for the state, e.g. statistical data related to students and study programs, data on institutions and employees; on the basis of which the analysis of resources, success of the higher education system and projections of investments in it can be performed. Raising the IT capacity of higher education contributes to the development of e-government in the Republic of Serbia. The introduction of UISE significantly contributes to the reforms of higher education, especially in the segment of perceiving its advantages and disadvantages, but also in the field of opening up to the environment and moving towards EU integration.

I. INTRODUCTION

In accordance with the context, directions and goals of the current Strategy for the Development of Education in the Republic of Serbia until 2020-SDES [1], mechanisms have been developed that will enable higher education: to become a competent part of the European education area (according to documents: Agenda 2030 in Serbia [2], Strategy of Scientific and Technological Development of the Republic of Serbia [3], Challenges in Higher Education [4]); to become attractive for international cooperation and provision of educational services in the immediate vicinity of the Republic of Serbia and in the Western Balkans [1]; to improve its work and use its own resources more rationally towards achieving goals in the future. In order to implement the SDES and enable the State to act in the entire education system, a set of amendments has been made to the Law on the Fundamentals of the Education System [5] and the Law on Higher Education [6,7]. Relevant bylaws have also been implemented.

This paper discusses the importance and expected effects of implementation of UISE on the development of higher education. It is assumed that in the education system only one law, i.e. the Law on the Fundamentals of the Education System [5], establishes and regulates UISE, which will cover pre-university education and higher education. Accordingly, the Law on Higher Education [7] represents the so-called related regulation. It is also assumed that UISE represents one of the most important instruments for achieving higher education reforms, which would lead to its modernization and internationalization.

II. LEGAL BASIS FOR THE INTRODUCTION OF UISE

The original legal basis for the introduction and functioning of UISE in higher education is the Law on the Fundamentals of the Education System [5]. It regulates the matter of UISE at all levels of education, which makes it important to be applied in practice. Bylaws regulate in more detail the mechanism of functioning of UISE; manner and procedure of introducing it and the use of the Personal Educational Number-PEN for the needs of UISE; key leaders and executors, monitoring and reporting instruments within the UISE.

It must be emphasized that the provisions of the Law on the Fundamentals of the Education System [5] related to UISE, are harmonized with the Law on Personal Data Protection, which is a very important fact in the electronic society to which the Republic of Serbia aspires.

A. The role of the Law on the Fundamentals of the Education System

The provisions of Articles 175 and 176 of the Law on the Fundamentals of the Education System [5] regulate the implementation of UISE and PEN.

UISE is a set of databases and computer programs, necessary for the collection and processing of data in records and registers, while ensuring the protection of personal data. The higher education institution, i.e. the institution of student standard keeps records on children, adults and students covered by formal education, on students' parents as well as on employees [5].

The Ministry of Education, Science and Technological Development-Ministry, within the UISE keeps the following registers [5] relevant to higher education:

- ✓ accredited higher education institutions;
- ✓ accredited study programs;
- ✓ students;
- ✓ employees in higher education institutions.

Data from the records kept by the higher education institution are entered and updated in the mentioned registers [5]. The Government Service is a data processor in accordance with the regulations governing e-government and information security.

For the needs of keeping the mentioned registers [5] and protection of personal data, the PEN is formed, which follows its holder through all levels of formal education (and through non-formal education). The PEN is the key to linking all data about the child, student, as well as adult learner and candidate for attending short study programs within higher education system [5].

The PEN is an individual and unique label consisting of 16 characters and which is assigned to a child, pupil, adult and student in an automated procedure through the UISE at the request of the institution, higher education institution. The PEN is assigned at the first enrollment at the institution, and upon verifying the data against the data from the records kept by other bodies in electronic form [5]. Personal data may be processed for the purpose of compiling statistical reports in a manner that does not enable the disclosure of personal data, in accordance with the relevant regulations. The manner of assigning PEN and applying security measures is prescribed by the Minister of Education, Science and Technological Development [5].

B. The Role of the Law on Higher Education

According to the provisions of Articles 114 and 115 of the previously valid versions of the Law on Higher Education [6], a framework for the introduction of the UISE and the assignment of the PEN was defined. The provisions were very similar to the current provisions of the Law on the Fundamentals of the Education System [5] but were only partially harmonized with the Law on Personal Data Protection, in the Records section. Amendments to the Law on the Fundamentals of the Education System [5], that is, the introduction of the current articles, made it possible for Articles 114 and 115 in the Law on Higher Education [7] to cease to be valid.

In this way, the Law on the Fundamentals of the Education System [5] took over the authority to introduce the UISE and the PEN in higher education while harmonizing these regulations with the Law on Personal Data Protection. The Law on Higher Education [7] became the so-called related regulation, which is in accordance with the assumption used in this paper.

By harmonizing regulations [5,7] in the period from 2018 to 2020, the UISE has become an instrument for connecting different levels of education, which enables monitoring of all participants in the educational process through a system. The basic goal of its introduction has been achieved.

C. The Rulebook on the Unified Information System of Education

The Rulebook on the Unified Information System of Education - The Rulebook [8] regulates in detail the conditions and manner of establishing the UISE and registers [5], collecting and entering and updating data entered in registers, types of statistical reports based on data from the register [8]. The Rulebook is a bylaw, which originated from the Law on the Fundamentals of the Education System [5]. It is applied in higher education institutions which are obliged to keep registers. The data from the records kept by the institutions need to be consistent with the data in the UISE. In order to establish the UISE and its full functioning in all segments, it is necessary for the higher education institution to access the system through its access account, but with the use of the PEN. The procedure of assigning the PEN to a student when enrolling at a higher education institution (provided the PEN was not assigned to him in the previous level of education) is defined by the Rulebook on

detailed conditions and the procedure of assigning the Personal Education Number [9].

The UISE is established and managed by the Ministry. The Ministry provides the higher education institutions with conditions for the safety and security of technical equipment and software, as well as the necessary resources for the functioning of the UISE [8].

The register of higher education institutions contains the following general data on the higher education institution [8]:

1. legal status: name and seat of the institution; founder; number and date of work permit; number and date of the accreditation certificate; the date of the beginning of the work of the higher education institution; registration number; Taxpayer ID; contacts; current account of budget / own funds;
2. the status of the higher education institution in the higher education system;
3. study programs: name, type, degree, scope, field of study, accredited number of students; number and date of the accreditation certificate, decision of the professional body on the abolition of the study program;
4. realized short study programs and issued certificates;
5. tuition fee;
6. the weekly number of classes according to the study program for each year for lectures and exercises;
7. the language in which the study program is realized;
8. the number of budget and self-financing students per study program and per year of study;
9. facilities inside and outside the seat;
10. legal documents of the higher education institution: Memorandum of Association and Articles of Association;
11. the bodies of the higher education institution;
12. the accreditation of the higher education institution and the results of the external evaluation of the institution;
13. sources of financing: data on financial resources from the budget and from own revenues; data on their spending;
14. other data of importance for the development of the higher education system and for inclusion in the European Higher Education Area.

The institution enters and updates the following data in the register of accredited study programs, [8]:

1) Accredited study program, accreditation, type of studies, scientific field and area, language in which it is conducted, tuition fee, number of budget and self-financing students per year of study, number of students who have completed the study program, other data on the realization of the study program.

2) data on short study programs.

The higher education institution enters and updates data (via its access account and via the PEN entry) [8]:

1. on the student: age, place and country of birth, country of residence, nationality;
2. in order to determine the educational status of the student: previously completed education, language in which the previous education was acquired, the enrolled study program, type of study, year of study, year of first enrollment at the study program, year of completion of the study program, data on ECTS credits and issued documents;
3. in order to determine the social status of the student: the way of financing the studies, the way of providing living expenses during the studies, the use of the student loan, the work status during the studies, parents' level of education;
4. in order to determine a student's health status.

III. EXPECTED EFFECTS OF IMPLEMENTATION OF THE UISE ON HIGHER EDUCATION

The main effect of the introduction of the UISE is that the Government gets a picture of the entire education system in the Republic of Serbia in one place. It is reasonably expected that there are numerous short-term, medium-term and long-term effects of the introduction of the UISE (with the application of the PEN) on higher education.

The UISE has been designed and its implementation has started in order to provide IT support to the rational functioning of the higher education system, but also as a tool for its modernization.

The introduction and functioning of UISE can produce the following effects on higher education:

- ✓ better organization / simplification, efficiency, effectiveness, reliability of business processes in higher education institutions and in the whole system;
- ✓ greater transparency in the work of higher education institutions;
- ✓ unification of the type of data, which higher education institutions exchange with the Ministry;
- ✓ reducing the need for complicated individual information systems for keeping records in institutions;
- ✓ raising the IT basis for the modernization of the process of managing the work of the institution as well as management decision-making based on reliable and verified information;
- ✓ more efficient resource planning and resource management;
- ✓ rationalization of the existing way of financing and preparation of a new model of financing higher education;
- ✓ simplification of monitoring all activities in higher education institutions.
- ✓ quick and comprehensive overview of all relevant data on study programs, institution, employees and students;
- ✓ complete analysis of the higher education system, preparation of statistical reports in order to evaluate the performance of the institution and / or the entire education system;
- ✓ establishing the so-called feedback in communication between domestic higher education institutions; domestic higher education institutions with economy and public administration; higher education system with international organizations and relevant institutions;
- ✓ IT support for monitoring development indicators in the field of higher education as a step towards integration into the European Higher Education Area;
- ✓ obtaining accurate and precise data on the state of higher education as a starting point for personnel and financial reform.

Work of institutions with registers of accredited higher education institutions; accredited study programs; students and employees; enables the Ministry and the Government to monitor in one place the number of pupils and students, the number of employees at all levels of education, the transition from pre-university to university education. It also provides the opportunity to monitor students from enrollment at primary school through the completion of secondary school to the completion of higher education and their employment. The registers make it possible to monitor the total number of active students during each school year, which has clear implications in the design of budget expenditures for their education.

Indirectly, by statistical processing of data from various registers, the Government can have an overview of the total number of higher education students in the Republic of Serbia and an overview of the number of graduates by scientific fields / areas or school years (or other given criteria of interest for specific analysis).

The structure of graduate students by study programs and scientific fields / areas is a very important piece of information for employers in the economy. Employers are given the opportunity to find professional and competent staff according to their needs through the UISE, and at the same time that staff has legally valid diplomas. UISE also provides feedback to employers on the state higher education system. According to the requirements of employers, the Ministry can encourage the creation and accreditation of certain study programs that produce graduates with pre-defined employment opportunities. A search of the registers of accredited higher education institutions and accredited study programs provides a comprehensive insight into the higher education market and implies raising its competitiveness. Accredited higher education institutions operate on the basis of the Certificate of accreditation of the Institution and the study programs, issued by the National Entity for Accreditation and Quality Assurance. The issued Certificates represent a guarantee of fulfillment of conditions according to the appropriate Standards for accreditation and ensuring the quality of work according to the Bologna principles.

The student register speeds up and facilitates the process of student mobility, but checks the legality of the degree they have obtained.

Based on the data from the UISE, the Ministry can prepare appropriate statistical reports in order to analyze the work or performance of the education system and take corrective measures in order to improve or optimize resources. With the introduction of UISE, the Ministry can also monitor in real time how much money has been invested in the education of each student and how much return on that investment (through allocations for taxes and contributions by employers) can be counted on. In the long run, the Government will be able to assess which higher education institutions are more successful and which study programs are more attractive for students, and to realistically create an educational policy based on these data.

It must be emphasized that the UISE recognizes a student exclusively by the PEN. Publicity of personal data is no longer required. The use of data from the UISE (along with the PEN) should enable a simpler procedure for the transition of a future student from pre-university to university education while respecting their social status and objectively evaluating the results achieved in high school.

IV. CONCLUSION

The Law on the Fundamentals of the Education System is a key basis for the introduction of UISE in higher education. The legal framework defines the key leaders and executors, monitoring instruments, reporting procedures in the UISE. In this way, the UISE becomes an important instrument for modernizing the work of higher education institutions and a tool for higher education reforms.

Based on the analysis of data from the UISE and statistical reports, the Ministry of Education, Science and Technological Development as well as other government departments of the Republic of Serbia: can draw reliable conclusions about the current situation in higher education, can make accurate decisions for modernization of higher education, can design measures for implementing reforms and approaching the European Higher Education Area.

It can be considered that the final outcome of the introduction and implementation of the UISE will enable raising the quality of life of the citizens of the Republic of Serbia from the aspect of simplifying the communication procedures of the persons interested with the higher education system while reducing costs of communication. This represents a step towards the development of e-government and the information society as a whole.

The further course of work could include an analysis of the structure of individual registers that higher education institutions are obliged to keep in accordance with the considered regulations, a detailed elaboration of the role of UISE and PEN at all levels of education, etc.

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Education and Knowledge Improvement of Employees in Driving Schools in the Republic of Serbia

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Abstract: Traffic safety largely depends on the previous training that the driver has received. In the Republic of Serbia, formal training in driving schools is mandatory. The quality of training depends on the knowledge, experience and skills of the employees (instructors) who work in driving schools, and how effectively they transfer knowledge to their candidates/learners. This paper presents a research that shows the importance of education, knowledge, skill, and improvement of knowledge of employees in driving schools for the overall quality of training. This research included 74 respondents (N=74) of different expertise, as well as different demographic categories The results of the research indicated that there is a statistically significant correlation between the analyzed dimensions Importance of acquired knowledge during education; Importance of seminars and tests for knowledge improvement; Importance of independent learning on knowledge improvement; Importance of practical exams; Importance of knowledge and its improvement for quality training) and control variables (gender, age and education).

I INTRODUCTION

The modern society is characterized by constant changes, which has led to the need for constant improvement of knowledge. In such a turbulent environment, knowledge is a key resource for successfully conducting business. Knowledge needs to be effectively managed and needs to be constantly improved. As in all areas of business, so in the field of traffic safety, knowledge plays a key role. Namely, in order to increase traffic safety, it is necessary to start from the beginning - driving schools. Given the fact that young drivers fall in the high-risk group of drivers, and are most likely to cause a traffic accident, it is necessary to bring training in driving schools to the highest possible quality. Hence, there is a necessity for improving education and knowledge of driving school employees. According to the Law on Traffic Safety in the Republic of Serbia, all employees in driving schools (lecturers of theoretical training, driving instructors and examiners of theoretical and practical exams) must have a license. The license is acquired through theoretical training that covers areas related specifically to an expertise of one or more of the exams that are conducted in driving schools. These licenses last for five years and during those five years the license holders are required to attend knowledge improvement seminars. After the license expires, the employees in the driving schools have to renew it by taking the exam again.

In this paper the correlation between the observed variables is analyzed. These dimensions are in the domain of knowledge improvement in driving schools and the improvement of overall training quality in driving schools. The paper includes three main sections (excluding the Introduction and Conclusion sections). The first section provides a theoretical framework of the research and discusses the importance of knowledge improvement in driving schools, and overall traffic safety. The second section includes the research methodology where the sample and hypotheses are presented. Afterwards, in the third section, the research results are presented and discussed in more detail. Based on the obtained results, conclusions are drawn.

II THEORETICAL FRAMEWORK OF THE RESEARCH

A. Knowledge - the most important resource of modern business

Conducting business in the modern business environment and within the framework of Industry 4.0 is marked by technological changes, which represent the most dynamic factor of development. Industry 4.0 has also created new challenges in the domain of education [1]. Industry 4.0 provides unlimited opportunities for multiple learning processes at all times, enabling each individual to acquire knowledge and skills throughout their lives [2]. The concept of knowledge refers to the product of cognition of reality, which has been tested in

practice and faithfully copied to human opinion [3], and through the use of knowledge organizations gain their competitive advantage. The most common division of knowledge is made between knowledge that is based on information (explicit knowledge) and knowledge based on experience (tacit knowledge) [4]; [5];[6]. Knowledge is the most important strategic resource, and learning is the most important ability of an enterprise, for that reason knowledge needs to be managed properly. Knowledge management can be presented as the ability to identify, store, and retrieve knowledge [7]. The activities within knowledge management should contribute to the increase of consumer satisfaction, increase of profits, cost reduction, increase of employee productivity, increase of innovative skills, organizational stability, and embracement of market changes [8]. Further, inadequate knowledge management can lead to organizational errors that can cause problems in the domain of worker departure and retention. If these workers possess strategic and professional knowledge, the organization can experience great financial and productivity losses [9]. Due to these conditions, the concepts of learning organization and organizational learning begin to have a crucial role on achieving competitiveness. The concept of organizational learning represents learning as a process of critical importance for the survival and success of the organization [10]. This concept supports and generates major changes in the enterprise. The main feature of organizational learning is the development of new knowledge. From here, this new knowledge has the potential to improve existing routines and processes, both on an individual level and on a collective level of the organization.

B. Traffic safety and driving schools

The development of motor traffic has brought great changes not only in traffic, but also in human life itself [11]. One of the wider social problems is the issue of traffic safety. Factors that affect traffic safety can be categorized into human factors, road factors, and vehicle factors [12]; [13]. Measures to increase traffic safety could be divided into two groups [14];[15]:

- technical measures - direct measures such as measures related to the development of road infrastructure, vehicle design, traffic laws and their application, medical services, and insurance premiums;
- institutional measures - measures that indirectly act to improve traffic safety such as research and development in the domain of traffic safety, improving the quality of training of future drivers, and education and training of staff involved in the training of future drivers.

Driving has become an instrumental activity of everyday life. However, it can be very dangerous, as even the smallest mistake can lead to traffic accidents. This is especially the case with young drivers (novice drivers) as they fall into the high-risk group. Research has shown that the main reason for causing traffic accidents by young drivers is insecurity, but also reckless driving, alcohol consumption, and use of mobile phones [16]. Driver behavior can be improved through traffic safety education programs. These are important for all the noted reasons which involve novice drivers. Therefore, the importance of obtaining a driver's license and the importance of quality training of future drivers is especially emphasized [17]. Acquiring a driver's license, and even the principles of how driving schools operate, differ from country to country. In France, until 1997, compulsory military service was a way for young French men to obtain their driver's license. With the abolition of military service, the number of drivers in France was reduced, but still, due to modern life routines, men were practically "forced" to obtain their driver's license [18]. In developed countries, in order to increase traffic safety, driving simulators are used in training, where the learning candidate is practicing driving in a virtual environment [19]. In Austria, after taking the driving test, they get a "trial driving license", and after a year, the candidates pass another knowledge test and safe driving training at a special training ground, which proves that they are ready to obtain a "permanent driving license". Depending on the country in which the driver's license is applied for, there are informal and formal driver training. Informal driver training involves the presence of an experienced driver with the person who is learning to drive. Formal training involves a standardized driving curriculum, with defined training hours [17]. In the Republic of Serbia, formal driver training is mandatory, and it implies mandatory attendance at driving schools. One of the main reasons of the large number of traffic accidents is inadequate quality of training provided to candidates in driving schools. The reason behind this problem is the lack of financial resources and the lack of professional staff, as well as the inadequate control of driving schools by government-employed inspectors. Therefore, it is necessary to work on the continuous improvement

of knowledge and skills of employees in driving schools.

III THE IMPORTANCE OF EDUCATION AND IMPROVING THE KNOWLEDGE OF EMPLOYEES IN DRIVING SCHOOLS FOR TRAFFIC SAFETY

In the Republic of Serbia, new laws on traffic safety and a wide array of new sub-regulations have practically "reengineered" the concept of how drivers' licenses are acquired. With new laws in place, theoretical training and theoretical exams before starting practical training, as well as licensing of employees who teach driving school candidates, became mandatory. To become an instructor in driving schools, education in the domain of traffic and/or traffic safety is required. Another option is to complete a training program. However, regardless if there is formal education in the domain of traffic and traffic safety, every new potential instructor has to obtain a license in order to teach in driving schools. After introducing new comprehensive laws and regulations, at the beginning of 2013, conditions were met for the Traffic Safety Agency to start licensing new instructors for driving school positions.

Lecturers of theoretical training - have a great professional challenge in front of them in terms of establishing a solid and correct foundation for future drivers. This theoretical background is the cornerstone of safe participation in traffic of future drivers. Theoretical training lecturers are a novelty in the process of training candidates who want to obtain their drivers' license. The importance of these lecturers is evident even in the training program for becoming a lecturer. Namely, five main subjects are learned within 35 hours. This training is mandatory, before the future lecturer can take on the professional exam [20] The program for taking the professional exam for a lecturer of theoretical training, includes the following subjects: Traffic ethics, Road traffic safety, Traffic safety regulations, Driver training and taking driving exams, Theory of performing work on the road, Methodology of conducting theoretical training.

Driving instructor - the basic task of the instructor is to enable the candidate to drive the vehicle properly. The instructor should have knowledge of safe participation in traffic. In addition, the instructor has to know how to apply the driver training methodology. During the entire course of the training, the instructor's attention is focused on the candidate's actions while driving, and on traffic in general. This is important, as candidates, due to inexperience, can make a wrong moves that would endanger themselves and other participants in traffic. The exam to become a driving instructor can be taken by a driver who has reached the age of 21 and has a driver's license for at least three years.

Examiner - the process of licensing examiners consists of taking a professional exam. This exam is taken in front of the examination committee of the Traffic Safety Agency. The exam consists of a theoretical part and a practical part. The exam includes questions that depend on which program is the candidate enrolled. Candidates who have passed the theoretical part of the exam (mostly by taking extending deadlines), are eligible to take the practical exam. In order to pass the professional exam, the candidate has to receive a qualitative grade "passed" in the theoretical part of the professional exam (where at least 80% of the total number of points for each individual module is acquired) and to receive the qualitative grade of "satisfied" in the practical part of the professional exam (where the candidate must meet the condition that he already has a driving instructor license, issued by the Traffic Safety Agency). The subjects that are taken in the professional exam (to become examiners) are: Traffic ethics, Traffic psychology, Pedagogy and andragogy, Road traffic safety, Regulations on traffic safety, Driver training and passing the driving test, Vehicles, and Theory of performing work with a vehicle on the road [20].

After the licenses are issued, lecturers of theoretical training, driving instructors, and examiners are required to attend seminars for improving knowledge. In addition, the Traffic Safety Agency is required to adopt an annual plan of mandatory seminars for improving the knowledge of driving school staff. The licenses are valid for five years. License holders are obligated to attend five seminars during those five years, as well as to pass a knowledge test in order to renew their license. The program of mandatory seminars for improving the knowledge of instructors includes the following subjects: Traffic Ethics, Traffic Psychology, Pedagogy and andragogy, Road Safety, Traffic Safety Regulations, Driver Training and driving Exam, Vehicles, Theory of Performing Vehicles in Road Traffic and Practical driver training methodology.

The obligatory seminars include programs in five subjects that the lecturer has passed when he took the professional exam in the first place. The obligatory seminars of examiners include eight subjects and these are shared subjects with driving

instructors with the addition of Methodology and technique for training candidates for the driving test. These obligatory programs are aimed at improving knowledge and skills of employees at driving schools.

IV RESEARCH METHODOLOGY

The subject and research problem of this paper aims at identifying the importance of improving knowledge and skills of employees in driving schools, in order to provide candidates with quality training and to increase traffic safety. In addition, the paper tends to identify the extent to which employees' education, knowledge and skills affect the quality of their work. The aim of the research is to show how much knowledge, and skills of employees in driving schools possess and to what extent they improve it. Additionally, the goal is to analyze how does employee knowledge affect the quality of their work, and based on the results, suggestions for improvements are proposed.

The research was conducted via structured survey. Overall, there are 74 respondents (N=74). The sample is consisted of employees in driving schools that operate in the Republic of Serbia. The employees are of different profiles (lecturers of theoretical training, driving instructors of all vehicle categories, and examiners). In addition, the survey included questions regarding gender, age, and education.

The survey contains 19 items, which are categorized into five dimensions. These dimensions are:

1. Importance of acquired knowledge during education;
2. Importance of seminars and tests for knowledge improvement;
3. Importance of independent learning on knowledge improvement;
4. Importance of practical exams;
5. Importance of knowledge and its improvement for quality training.

Dimensions were evaluated with five-point Likert scales (1 - negative attitude/irrelevant/weak; 5 - strong attitude/very important/significant). As noted previously, other, non-Likert scale items were also included (age, gender, education etc.).

Based on the defined research problem, research goals and defined dimensions, the following hypotheses are developed:

- H1: There are significant correlations between control variables (gender and education) and the observed research dimensions.
- H2: There are significant correlations between the observed research dimensions.

The obtained data was processed in the IBM SPSS Statistic Version 21 software. The main statistical tools and methods were descriptive statistics and correlation analysis.

V RESEARCH RESULTS AND DISCUSSIONS

Table 1 presents the results of the descriptive statistics for all five dimensions.

TABLE 1. DESCRITPIVE STATISTICS FOR ALL OBSERVED DIMENSIONS

	N	Min	Max	Mean	Std. Deviation
Importance of acquired knowledge during education	74	3	15	11,55	2,906
Importance of seminars and tests for knowledge improvement	74	10	30	20,80	3,690
Importance of independent learning on knowledge improvement	74	2	10	7,69	1,894
Importance of practical exams	74	5	10	8,38	1,300
Importance of knowledge and its improvement for quality training	74	6	10	9,32	1,087
Valid N (listwise)	74				

In Table 2., the results of the correlation analysis are presented. The results provide insight into the relations between the observed variables.

From the correlation analysis it can be noticed that there is a significant correlation:

- between Gender and the Importance of knowledge acquired during education at 0.244 * (level of significance at 0.05);
- between Education and the Importance of seminars and tests for improving knowledge at 0.271 * level of significance at 0.05);

From the above, it can be concluded that hypothesis H1: There are significant correlations between control variables (gender and education) and the observed research dimensions. is confirmed.

TABLE 2. CORRELATION ANALYSIS

	Gender	Age	Education	School of traffic as and educational background	Importance of acquired knowledge during education	Importance of seminars and tests for knowledge improvement	Importance of independent learning on knowledge improvement	Importance of practical exams	Importance of knowledge and its improvement for quality training
Gender	1	-,196	,105	,032	,244*	-,100	,208	,112	,124
Age	-,196	1	-,141	,188	,110	,038	,048	-,110	,185
Education	,105	-,141	1	-,122	,194	,271*	,206	-,019	,141
School of traffic as and educational background	,032	,188	-,122	1	,020	,138	-,078	,191	,160
Importance of acquired knowledge during education	,244*	,110	,194	,020	1	,578**	,973**	,444**	,459**
Importance of seminars and tests for knowledge improvement	-,100	,038	,271*	,138	,578**	1	,567**	,427**	,331**
Importance of independent learning on knowledge improvement	,208	,048	,206	-,078	,973**	,567**	1	,399**	,422**
Importance of practical exams	,112	-,110	-,019	,191	,444**	,427**	,399**	1	,503**
Importance of knowledge and its improvement for quality training	,124	,185	,141	,160	,459**	,331**	,422**	,503**	1

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

Further, significant correlations can be observed between the following dimensions:

- Importance of acquired knowledge during education and Gender at 0.241 * (level of significance at 0.05); Importance of seminars and tests for knowledge improvement at 0.578 ** (level of significance at 0.01); Importance of independent learning on knowledge improvement at 0.973 ** (level of significance at 0.01); Importance of practical exams at 0.444 ** (level of significance at 0.01); Importance of knowledge and its improvement for quality training at 0.459 ** (level of significance at 0.01).
- Importance of seminars and tests for knowledge improvement and Education at 0.271 * (level of significance at 0.05); Importance of acquired knowledge during education at 0.578 ** (level of significance at 0.01); Importance of independent learning on knowledge improvement at 0.567 **(level of significance at 0.01); Importance of practical exams at 0.427 ** (level of significance at 0.01); Importance of knowledge and its improvement for quality training at 0.331 ** (level of significance at 0.01).
- Importance of independent learning on knowledge improvement and Importance of acquired knowledge during education at 0.973 ** (level of significance at 0.01); Importance of seminars and tests for knowledge improvement at 0.567 ** (level of significance at 0.01); Importance of practical exams at 0.399 ** (level of significance at 0.01); and Importance of knowledge and its improvement for quality training at 422 ** (level of significance at 0.01).
- Importance of practical exams and the Importance of acquired knowledge during education at 0.444 ** (level of significance at 0.01); the Importance of seminars and tests for knowledge improvement at 0.427 ** (level of significance at 0.01); the Importance of independent learning on knowledge improvement at 0.399 ** (level of significance at 0.01); and the Importance of knowledge and its improvement for quality training at 0.503 ** (level of significance at 0.01).
- Importance of knowledge and its improvement for quality training and the Importance of acquired knowledge during education at 0.459 ** (level of significance at 0.01); the Importance of seminars and tests for knowledge improvement at 0.331 ** (level of significance at 0.01); the Importance of independent learning on knowledge improvement at 0.422 ** (level of significance at 0.01); and Importance of practical exams at 0.503 ** (level of significance at 0.01).

Based on these results, it can be concluded that hypothesis H2: There are significant correlations between the observed research dimensions. is confirmed.

It can be noticed that the strongest correlation coefficients exists between Education and the Importance of seminars and tests for knowledge improvement (0.271 *). Overall, there are

significant correlations between all five dimensions, while the Age of the respondents and the School of traffic orientation do not correlate with any of the observed dimensions.

The results indicate that every aspect of knowledge improvement, is important, and that they are all connected (they have a mutual influence). It is necessary to raise the awareness of employees in driving schools about the importance of their education, as well as the improvement of their knowledge. Given that the prices, places and dates of knowledge improvement seminars are not always available to everyone, regulation is needed in order to improve the conditions for knowledge improvement. This would increase the motivation of employees in driving schools to independently improve their own knowledge and skills.

VI CONCLUSION

Knowledge, as a result of employee development, has become a strategic resource and a source of competitive advantage for all enterprises. Therefore, in order to survive and be more successful on the market, organizations must insist on creativity, adaptability and continuous learning. More precisely they must transform into a learning organization. This is where the importance of leaders, (managers), comes into play. Their task is to motivate and encourage their employees to learn and improve their knowledge and skills.

Knowledge and learning play an important role in traffic safety. Training of drivers to drive motor vehicles is conducted in driving schools. Driver training is a systematic development of a set of behaviors that consist of attitudes, and knowledge and skills. To achieve this goal, it is necessary that the employees (theoretical training lecturers, driving instructors and examiners) involved in the training of new drivers, be sufficiently trained for the job. Additionally, they have to possess adequate knowledge, as well as to continuously improve their knowledge. These employees have to must obtain adequate licenses in order to train candidates for drivers, and they are obligated to attend knowledge improvement seminars, which are organized by the Traffic Safety Agency. After the expiration of their license, they are obligated to retake the exam and renew their license.

Based on the results of the conducted research, it can be concluded that education and knowledge of driving school employees, as well as the improvement of knowledge and skills through knowledge improvement seminars, have an strong impact on the quality of training. For that reason, it is necessary to constantly encourage the improvement of knowledge and skills of driving school employees. Is also necessary to conduct changes that would make it more accessible to all employees in driving schools in the Republic of Serbia to attend seminars.

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Incorporating Digital Media to Motivate Students in EFL Classes

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Abstract - This paper will focus on how digital media, videos and tools can be used alongside traditional ones. However, pedagogical use of videos and apps for language learning purposes is still often anchored in classroom tasks which don't fulfill its true potential. This paper analyses the effects of internet apps and audio visual material in order to offer and create successful language classes, which will have effect on students' motivation and participation in EFL courses at university level in the viewpoint of English instructors. Materials as videos should be selected by certain criteria, such as: they should contain the desired linguistic material; be thematically interesting; repeat the viewings for students to understand the text fully; and be brief. As with selecting all instructional materials, there is a good video and a bad video for language teaching purposes. A useful video must contain the desired linguistic material for instructional purposes. In most cases, for language courses attempting to develop communicative performance, this criterion means language that is current, useful and accurate in a corresponding situation. The purpose of this study is to investigate and show the benefits that the language teachers and learners get from using media and technology in teaching and learning the English language. According to the analysis and the data collected in English classes, the findings reveal a positive effect of internet apps and video use on students' motivation and participation.

I. INTRODUCTION

The study may raise EFL teachers' awareness to the importance of incorporating social networks in their classrooms and be up to date with the latest technological advances in education.

The findings of the study may contribute enormously to solve many educational problems, hence make the teaching and learning process easier for both teachers andstudents.

It is hoped that the findings of the study will contribute tothe previous literature in the field of education particularly foreign language learning

II. LITERATURE REVIEW

Social networks that in other words represent social media seem to influence almost every little aspect of human life, and the field of education is not an exception in this case. Khedo et al. (2012) posit that, "Information and communication technology is known to help expand access to education, strengthen the relevance of education to the increasingly digital workplace, and raise educational quality" (p. 907). A continuum of studies has emerged across the research industry with an aim of elaborating Hershkovitz and Baruch (2010) add, "Internet integration in higher education has stimulated high expectations, especially regarding accessibility, interactivity and opportunities for improved instruction" (p. 14).

However, as noted by Zaidieh (2012), social networks come with unique challenges integrated into the educational system and some of such challenges include privacy concerns among educators and learners, miscommunication and time consuming.

Students' Motivation Educational attainment using has been successful following a great number of positive responses among students and instructors. Scholars describe social- networking sites as attractive means for meaningful communication and effective collaboration.

III. METHODOLOGY

The population which is included in the study are all EFL students at SEE University. Their ages range around 18 to 23 years old. They were EFL students who were using the educational networking site Google classroom in their language learning process. The sample of the study was 2o students. The instrument used to find answers to the research questions was a structured questionnaire with close-ended questions to the students. The questionnaire examined the impact of educational networking site Google class on two different variables: EFL students' motivation and teacher-student's communication at University.

The questionnaire included 40 items; the first 21 items covered certain indicators of students' motivation in language learning internal factors such as, engaged learning activity, curiosity and challenge, interface design and ease of use, and external/environmental factors such as, convenience, flexibility in time and place of learning, recognition and usefulness.

This paper looks at the concepts of authenticity and student motivation and how they may possibly be incorporated and enhanced by using video materials as supplementary material in an EFL classroom. Sherman (2003) presents a convincing argument for incorporating authentic video material into language classrooms. She provides a variety of practical classroom activities showing how to use video to bring real world language and culture into the classroom in contemporary, engaging and productive ways. There are a lot of documentaries, educational films, interviews and sites containing a large body of material created and posted by people all over the world to communicate their ideas and beliefs.

CONCLUSION

According to many researchers language teachers like video because it motivates learners, brings the real world into the classroom, contextualizes language naturally and enables learners to experience authentic language usage. Students like it because video presentations are interesting, challenging, and stimulating to watch, and a very regular media which is used for every field now. This article looks at using videos as supplementary material in an EFL setting. It is hypothesized that video material can be used as authentic material input and as a motivational tool.The connection between the classroom and real world encourage students to understand the relationship between learning and practicing. Digital media is widely accepted as more powerful and more comprehensible than other media for second and foreign language students.

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Investigating the Effects of Online and Flipped Classroom Approach during COVID-19 Pandemic

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Abstract – In an effort to prevent the transmission of COVID-19, governments around the world have closed universities and schools. Educational institutions needed to respond quickly and adapt to the new situation. Many of them have applied an online teaching model, but there were also some that have applied the flipped classroom model. This study investigates the effects of online and flipped classroom model, in 7th grade students. Empirical research was conducted in three elementary schools in Republic of North Macedonia during corona pandemic. The study lasted for two months and involved 167 participants.

The results showed that both methods have a positive impact on the students' learning motivation, attitudes, engagement, interaction, collaboration and general satisfaction. These findings suggest that the aforementioned teaching methods can facilitate the delivery of theoretical knowledge not only during emergencies (such as Covid-19 pandemic), but also during normal educational process.

I. INTRODUCTION

The COVID-19 pandemic has created the largest disruption of education systems in history, affecting nearly 1.6 billion learners in more than 190 countries on all continents. All educational institutions in Republic of North Macedonia were also closed on March 10, 2020.

To ensure learning continuity during this disruption to the traditional (face-to-face) teaching, most schools and universities were constrained to adopt the online teaching and learning models in a relatively short period of time.

This need for rapid shift to online learning revealed many problems in the education systems all over the globe but, it also revealed a deep gap in our overall approach to education.

Despite the rapid development of ICT, artificial intelligence (AI), robotics and electronics, and their application in various institutions and sectors [1-12] it seems that the schools have been under-resourced and underfunded when it comes to the uptake of this technology.

On the other hand, this crisis has stimulated innovation within the education sector [13]. We have seen innovative approaches in support of education and training continuity: from radio and television to take-home packages.

In Republic of North Macedonia, the Ministry of Education and Science in cooperation with UNICEF and other partners created a new online-learning platform called EDUINO (Fig. 1), where pre-primary, primary and secondary school students can continue their education through video lessons, resources and a variety of games [14].

EDUINO is a web-based collective platform, created using the design thinking methodology as well as the principles of co-creation and collective action, involving more than 1200 teachers, educators and parents.

EDUINO offers more than 3000 video lectures on Macedonian, Albanian, Serbian, Bosnian and Turkish languages. All video lectures are divided and grouped by study year and subject. Each video lecture is covering micro-units of the study program accredited by the Bureau for Development of Education. During the spring semester EDUINO was the main channel of educational content delivery and this resulted in more than 2.5 million of video previews or downloads.

In addition, an educational program called TV Classroom has been broadcasted on the national television (Fig. 2).

Figure 1. EDUINO platform

Figure 2. TV Classroom project on national television

Despite these initiatives, many educational institutions and many teachers have become interested in how to best deliver course content online, engage learners and conduct assessments.

In the absence of systemic solution at national level, teachers started adopting new pedagogical concepts and modes of delivery of teaching, for which they may not have been trained. Teachers were also adapting to online education while keeping their students engaged and learning.

However, getting students to attend online classes does not guarantee their benefit from what is presented [15]. Therefore, it is very important to find the most effective methods that will increase the learning efficiency of students.

The integration of flipped learning concept in online teaching is believed to add value to online learning during times of disruption to traditional teaching. It is believed that the combination of online teaching with flipped classrooms may improve the learning effectiveness of the online class.

This paper investigates the effects of online and flipped classroom approach under COVID-19 pandemic. The retrospective survey was used to determine students' motivation, attitudes, engagement, interaction/collaboration and satisfaction of two groups of students. One group was taught by synchronous online model, while the other attended flipped classroom. The research questions that we'll try to answer here are:

RQ1: What are students' perceptions about online teaching/learning during Covid-19?

RQ2: What are students' perceptions about flipped classroom approach during Covid-19?

RQ3: Are there any differences between the two groups of students regarding their motivation, attitudes, engagement, interaction/collaboration and satisfaction?

To answer these questions an empirical study was conducted. The research methodology, results and conclusions are presented in the rest of this paper.

II. ONLINE AND FLIPPED CLASSROOM MODELS

Online education is electronically supported learning that relies on the Internet for teacher-student and student-student interaction, as well as the distribution of class materials. Its primarily aim is to foster students to be independent at certain times and take responsibility for their learning. Besides, online learning should allow students to play a more active role in their learning because it focuses on personalization, which includes the ability to adapt to the level of learners' skills and collecting knowledge resources as mutual support [16]. Research has indicated that online learning is pedagogically promising approach, because it encourages deeper learning due to its self-paced and student-centered approach [17, 18]. However, the separation of the instructor from students in this type of learning is reported to cause a sense of isolation among students [19].

In recent years, another approach based on constructivism theory has been developed. Flipped classroom is an alternative pedagogical approach focusing on student-centered instruction that reverses the traditional classroom environment. In the flipped

classroom model, the delivery of content is usually obtained through online videos prepared by the teacher or a third party. Students' watch the assigned short instructional videos at their own time and pace prior to attending classes in which they participate in group activities or the teachers answer their questions [20]. This can be effective in making the learning process begins prior the class and engage the students to learn the content at a deeper level during the class [20, 21, 22, 23, 24]. With the flipped classroom, rather than relying on a singular model, the instructor should apply multiple approaches, such as group discussion, mini-lectures for review, or student questioning [25].

Flipped classroom method allowed teachers to observe how well the students managed with given tasks, or if they needed more exercise with certain topics. It also allowed more possibilities for one to one interaction with those students who seemed to need help, encouragement or positive feedback, in order to be able to continue with more demanding topics.

III. METHODOLOGY

Methodology that is used in this study is based on Input-Process-Output (IPO) model paradigm (Fig. 3).

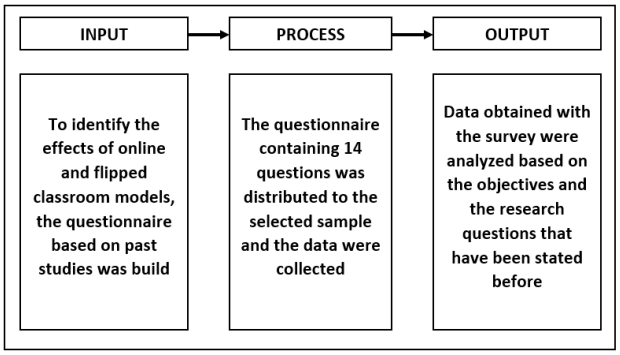

Figure 3. IPO model used in the study

According to Cohen and Bailey [26] input factors are factors that can be manipulated to change the process and the result. These factors can be input at the level of individuals, groups or the environment [27]. In our IPO model, in this phase, we have developed the questionnaire based on previous research. A total of 14 questions will be provided in the questionnaire where participants are required to answer all the questions that have been provided (Table I). A five-point Likert scale is used for scaling the responses of the questionnaire items. The reliability of the questionnaire was also performed on 10 participants to test the Cronbach alpha. The coefficient reliability for the questionnaire was $\alpha = 0.81$, which is above the suggested value of 0.70. We believe that this value is suitable for the purposes of the current study.

TABLE I. QUESTIONNARIE ITEMS USED IN THE STUDY

Construct	*Item*	*Question*
Overall satisfaction	OS1	Generally, I am happy and satisfied with this online/flipped learning experience.
	OS2	I preferred online/flipped classroom over conventional teaching.
Interaction/ Collaboration	IC1	It was helpful to collaborate with my classmates by sharing ideas and commenting.
	IC2	The process of discussion was helpful.
	IC3	The interaction between the students and the teachers was helpful.
Learning Motivation	LM1	I feel motivated and use my own initiative to collect the materials about this course content, in an online/flipped classroom.
	LM2	The way the class is taught draws my attention.
	LM3	I became a more active learner in the online/flipped classroom.
Learning Attitudes	LA1	I had to work harder in this course.
	LA2	Learning activities in this course are helpful for me.
	LA3	I had sufficient ability to learn and comprehend the course content.
Learning Engagement	LE1	I participated more in group discussions in the online/flipped classroom.
	LE2	I spent more time and effort than usual on online/flipped classroom learning activities.
	LE3	I devoted myself more to the class activities in the online/flipped classroom.

The information processing is an important characteristic in completing tasks and problem situations [28]. In the "process" phase, a questionnaire containing 14 questions, was distributed to the selected sample and the data were collected.

The output or the outcome is the result of the process. It is usually defined by how far the goal is achieved [29]. The data, collected from questionnaires, were analyzed based on the objectives and the research questions that have been stated before.

A. Participants

Students from three elementary schools located in three different regions in Republic of North Macedonia (East, South-west and North), form 7th grade, were included in the study. The total number of participants was 167 students of which 89 were female (53%) and 78 were male (47%). Two classes from each school were involved. One class was taught by synchronous online model, while the other

attended flipped classroom. All students attended the "Math" course.

Synchronous online model means that the teacher and the students interact in a specific virtual place at the same time. In our case, the synchronous online classes were performed using Zoom videoconference application. Classes were scheduled a few days in advance to keep students informed in a timely manner.

The flipped classroom model was conducted as follows: 7 days prior to class, the teacher delivers short instructional video, for the content that should be taught in the class. The videos, for this study, were provided through the EDUINO platform [14]. Students were required to watch the assigned video before the live class, and to make notes about the content they watched. They were also encouraged to use a variety of collaboration tools during this phase. During the in-classroom learning activity, students presented their notes, asked questions and participated in active discussion with teachers and their classmates.

B. The study and data collection

The study took place in three elementary schools in Republic of North Macedonia, from 1st of April till 1st of June. The last days of the school year (from 1st to 10th of June) was reserved for completing the questionnaires and gathering the feedback. A pre-designed Google form questionnaire was used to collect desired data. The link of the Google form was sent to the students by e-mail. A total of 156 questionnaires were collected, representing a return rate of 93%. All received questionnaires were valid and were used in this study.

Data were collected on students' learning motivation, attitudes, engagement, interaction/collaboration and general satisfaction, all measured by the self-report questionnaire.

The learning effects of the online and flipped classroom model were obtained through statistical and comparative analysis of the data.

Before starting the research, the researchers had a brief session with the participants, in order to explain the basic principles of online and flipped classroom pedagogy. They also gave the participating students an opportunity to experience a flipped classroom before they implemented it in their class, so they could have a better understanding of this pedagogy.

IV. RESULTS AND DISCUSSION

Table II shows the mean (M) and standard deviations (SD) of the two groups of students, for the defined sets of questions (constructs). According to the findings, the average score of all constructs, for both groups, was above 3 which was set as a median score.

TABLE II. DESCRIPTIVE STATISTICS OF THE QUESTIONNAIRE BY CONSTRUCT, FOR BOTH GROUPS OF STUDENTS

	Online		**Flipped classroom**	
Construct	***Mean***	***SD***	***Mean***	***SD***
Overall satisfaction	3,6	1.18	3.8	1.06
Interaction/ Collaboration	3.31	1.27	4.08	1.13
Motivation	3.3	1.32	4.15	1.04
Attitudes	3.56	1.08	3.78	1.19
Engagement	3.63	1.14	3.75	1.12

As observed in Table II and answering to RQ1 and RQ2 of this research, participants were satisfied with the new ways of teaching (Fig. 4), and they preferred them over conventional teaching (Fig. 5).

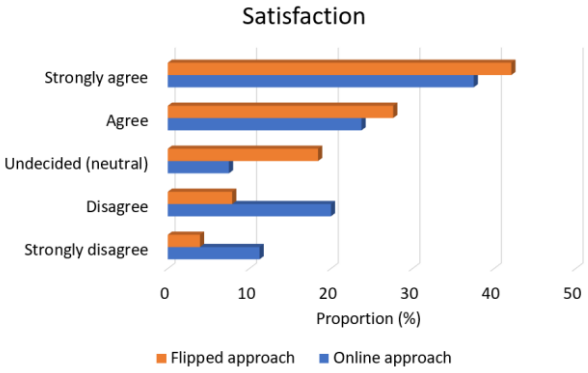

Figure 4. General satisfaction with both learning approaches

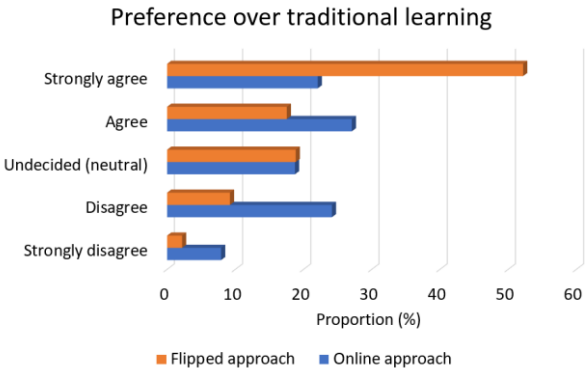

Figure 5. Preference over traditional learning

Both groups (the students who attended online classes and the students who attended flipped classroom) highly regarded the online and flipped classroom activities. They reported increased motivation and engagement, as well as positive attitudes during the new learning experience. This is

in line with the previous research, where positive effects on learning motivation [30, 31, 32], as well as on learning attitudes [33, 34] and student engagement [35, 36, 37] have been reported.

Regarding RQ3, we can state that there are no major differences in constructs, except for "Motivation" and "Interaction/Collaboration", where significantly higher scores are reported by the group attended flipped classroom. This can be explained by the specific approach that the flipped classroom has.

There are two factors that influence motivation and learning: internal and external [38]. Internal factors are related to individual's own capacity, while external factors are related to the learning environment and materials. Although we cannot influence the internal factors, we can still influence the external ones. Most of the learning difficulties that students face in the traditional school setting, are due to their passive role during the class. With the flipped classroom, the teacher-centered approach has been shifted to student-centered approach, enabling students to be active participants. Flipped classroom allows students to construct their own learning process and deepen their learning, through in-class activities, questions and answers and discussions. The interaction with others and the reflection of this interaction process in the individuals' inner world is also important for the learning process [39]. So, interaction and collaboration can make essential contributions in increasing students' learning motivation.

V. CONCLUSION

Technologies have changed the traditional way of education to the modern way of teaching and learning. Digital technology in education enables us to find new answers not only to what people learn but also to how they learn, where and when they learn.

This study aimed to examine the effects of online and flipped classroom approach on elementary school students, using the questionnaire. Analyzing the responses, it was concluded that both methods have positive impact on students' motivation, attitude, engagement, interaction/collaboration and general satisfaction.

However, when it comes to students' motivation and interaction/collaboration, as well as their general satisfaction, the flipped classroom was preferred by most of the students.

As a general conclusion, we can say that the aforementioned teaching methods can facilitate the delivery of theoretical knowledge not only during emergencies (such as Covid-19 pandemic), but also during normal educational process. Therefore, we can strongly recommend the teachers to continue with these teaching methods even after the pandemic whenever and wherever possible.

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Recovery of Partitioned Databases Based on Time Stamp Data and the Role of CRUD Operations: Two Educational Web Applications

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Abstract – Storage of time stamp value with every record in a table of a database is recomended standard. This way, changes over the set of records can be monitored, by consuming the value of time stamp data. Aim of this paper is to present the use of time stamp data with all CRUD (Create, Read, Update, Delete) operations over the records in a relational database. Particular aim of this paper is to present the use of time stamp data in the context of partitioned databases recovery. The paper describes two web applications that enable performing CRUD operations over partitioned databases and include databases recovery function performed by exploiting time stamp data. These web applications were developed within the educational process in the course Distributed Information Systems at University of Novi Sad, Technical Faculty „Mihajlo Pupin" Zrenjanin, Serbia. Special focus of this paper is to present the impact of CRUD operations to time stamp data and possibilities for using time stamp data for partitioned databases recovery.

I. INTRODUCTION

Contemporary software development is often oriented towards creation and maintenance of distributed information systems, based on creating web and mobile applications. Distributed information systems belong to a broader category of distributed systems [1], with emphasize on distributed data and distributed data processing [2].

In aim to enhance students' knowledge and skills, so they get eligible and profession ready before enter professional environment, higher education courses are designed and regularly updated according to technology trends. University of Novi Sad, Technical Faculty "Mihajlo Pupin" Zrenjanin, Serbia (in the rest of paper: @TFZR) have included the course Distributed Information Systems in the educational process within the Master studies in Information Technology [3]. This course has been established at this Faculty for more than a decade, starting with the accredited Master studies in IT. Since then, the course evolved, particularly in the teaching content and methods. Several years ago, particular educational software has been created as an example for students – a web application that has all important components implemented and functional, to illustrate the most important educational concepts. In the rest of the paper it will be named DIS@TFZR.

Aim of this paper is to emphasize recent improvement of the DIS@TFZR web application related to dis. The DIS@TFZR software solution and its' distributed databases recovery module based on time stamp data has already been presented in [4]. This paper presents new results in the improvement of the DIS@TFZR solution, that are related to all CRUD operations support in the solution, with particularly addressed concerns related to the role of time stamp in these operations.

The rest of the paper is organized as follows: next section is related to theoretical background related to distributed systems, distributed information systems, distributed databases and time stamp. Third section presents related work in database recovery and time stamp applications. Fourth section describes the basic version of DIS@TFZR software solution, including the latest improvements with data consistency checking upon all database partitions and data recovery. Fifth section explains the second example of software solution, while the section six emphasizes the timestamp value role in CRUD operations and the relationships between the timestamp values in central and partitioned databases. Final section provides conclusions and future work directions.

II. THEORETICAL BACKGROUND

Distributed system could be defined as a collection of independent computers that appear to users as a coherent complete system [1]. The most

important features of distributed systems include autonomy for each node in the system, multi-component and multi-layered system, (non-) transparency to users, scalability, reliability, openness, flexibility and others. Certain advantages of creating and using distributed systems include increased availability of resources, improved collaboration, reliability and availability, as well as increase of system performance. Risks related to the use of distributed systems include safety of data, data privacy, reliability of nodes connections, compatibility and synchronization of processes and data. Distributed systems consist of distributed computing systems (grid and cluster), distributed information systems and distributed embedded systems.

Distributed information system is defined as an information system that supports distributed data processing, over the distributed database [2]. Distributed data processing is usually supported by modular approach, with software components, class libraries and services. Distributed data includes data formats for data exchange between software components (such as XML, JSON) and distributed databases.

"A distributed database (DDB) is a collection of multiple, logically interrelated databases distributed over a computer network. The database is physically distributed across the data sites by fragmenting and replicating the data. Given a relational database schema, fragmentation subdivides each relation into horizontal (by selection operation) or vertical (by projection operation) partitions."[5] According to [5], benefits of fragmentation are in reducing data transmission costs, with reducing size of data within user queries and potentially closer proximity to the location of use.

Time stamp is defined as a data member that is closely related to time of creation of a data record or a message [6]. According to [6], the time stamp data is usually created according to local time at the place of creation. Time stamp values are created in an infinite row and they could be used for organization of records or messages, their grouping, ordering and prioritization. Time stamp is also defined and described as "a unique identifier created by the DBMS to identify a transaction. Timestamp values are assigned in the order in which the transactions are submitted to the system, so timestamp can be thought of as the transaction start time." [7]

III. RELATED WORK

A. Database recovery

The problem of database recovery has been addressed in both professional and educational environments [8]. Some of techniques used in database recovery included transactions processing [9], but the data recovery also addressed keeping the whole database in a main memory [10]. Information systems technology advancements introduced the same problem within the client/server [11] and online [12] systems, as well as with partitioned distributed databases [13] [14], by using database catalog (journal) [15].

Other significant aspects and methods are related to using online mirror database [16], performance metrics [17], recovery process acceleration [18], formalization [19] and cost estimation [20]. Finally, with the introduction of mobile technologies, database recovery techniques for Android have also been addressed [21]. A particular concern has been examined in the case of combined data store, consisting of a (relational) database and files (such as multimedia files), with special focus on issues related to backup/recovery and data consistency [22].

B. Time Stamp Applications

Time stamp as a term has been examined in the context of relationship between the real-world fact occurrence time (validity of a fact that describes an event or characteristics of an object) and the time of recording of that fact in a database. The first is assigned a "valid time-stamp" and the second is named "transaction time-stamp" [23]. Time stamping is not related only with databases, but they are used generally with diversity of digital document types, such as text, audio, photos, video files and others, in aim to keep and maintain additional data related to the time of creation and modification of these files [24]. Time stamping is found useful in cases of synchronization of multiple data sources for video data, particularly in data acquisition and telecommunication application areas. [25] Another beneficial use of time stamping is related to measurement systems, where accurate time of obtaining measurement data is crucial. [26]

Time stamping has many application areas, particularly in distributed systems. Such systems are collaborative virtual environments [27]. Specially demanding is an orientation towards optimizing timestamp management, in the case of data streams, where simultaneous events occur and their data records tuples have exactly the same value of timestamp. [28] Especially important is using time

stamp data in collective resource acquisition in a distributed system, with the simultaneous access to all requested resources [6]. Very interesting problem is related to dynamism with real-time databases, where data are obtained and serialized, with the use of timestamp value [29].

IV. BASIC EDUCATIONAL SOFTWARE DIS@TFZR

In the last few years, a specific web application (named DIS@TFZR) has been developed for the educational purpose, as an example of distributed information systems software. Previously mentioned software DIS@TFZR has been presented with all models, user interface and other details in [4]. It consists of structural and functional elements to illustrate fundamental concepts of a distributed information system:

1. *Distributed data*, with horizontally and vertically partitioned databases and the use of data exchange formats,
2. *Distributed processing*, with n-tier layered structure of software and the creation and usage of web services.

Particularly, the developed software is ASP.NET web application that consists of layers:

1. *Data Access Layer* – class library with classes that are used for data processing into relational database, as well as data retrieval from the database.
2. *Business Logic Layer* – class library with business-domain named classes, which have methods to make business-related computations, automatisms and enforce business rules.
3. *Service Layer* – consists of: A) web service (SOAP type) which enables additional data and functionality to the business logic layer, B) class library with mapper classes, providing a bridge between different layers and overcoming differences between their data models.
4. *Presentation Layer* – ASP.NET user interface, Presentation Logic as a Class library that obtains input data, validates data according to basic validations and business-related validations and transforms input data in the form suitable for database processing.

Previously mentioned software enables storing data in multiple databases, which are logically connected. These databases represent horizontal and vertical partitions of the central database. This way, the developed web application stores data in the central database, as well as to several horizontal and vertical partitions. The application uses XML file with the data related to all databases (both central and all partitions), in aim to represent a distributed database catalog. Once the data entered, the record is transformed into a set of "Insert into" queries and, within a loop, each database from a database catalog is populated with appropriate data, by processing adequate SQL query.

Regarding functional aspect of DIS@TFZR software solution, there is support to:

- *Data entry* with usual data input form, where entered data is sent to multiple databases for their storage. Horizontal partitions get only the rows that suit their criteria of classification, while all vertical partitions get each row, but only according to particular part of the table structure.
- *Data presentation* in tabular form, where horizontal partitions represent subsets of rows with all equal structure and the data are merged at the memory level (by merging datasets), so the user do not recognize the fact that data come from multiple databases
- *Data consistency check and data recovery* – supported at separate user interface form, where a user could start checking if each database partition has adequate records, comparing to the central database. After checking, the missing records and appropriate databases with the missing records are determined. Here, time stamp data are used to determine which data records are missing, by extracting the last timestamp value for each database (central and all partitions) and comparing these values.

The DIS@TFZR software is created upon the simple domain of keeping records about the preschool children.

V. SECOND WEB APPLICATION WITH EXTENSION TO SUPPORT ALL CRUD OPERATIONS

Within the practical pre-exam requirements at course Distributed Information Systems @TFZR, students used the previously developed example DIS@TFZR as a template for their own pre-exam work. Since the existing solution of DIS@TFZR software, before school year 2019/20 did not have the module for partitioned databases consistency checking and recovery, based on timestamp data, during regular and online classes in school year 2019/20 students and Ljubica Kazi together improved the previous DIS@TFZR version with adding this functionality. This way, students of 2019/20 generation could use an improved version for their own pre-exam required projects.

One of such solution has been developed by Slobodan Nadrljanski upon the improved version of

DIS@TFZR as a template. The second example, created by Slobodan Nadrljanski, has an improved functionality (comparing with DIS@TFZR template), by adding functions for updating (changing) and deleting records in the central database and all partitions. This way, the developed students' solution provided support for all CRUD operations. The developed solution was firstly used as a pre-exam required project. Later, with additional improvements, the software was included in the final master work, defended @TFZR [30]. Business domain that has been used for this example was related to registration of a new company.

Listing 1. explains the principle, firstly developed in DIS@TFZR template, with the example applied in [30]. First part presents CREATE table SQL script and second presents extracting time stamp value and transforming into bigint type in a horizontally partitioned database. Figure 1 and 2. Present results from [30]. Figure 1. presents a data entry form for adding new data about the company to be registered, while Figure 2. shows tabular presentation of merged data from different horizontal partitions, where each row has links to enable: a) loading particular data to another form in aim to be changed (updated); b) deleting a selected record.

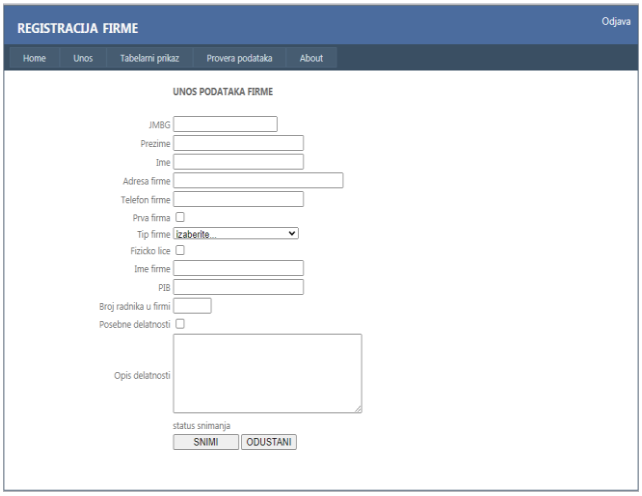

Figure 1. Data entry form for a new company registration [30]

CENTRAL DATABASE	**HORIZONTAL PARTITION DATABASE**
CREATE TABLE [dbo].[FIRMA]([JMBG] [nvarchar](40) NOT NULL, [Prezime] [nvarchar](40) NOT NULL, [Ime] [nvarchar](40) NOT NULL, [AdresaFirme] [nvarchar](60) NOT NULL, [TelefonFirme] [nvarchar](60) NOT NULL, [PrvaFirma] [bit] NOT NULL, [TipFirme] [nvarchar](60) NOT NULL, [FizickoLice] [bit] NOT NULL, [ImeFirme] [nvarchar](60) NOT NULL, [PIB] [nvarchar](60) NOT NULL, [BrojZaposlenih] [int] NOT NULL, [PosebneDelatnosti] [bit] NOT NULL, [OpisDelatnosti] [nvarchar](100) NOT NULL, **[BrojacPoslednjeIzmene] [timestamp] NOT NULL**)	CREATE TABLE [dbo].[FIRMA]([JMBG] [nvarchar](40) NOT NULL, [Prezime] [nvarchar](40) NOT NULL, [Ime] [nvarchar](40) NOT NULL, [AdresaFirme] [nvarchar](60) NOT NULL, [TelefonFirme] [nvarchar](60) NOT NULL, [PrvaFirma] [bit] NOT NULL, [TipFirme] [nvarchar](60) NOT NULL, [FizickoLice] [bit] NOT NULL, [ImeFirme] [nvarchar](60) NOT NULL, [PIB] [nvarchar](60) NOT NULL, [BrojZaposlenih] [int] NOT NULL, [PosebneDelatnosti] [bit] NOT NULL, [OpisDelatnosti] [nvarchar](100) NOT NULL, **[CentralniBrojacPoslednjeIzmene] [bigint] NOT NULL)**

Copy time stamp value

TRANSFORMATION OF TIMESTAMP VALUE TO BIGINT

```
DataSet dsIntTimeStamp = new DataSet();
Int64 intVrednostTimeStamp = 0;
 string SQLUpit="";
SQLQuery = "select top 1 CAST(BrojacPoslednjeIzmene as BIGINT) as IntTimeStamp from FIRMA order by BrojacPoslednjeIzmene desc";
dsIntTimeStamp = objTabela.DajPodatke(SQLQuery); // method that retrieves data from database by executing SQLQuery
intValueTimeStamp = Int64.Parse(dsIntTimeStamp.Tables[0].Rows[0].ItemArray[0].ToString());
```

NOTE: bigint value inValueTimeStamp will be inserted into all partitioned databases having the same name and value under field: „CentralniBrojacPoslednjeIzmene"

Listing 1. The structure of a data table in the central database and horizontal partitioned databases and copying the value of timestamp [30]

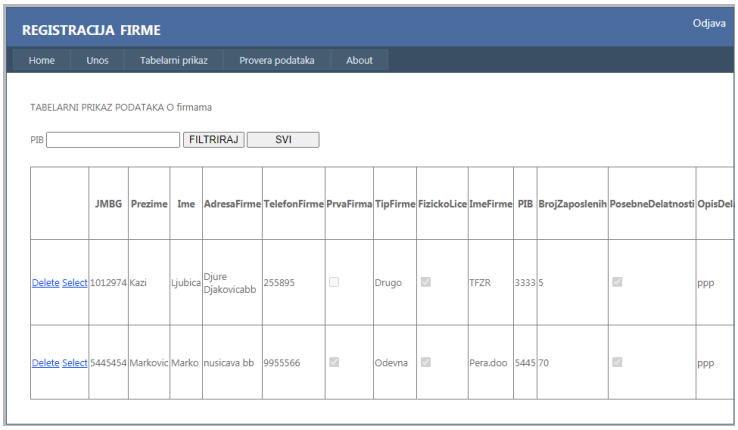

Figure 2. Tabular presentation of merged data from horizontal partitions with added links for delete and select (leading to update) [30]

VI. THE IMPACT OF CRUD OPERATIONS TO TIME STAMP DATA AND THE ROLE OF TIME STAMP DATA IN PARTITIONED DATABASES RECOVERY

Aim of this section is to explain the use and change of time stamp data in all CRUD operations performed upon the central database and distributed database partitions. It is briefly explained in Table 1.

Table 1. CRUD operations and time stamp data in partitioned databases

CREATE operation
1. Central database gets the input data (all except time stamp data) and in the very moment of inserting of all non-timestamp data to DBMS, it automatically creates timestamp value and stores it in timestamp type of field. Timestamp field could not be reached by insert into query, so the insert into query includes all non-time stamp fields. 2. Each horizontal and vertical database partition gets adequate data and exactly the same value of time stamp, stored in integer data type field.
READ operation
Time stamp data could be used in SQL queries of select type, but their value do not change while data retrieval.
UPDATE operation
1. When Update query is performed upon the record in the central database, a new value of timestamp is automatically generated by DBMS and replaces old value. 2. All database partitions should receive new regular data, as well as new timestamp data. This way, all database partitioned databases remain up-to-date with data and comparable with the central database.
DELETE operation
1. Delete operation removes a record from the central database. The time stamp value for any other data record added after the deletion is automatically generated and does not continue to the last value in the list, as well as do not fill the gaps made when some record is deleted in the middle position of all records. 2. It is necessary to remove all records from all horizontal and vertical partitioned databases, to make them be up-to-date with the recent deletion in the central database. Note: Existing module for database recovery is not developed in direction from partitioned databases to the central database, but in the opposite direction. If this feature was developed, then the deleted row from the central database could be recovered by inserting the missing data, but in that case, new timestamp value would be generated and all partitioned databases should then update their time stamp values for the particular record.

To illustrate previously mentioned role of CRUD operations in timestamp creation and update, as well as the timestamp value alignments within the distributed database recovery, Figure 3 presents a simplified data table with regular and time stamp data, with the illustration of the impact of data row update to the value of time stamp. Figure 4. presents the impact of delete and insert SQL statements on time stamp data.

Obviously, in previously mentioned examples, when updating name from “Ljubica” to “Ljubica1”, the value of time stamp data changed. After deletion of “Marko” record, new record, inserted immediately after that, gets the time stamp value as incremented (+1) comparing to the last record being created or updated (in this case, the last operation was update, so that record keeps the last timestamp value, to be used with increment to the new record to come).

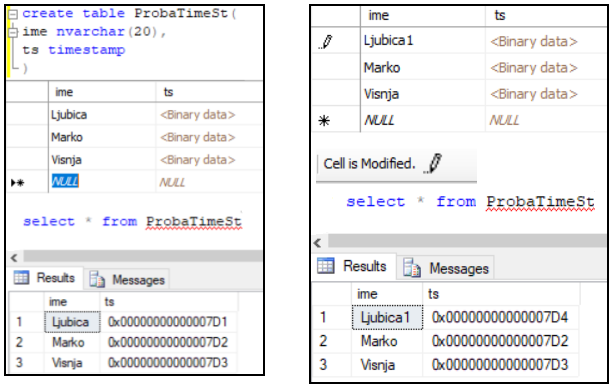

Figure 3. Simplified example of a table with regular and time stamp data and the impact of UPDATE operation to time stamp value

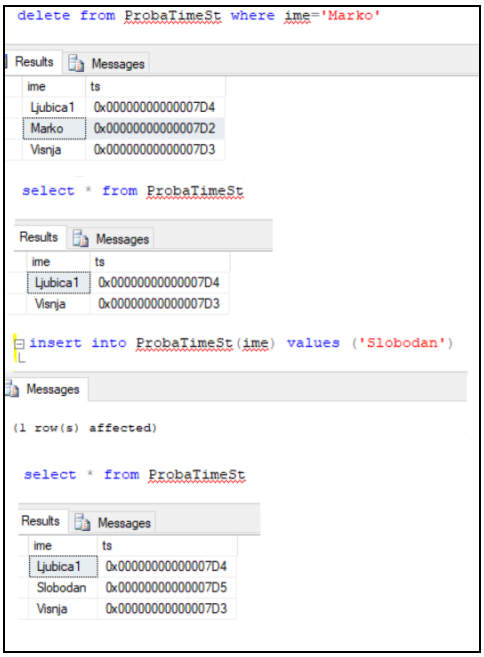

Figure 4. Simplified table with regular and timestamp field – impact of DELETE and INSERT (performed after DELETE) operations to time stamp value

VII. CONCLUSION

Distributed databases usually are created with database partitioning. Horizontal partitioning enables creation of tables with exactly the same structure, but data is categorized before sending to a particular partition. Vertical partitioning enables splitting the structure of a complex database table into multiple tables having different structure, but the same primary key value. In keeping all databases partitions up-to-date with records in central database, usually time stamp data is used.

Aim of this paper was to present the impact of CRUD operations to time stamp data and to explain how the time stamp data could be used for synchronization of data between the central database and partitioned databases. This way, the concept of alignment of central database with all partitions could be used in distributed databases recovery.

This paper presents educational software that was created for the purpose of teaching distributed information systems at master level course in information technologies at University of Novi Sad, Technical Faculty "Mihajlo Pupin" Zrenjanin. Two examples of the developed solution have been presented – initial software DIS@TFZR, created in collaboration of Ljubica Kazi with students, during classes (with only data entry and tabular presentation functionalities, improved with distributed databases checking and recovery) and the second example of students' master thesis work (with other business domain and additional options for delete and update upon data in central database and all database partitions).

The presented solutions demonstrate the creation and use of time stamp data in distributed databases recovery, with special emphasize on all CRUD operations impact on the time stamp data.

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Switching to Online Education, Experiences from Hungary and Serbia

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Abstract - This study examines the impact that the Covid-19 pandemic had on education systems in 2020, with particular reference to Hungary and Serbia. It examines technical possibilities and solutions, and covers methodological principles as well. The study outlines all this in the light of the available statistical and official reports.

I. INTRODUCTION

As a result of the Covid-19 pandemic, social conditions around the world have changed radically in a short time. In addition to social conditions, education has also been significantly affected by this global pandemic. A large number of educational institutions have been closed, and the only option for continuing education became (online) distance learning. According to visualized UNESCO (https://en.unesco.org/covid19/educationresponse) reports, April 2nd saw one of the highest amounts of school closures, when 84.8% of the total enrolled learners' institutions had been closed either partially or completely. At this time, this process has affected 1,484,712,787 learners and 172 country-wide closures from 210 countries.

In this situation, due to the circumstances, the transition to distance learning was not a result of pedagogical innovation but rather an emergency response. Nonetheless, some institutions have handled the situation successfully, and in many cases, even created a more efficient, interactive and learner-centered educational environment. In many cases, however, these emergency solutions have not been founded on well-thought-out strategies. Our view is that the teacher's explanation should not be left out of any education system, so that the effectiveness of the tasks sent via e-mail doesn't fall short of the expected efficiency and interactivity.

II. PUBLIC EDUCATION

In Serbia, a state of emergency was imposed on the 15th of March, 2020, which lasted until the 6th

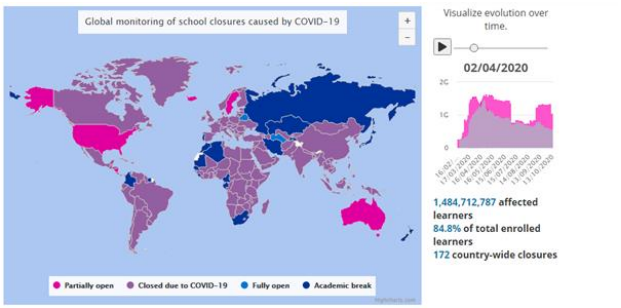

Figure 1.: The number of children and youth not attending school because of closures mandated by governments in an attempt to slow the spread of COVID-19 on April 2nd (source: UNESCO)

of May (Службени гласник РС", бр. 29/2020, Службени гласник РС", бр. 65/2020). Starting from the 17th of March, education has been organized in the form of distance learning and traditional education was completely discontinued. The Ministry of Education, Science and Technological Development has adopted an operational plan that includes a large number of different programs and alternative digital ways of teaching and learning in preschool institutions, and in all grades of primary and secondary school. The focus is on organized distance learning that contributes to the implementation of programming with contents of general education subjects and professional subjects with the largest amount of classes (source: http://www.mpn.gov.rs/).

Educational contents are broadcast on the TV channels RTS2 and RTS3, and are also available for downloading through the free application for mobile phones and tablets via "RTS Moja škola" ("RTS My School"), on the RTS website and the multimedia platform "RTS Planeta" (https://mojaskola.rtsplaneta) . A national platform for online learning has been established on the "Moja škola" website available at

www.mojaskola.gov.rs, which supports the broadcasting of classes on RTS. The website available at www.rasporednastave.gov.rs was also established, where the broadcast schedule of the RTS classes is available, along with a link to the platform "Moja škola" www.mojaskola.gov.rs. During the crisis period, Microsoft provided the use of the Office 365 platform for free, within which a version of the "Teams" application, adapted for education, is available. The "Zoom" application is intended for online meetings and is available in a free version with certain limitations in functionality. Due to the fact that some schools use it for remote teaching, for those who do not have Internet access at home, free access to the application was provided through the mobile networks MTS Telekom and Telenor. Upgrading and expanding the functionality for formative monitoring and evaluation of students is done through "esDnevnik" – starting on the 2nd of April, 2020, parents have been enabled to follow all the formative grades of students through the portal's parent module (https://moj.esdnevnik.rs/). For eighth grade students who did not have the conditions to attend distance learning and access the online final exam, Internet access and/or technical devices (tablets and mobile phones) were provided from donations thanks to the Huawei Serbia Office and companies donated 100 tablets. In addition, Comtrade provided 300 phones, Telekom provided 800 Internet cards and 800 phones, VIP donated 800 Internet cards and 400 phones, while Telenor donated 800 Internet cards and 400 phones, which totals at 4,400 devices and cards (source: http://www.mpn.gov.rs/) (Gy. Molnár et al., 2020).

The largest number of students in the Republic of Serbia, according to school reports, is included in the implementation of distance learning - in both primary and secondary schools this is true for 99% of students, while in schools for the education of students with disabilities the coverage is 93%. This applies to both watching TV classes and using the online learning platforms, as well as the use of alternative forms of distance learning (source: http://www.mpn.gov.rs/).

In Serbia, these reports of The Ministry of Education, Science and Technological Development are based on the reports of the individual institutions.

At the end of 2019, the new coronavirus (SARS-CoV-2), which poses an unprecedented threat, has begun spreading worldwide, causing a disease called COVID-19. The Hungarian Government introduced a new digital work schedule in public education and vocational training institutions. (A Magyar Kormány 1102/2020. (III. 14.) számú határozata a köznevelési és szakképzési intézményekben új munkarend bevezetéséről.) This order was in effect from March 16th, 2020, until the end of the respective school year. During this period, online communication between teachers and students, and social platforms played a prominent role in education. The Hungarian Educational Authority formulated methodological recommendations: "The teacher's role in education is complex. On the one hand, the educator is at the disposal of the students as a source of information, the transferor of knowledge, and the developer of various competencies; on the other hand, the educator also has the role of motivating, guiding, and tutoring the students' independent learning. In a situation where the educator does not have the opportunity to maintain direct personal contact with the students, the role of the latter becomes more pronounced: the students' independent learning, information retrieval and processing must be supported."

During this extraordinary period, education in Hungarian schools was organized in a digital work schedule and not in the classroom. In practice, this meant the introduction of online, digital distance learning. In this forced move, online communication technologies and digital media interfaces did not expand the field of education, according to digital pedagogy methodology; however, they did replace the traditional classroom as an interactive platform. Based on the fragmented experience so far, we can say that using the methodology of digital pedagogy in distance learning without physical presence is sufficient if the minimum technological conditions are met. Without it, education is not possible. Even in distance education, it is essential to maintain the classic timetable and the order of lessons as a vital organizing principle. The use of a single learning management system (LMS) reduces uncertainty, as it does not burden students with using multiple different platforms and reduces the possibility of ignoring specific tasks. Asynchronous communication channels (i.e. e-mail, websites) must dominate the course of learning and access to the curriculum, while at the same time, the teacher's instructions must take place on synchronous platforms (video or written chat). The learning management system must archive the chat, video conference, or video stream and make it available to the class community regardless of space and time. During education, it is essential that students receive clear, concise and unambiguous instructions, and that teachers maintain the flow of communication, while also setting time frames for it. Special consideration should be given to avoiding a reduction in the amount of curriculum as well, as it is not possible to transfer the same amount of knowledge in the online environment as in the classroom.

It is also essential to check the reliability of the technology used in distance learning in order to know its possibilities, abilities, and limitations in educational practice. For example, it is not possible to invite an entire class to a video conference; the students must be divided into smaller groups. As long as nonverbal communication in the classroom allows for effective teaching, these communication components are not present in the environment of secondary oral and written language. If a form of technology does not work properly, the stress factor related to learning will be high. Let's suppose there is no personal interaction with the teacher who can handle these kinds of situations as a facilitator, in that case, there is a risk that the mistakes made while using the technology, will create so much distraction that the student will not be able to participate in the learning process. Similar distractions occur when education is not conducted on a single platform, or instructions are not clear. The platform chosen should serve pedagogical purposes and be based on a logic-based platform familiar to both the teacher and the students.

While the classroom curriculum and its extension consist of the knowledge defined by the standard curricula, the teacher is inevitably forced to make significant choices during distance learning. Therefore, it is necessary to restructure the curriculum, and self-checkpoints need to be included in the knowledge transfer system. The advantage of distance learning is that digital technology is based on interactivity and multimedia. However, the length of educational videos also must be adapted to the context in question. Among the frontal forms of work during distance learning, well-composed video presentations should remain within the 15-20 minute scope and cover several topics. The online context supports group work and collaboration, so it is possible to organize a larger number of group project work for students, using cloud-based platforms. However, students need to develop media awareness as well, due to the high amount of fake news and false information available online.

Because online educational frameworks are far from students' everyday media consumption routines, teachers need to display a curriculum in a format that the students are already familiar with. It is not enough to move frontal education into the world of digital devices, but the possibility of teamwork and the experience of secondary literacy has to be taken into account as well. Based on a representative sample conducted between April 28th and May 10th, 2020, our research seeks to learn about the views, attitudes, thinking, and conceptual web of the pedagogical target group, supporting the possibility of modeling in the field. In the course of the research, we asked which online communication channels and digital platforms the teachers said to have proved to be the most efficient in terms of learning effectiveness in the distance learning that was ordered as a result of the COVID-19 emergency. We incorporated our results and conclusions into a unified theoretical framework.

According to the respondents, the most effective tools for expanding the classroom in distant learning regarding educational effectiveness are teacher-made tutorial videos, and real-time written and video-based chat. Some of the less effective tools include blogs, discussion forums, and free-to-write online platforms that support collaboration. Augmented and virtual reality spaces, bulletin boards, digital storytelling, and podcasts are considered to be the least effective. The greatest uncertainty surrounds our educational blogs, augmented and virtual reality learning spaces, discussion forums, online collaboration platforms, digital storytelling, podcasts, and bulletin boards, which also means that teachers have not tried these tools in practice.

Clearly, the digital transformation of lectures, as well as explanations is the most successful. The illustration is also effective in augmenting the classroom, which is not surprising since computers initially served as an illustration in education before their change in function. Student presentations are much more difficult to replace because, for the time being, it is difficult to filter out frauds. Facing technical difficulties can also negatively affect student participation, while having debates is irreplaceable, according to respondents. If we call on communication theory, we can say that the dynamics of communication processes present in and mediated by technology also differ in how effectively the moderator is able to do their work. In the online environment, a significant increase in workload accompanies the teacher's moderating activity. It is also difficult to replace project work; this result correlates with what we have obtained in judging the effectiveness of collaboration platforms. Similarly, the responses received for the simulation were also divided. The proportion of respondents who said pedagogical communication can be extended to online platforms is surprisingly high.

A survey conducted in Hungary using another methodology (Czirfusz, Misley, Horváth, 2020) showed that based on the answers of the responding teachers (N = 1248), 81.29% of the students managed to be involved in the online education process. The same survey showed that the most commonly used solution for the most commonly used online platforms is e-Crete (e-Kréta), which participated as an official platform in the digital agenda for communication, as well as administration. Based on the responses, this interface

was used by 76% of respondents (Czirfusz, Misley, Horváth, 2020).

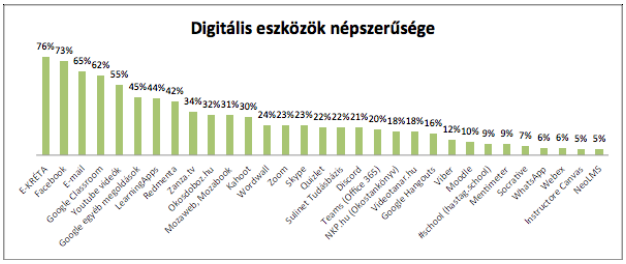

Figure 2.: The popularity of each digital device in Hungary during COVID-19 (Czirfusz, Misley, Horváth, 2020)

In Hungary, at least one third of the students from the group of socially disadvantaged students could not take part in online education (Rosa Parks Alapítvány, Motiváció Egyesület, Partners Hungary - Rosa Parks Foundation, Motivation Association, Partners Hungary, 2020). In most cases, there is a lack of distance learning equipment (laptop, tablet, Internet access) which most schools are unable to help with, as well as a lack of adequate space for learning, and in addition, many such households do not have electricity either. Parents are unable to help interpret tasks and in many cases lack the appropriate digital competencies. The situation is similar for disabled children, but it is likely that the interpretation of tasks and the lack of digital competencies are a problem here (Gy. Molnár et al., 2020).

In Serbia, the Ministry of Education, Science and Technological Development in cooperation with UNICEF and the Institute for Psychology assessed and published a report named: Tracking the ways of participation and learning processes of students from vulnerable groups during education through distance learning (Praćenje načina učešća i procesa učenja učenika iz osetljivih grupa tokom ostvarivanja obrazovno-vaspitnog rada učenjem na daljinu). In primary schools, distance learning covers 83% of students who are members of the Roma national minority who need additional support in education, with 56% of these students watching TV or online classes and 27% receiving alternative forms of support, while 17% of students are not included in learning in any way. In secondary schools, 91% of students from this vulnerable social group are covered by distance learning. Of the total number of these students, almost 74% watch TV or online teaching, and almost 17% participate in distance education through alternative forms of support, while 9% is not included at all (source: http://www.mpn.gov.rs/).

When it comes to students with disabilities, 96% of these students in primary schools are covered by distance learning. About 76% of these students follow TV or online classes, and for about 20% of them alternative forms of support are provided, while the remaining 4% are not included in distance learning. In secondary schools, distance learning covers 97% of students with developmental disabilities and disability. About 87% of students watch TV or online classes, while 10% are included in alternative forms of support, and the other 3% are not included in any form of teaching (source: http://www.mpn.gov.rs/).

When it comes to students from other vulnerable groups, such as students from families of low socioeconomic status, refugees, migrants and others, 94% of those attending primary schools are involved in some form of distance learning. Of the total of these students, about 82% watch TV or online classes, about 12% are covered by alternative forms of support, and 6% are not included in any way. In secondary schools, 67% of students in this category are enrolled in classes via distance learning. Among all these students, 60% watch TV or online classes, about 7% are covered by alternative forms of teaching, and 33% are not included at all (source: http://www.mpn.gov.rs/).

The other area from which most requests for help came was the scope of activities associated with music. Here, fluctuations in Internet bandwidth can result in serious outages and it is difficult to monitor the process, while playing music together online can also be a huge challenge both organizationally and technically (Gy. Molnár et al., 2020).

III. PRESCHOOL EDUCATION

During the state of emergency, kindergarten education also stopped and switched to online. In this regard, the priority tasks of the system of preschool education in this period include the following groups of activities:

1. activities related to the preservation of human health and safety in accordance with the measures prescribed by the Government of the Republic of Serbia, Government decisions, recommendations and instructions;

2. activities that support families with preschool children on how to provide proper conditions for the normal functioning, learning and development of children during the state of emergency and home isolation;

3. activities that support professional networking, networking and exchange of experiences of practitioners in the field of research, joint learning

and competence development (Gy. Molnár et al., 2020).

According to the results of the Questionnaire (whose preliminary analysis was prepared by the UNICEF team), which was completed by 168 public preschool institutions in the Republic of Serbia, in the segment related to activities to support children and their families, the most commonly used media of communication with families were "Viber" and "WhatsApp" services (71%); in second place, in terms of frequency of use, preschool institution employees used social networks for communication with families. Most educators and parents agreed on the optimal way, frequency and terms of communication (84%). Parents, in accordance with their abilities and rhythm of life, were involved in the communication with educators, which is stated by 76% of preschool institutions (source: http://www.mpn.gov.rs/).

IV. PRESCHOOL EDUCATION

Universities and university faculties have independently defined methods and platforms for online education. For example, the University of Novi Sad used a MOODLE-based customized platform, "SOVA" (https://sova.uns.ac.rs/). In contrast to public education, higher education has been re-launched and admission, as well as some laboratory exercises and measurements have been maintained in the traditional way, while also respecting the rules of social distancing and hygiene (Gy. Molnár et al., 2020).

The Serbian Law on Higher Education does not allow online examinations, only on the basis of study programs that have been accredited as a distance learning program. ("The exam is taken at the seat of the higher education institution, ie at the facilities listed in the work permit."). This makes online education and examination significantly more difficult.

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Teaching and Learning Mathematics during COVID period

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Abstract - We are living in a time with new circumstances when the public health is the most important. Because of that, the schools, faculties and the total education process is disrupted. The teachers, but especially students face up with many problems and difficulties during the studying and learning. These kinds of problems are especially expressed for teaching and studying the exact and natural sciences. Mathematics as strict and rational science discipline plays an important role in the education process. Every interruption in the continuous process of teaching and learning could provoke many negative consequences for the students. In this paper we are considering some possibilities for adapting in these new conditions, when the students and teachers cannot be in the classrooms. The main aim of this paper is to analyze easy online ways and resources for teaching and learning mathematics.

I. INTRODUCTION

Mathematics as a science is a very important part in the education process, starting from the elementary school till the high school and faculties. Its importance comes from its applications in all sciences, such as technical sciences, engineering, natural sciences, finance and social sciences. Because of the huge application of the mathematical knowledge almost everywhere, the authors in [1], have said: "High student achievement in mathematics and related subjects may have important implications for the future role of some countries in the field of advanced technology, as well as its overall competitiveness at the international level. By contrast, poor student achievement in mathematics can have negative consequences for the labor market and the possibility of finding employment, as well as their ability to actively participate in society ".

Usually mathematics is perceived as difficult subject for the students in schools and faculties, [2]. Most of the students learn mathematics only when they are obligated to study. The first chance when they can omit mathematics, they do that. This is acceptable for those who see mathematics as only subject or exam which have to be passed. But this problem is very sensitive for the society. Mathematics is a gate for many technological and scientific fields. Leaving mathematics is a beginning of appointment of barriers for the students. Without mathematics, they have limitations for studying of many important sciences, in that way they have limitations of their future jobs. Therefore, it is very important to make efforts to improve the quality of mathematics teaching. Students must be convinced that mathematics is necessary for their quality as future competitors in the labor market. Mathematics develops logical thinking, introduces us to forms in the world around us, enables us to handle with numbers, shapes and other physical structures, and the most important, mathematics teaches us to think concisely, clearly and logically.

Mathematical literacy is "an individual's ability to recognize and understand the role that mathematics plays in the world, to make well-informed decisions and to apply mathematics in ways that suit the needs of that individual's life as a constructive, concerned and thinking citizen", see [1].

All of these competencies which are indivisible part of the mathematical literacy include knowledge of mathematical concepts, ability for monitoring and evaluating mathematical arguments, setting up mathematical problems, choice of mathematical model for representing some mathematical situation. To be mathematically literate that means that someone has ability to apply the mathematical knowledge in real-life situations. The applications of mathematical knowledge in new and unfamiliar circumstances today are increasingly emphasized as the main aim of mathematics education. Anyone who knows the art of mathematical formulas and solve abstract mathematical tasks, and does not know to solve the problem-solving situation that requires the application of mathematical knowledge and skills outside the school context, did not reach the level of mathematical literacy, see [3]. Instead of the content of too big material in math curricula the accent should be put more on the processes of learning mathematics.

II. TRADITIONAL METHODS OF LEARNING MATHEMATICS

Because of the great importance of mathematical literacy of the students it is so important to review the teaching methods which are used in the classrooms.

The teaching mathematics has been changed during the history, but traditional methods which are yet used in most of schools have the same goals.

In the traditional teaching of mathematics, the teachers paid much attention to the mechanical memorization of definitions, statements and formulas. Usually, the teachers who use traditional way of teaching mathematics strictly follow a book in which the authors have written content according some program. These teachers explain rules, procedures for solving certain type of problem and they expect their students to memorize all of that content in order to solve some similar problems in which they will only have different constants, variables and operations. In this way the students only learn how to do some type of calculations. The students can easily achieve these goals by solving similar numerical tasks, because they only use the taught procedures without need for thinking. Almost all the problem-solving tasks are thought in a way that the teacher demonstrates the process of solving a particular type of problem students, and later they are in the process almost unchanged applied to similar cases. In the traditional way of teaching the teacher is in the center and students see the mathematical tasks as abstract not applicable facts. In this kind of model, it is more important, the student to give correct answer instead of basically understanding of the mathematical concept, see [4].

In the classrooms where teacher used traditional model of teaching, the students usually work individually. The work in groups is not allowed by the teacher. Cooperation by the students is not practice on these traditional math classes.

Traditional approach emphasis weak features of mathematics that allow students to make sense of the world around them. This traditional way of teaching not put accent on communication and the use of mathematical knowledge, see [3].

III. CONTEMPORARY METHODS OF LEARNING MATHEMATICS

The basic idea of the modern mathematical and educational community is that in the present conditions of living, mathematics is used everywhere and that all people can successfully learn mathematics and apply it in certain situations. The modern mathematics education has set up main goals in form of standards. Standards related to the knowledge that the student must adopt the call content standards (or mathematical concepts), and competencies that an individual must develop a process called standards (or mathematical processes), see [3]. These standards allow comparison of mathematical results on international level and create broader methodical mathematical community united in order to achieve better educational outcomes in mathematics. Unlike the traditional way of learning mathematics, in modern way of teaching mathematics the practicing of mathematical facts and procedures is not the most important, but it emphasizes the gradual building of knowledge networks of mathematical concepts and their relationships, and flexible application of different procedures, procedures for resolving problems, see [5].

Students are encouraged to work in teams, to communicate and to make cooperation and collaborations with others in the classrooms. They are put in the situations when they can opposite their opinions, to modify concepts in order to make some conclusions on their own. The modern trends require deeper understanding of mathematical knowledge.

The modern curriculum based on standards, "says mathematical thinking and reasoning, conceptual understanding and problem solving in realistic contexts" as the primary goal of teaching mathematics, see [6]. While in the traditional teaching of mathematics most of their time are solving a simple, standardized, numerical tasks that are practiced procedures and automate arithmetic operations, in contemporary teaching solves a smaller number of more complex problems which often have multiple possible solutions. Solving the problem situation is set to the center of mathematical teaching, and of all the students expected to learn and use mathematical reasoning, reasoning, proof, communication and representation of mathematical ideas. In modern mathematics, the new content is usually introduced to students by presenting some unknown problem in your life, rather than through abstract, numerical tasks. These contemporary methods of teaching mathematics make mathematics closer, more interesting and more attractive for the students. These modern trends in mathematics education is actually a base for new modern STEM education – an integrated education of science, technology, engineering and mathematics.

In [7] and [8] the authors proposed two-fold reframing of the mathematics. The first shift is to re-emphasize the nature of mathematics—indeed, all of STEM—as a sense-making activity. The second shift is suggested by the first, with specific attention to classroom instruction. Whether mathematics or STEM, the focus of most instruction has been on the

content and practices of the discipline, and what the teacher should do in order to make it accessible to students. This kind of teaching mathematics will be new but easier and more acceptable for the students, because they will see that they learn something that can be applied in problems from real-life situations

IV. EDUCATION PROCESS DURING COVID PERIOD

For educators, the COVID-19 Pandemic is a transformative challenge; they have faced up with it suddenly and unprepared. The pandemic runs vary fast so the governments in many countries are implementing restrictions in people's movement in public places. Such restrictions have disrupted the normal functioning of all educational institutions. Because the duration of such restrictions is often extending, teachers find themselves in a situation to search alternative methods to continue with the educational process when attending schools and universities is not possible. They did not have tool that can guide them to all appropriate responses, so new ways of teaching become necessary. Educators must swiftly design responses, as the pandemic is spreading rapidly. However, it is very important to protect young people's educational opportunities during and after the pandemic. The continuity of teaching and learning during the COVID-19 Pandemic must be supported. Therefore, the teachers have to work on new methods and applying new technologies, which cannot avoid digital resources, because the process of learning has to be distance learning.

But not all students can easily have access to necessary digital resources and internet, and they should also be involved in the process of education, so it was serious challenge for the teachers to reach the educational goals in such environment. Teachers had to search and access different ways to continue educating students during the pandemic. Different resources and teaching materials for online learning were available and the teachers could use them, but some of them were not enough and appropriate and the teachers should adopt them or use as a sample to develop their own.

Online digital resources become a basic need in the process of teaching and learning, which have to support the continuity of learning for students who have access to the internet and digital devices, but also for students that do not have such access, something that was not so easy.

According to [6], it was published at the end of March 2020 a framework to guide an education response to the COVID-19 Pandemic, as a tool to support education leaders, based on a survey conducted between the 18th and 27th of March 2020. The survey assessed educational needs, priorities, implementation challenges and emerging responses, and was the first of a series of surveys to monitor the evolution of responses to emerging needs in the education sector. Subsequent modules will include radio and educational television resources, and a module to guide the implementation of effective education responses. Those resources will help educators collaborating across institutions and countries in the important and urgent task of supporting students' opportunity to learn during this challenging crisis shared among humankind.

In [6] we can also see an analysis from the survey regarding the resources for online education. The resources are grouped into three categories, according to their purpose: 1. *Curriculum Resources*: These include lessons, videos, interactive learning modules and any other resources that directly support students in acquiring knowledge and skills. 2. *Professional Development Resources*: These are resources which can support teachers or parents in supporting learners, guiding them to content, developing their skills to teach remotely, or more generally augmenting their capacity to support learners now learning more independently and at home, rather than at school. 3. *Tools*: These include tools that can help manage teaching and learning, such as communication tools, learning management systems or other tools that teachers, parents or students can use to create or access educational content.

Besides the available resources and tools, not too many educational organizations, especially schools, have accepted general solution for the educational process to be continued. All parties involved in the educational process (teachers, students, parents …) faced up with the new situation very suddenly and unprepared and not too many of them could response immediately to the requirements the new situation has imposed. Most of the teachers in many countries were left themselves to manage the process of education without support of their organizations. Some of them used different platforms that offer team working, but left without appropriate training, many of the teachers were improvising the educational process using social networks. Old and slow devices and interrupted internet connection often appeared as barriers in the teachers' effort to make the teaching as qualitative as they can. Teachers do not always have correct backward information about students' acquired knowledge. Video connections on the lessons and exams were not always possible. There were

students that don't do their tasks and exams individually. Many of the teachers and students don't have the equipment for overcoming such disadvantages in the process of online education. And that is not all. The biggest problem in many countries is that not all students have the opportunity to follow the teaching process online. They do not have the necessary digital devices; they not at all have an internet connection. So, the imposed restrictions in the movement on public places have cut the opportunity to such students to be involved in the process of education. It seems that such students have to be discriminated in the process of education. These problems remain still unsolved and open for consideration, although the education should be guaranteed right for the students, especially those in primary and secondary school.

V. TEACHING MATHEMATICS DURING COVID PERIOD

The contemporary methods have shown as more effective and more useful methods in the mathematics education.

But nowadays we are living in a specific period, when almost everything must be changed because of the COVID-19 virus pandemic. The COVID-19 pandemic has drastically influenced education. Education has had to migrate to the online environment. This change has impacted not only to schools and their staff but also to families by allowing mothers and fathers to be more involved in their children's education. Schools closed and mathematics teachers were facing with the challenge of developing alternative educational practices, including distance learning through digital technology. The teaching of the subjects in the area of social sciences maybe is easier for the teachers, and the students can easier study such kind of materials. However, the teaching and studying mathematics, physics, chemistry and other natural or technical sciences is more complicated in digital form. The material is more complex, and it is very difficult for the students, parents for understanding. In addition, the teachers face up with many difficulties during the process of explanation of these subjects, because of the nature of its contents.

According to the U.S. National Council of Teachers of Mathematics (NCTM) and the National Council of Mathematics Supervisors (NCSM), and taking into account that students learn at different speeds, they conclude that the curriculum must be flexible so students can reach the content at varying rates. They focus on three critical areas for planning, namely, structural considerations, teaching practices, and advocacy. They gave the instructions for all three critical aspects of the planning process, see [9], [10].

The structural considerations refer to the updating of the knowledge after the quarantine period. In order to that, they recommend some support strategies.

The NCTM and NCSM recommend joint teaching or team teaching to help instructors coordinate their school grade content with what came before and what follows. Both agencies emphasize the importance of teachers working together to determine what is prioritized before teaching math in the new school year.

In the part of teaching practices, they recommend more flexibility and formative evaluation. In order to implement these practices, the teacher needs to ask questions, analyze the assignments and activities, and observe them. These eight effective practices are:

- Setting math goals that focus on learning;
- Implementation of the tasks that promote reasoning and problem-solving.
- Using mathematical representations;
- Facilitating meaningful problem-solving course.
- Asking questions with a purpose;
- Developing procedural fluidity that comes from conceptual understanding.
- Supporting the productive struggle in learning mathematics;
- Obtaining and using evidence of students' mathematical thinking.

In addition, the most important is the point that refer to not limitation the process of students' mathematical reasoning. The teacher must try to show to the students, that math is everywhere, starting from their devices to politics and finance.

In the developed countries in Europe and America, the process of distance learning maybe is easier for the teachers and the students, because they have done many investments in distance learning before the pandemic. But, in the Balkan region, these changes in the education process draw out many problems in the education systems. Besides the problem with internet connection and computers, the teachers and students do not have enough material in digital form. All of the material is in English, and there are not enough digital platforms

that can make the process of teaching and studying easier for the teachers and students.

In addition, a list of resources that refer to the math education in primary and secondary school is given.

For the teachers in primary and secondary schools the helpful links are the following, see [11], [12], [13]:

- IllustrativeMath.org https://www.illustrativemathematics.org,this website supports Kindergarten through twelfth grade. It is organized by the Common Core State Standard math clusters and includes the 8 Standards for Mathematical Practice. The website includes high-quality tasks and analysis of answers. Teachers can assign a choice of tasks via Google Classroom using the student view.
- KhanAcademy.org https://www.khanacademy.org/ This website includes list of high-quality, standards-aligned lessons for kindergarten through twelfth grade. The lessons include videos, practice, and a formative assessment for math, science, reading, and more. Students are given immediate feedback and teachers are able to observe daily progress. Teachers may assign the lessons via Google Classroom or by using a class code.
- https://illuminations.nctm.org/. This website offers quality standards-based resources for teaching and learning mathematics, including interactive tools for students and instructional support for teachers. The lesson plans for teachers are also included in this website. There are many games and applets for the students.
- StraDDegy, https://app.straddegy.com/big-ideas, this website is for the small children in the first years of the primary education. StrADDegy is designed to move children away from a reliance on inefficient counting strategies and rote memorization to a mastery of addition and subtraction facts constructed from an understanding of the parts of numbers and their relationships.
- Cookie, http://www.cookie.com/kids/games/viewallgames.html – this website offers mathematical games for children from three to seven years. It also included working tables, videos and coloring pages.
- PurpleMath, https://www.purplemath.com/ - this website is intended for the students in primary schools who face up with problems and difficulties with mathematics.
- Free Math, https://freemathapp.org/ - this application allows to the students to have access to the problem which is solved in a few steps.
- AAA Math, http://www.aaamath.com/ - this website offers many interactive mathematical lessons in arithmetic.
- All In One High School, https://allinonehighschool.com/ - this is a free source for the students. All the material is distributed by themes. It includes videos, quizzes and activities for every day.
- Math Modeling, https://m3challenge.siam.org/resources - this website includes many mathematical real-life problems, which can be solved by using of mathematical modeling. There are mathematical handbooks, instructive videos and guidelines for mathematical modeling.

VI. CONCLUSION

The education has changed during COVID-19 pandemic period. The people must keep the distance, the physical contact should be restricted, the students must stay home and study at home with their parents and teachers who are at the other side of the computer. All these problems and challenges have high impact to the organizing of the teaching and learning process. The digital literacy has become necessary for the students, parents and teachers. Classrooms were moved to the online platforms. The total education is on the internet and the computers. It can be concluded that there are many digital resources for teaching and studying mathematics. Most of them are free for using. The teachers should use these digital resources and possibilities in order to facilitate the education process for the students.

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Verification of User Behaviar Model in P2P Storage Distributed System Simulations

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Abstract – In previous years many researchers, for their proof of concepts, used some kind of computer simulation. Simulation tools have predefined models for different aspects of their simulations. Correctness of these models has a big impact on simulation results. As time elapses, technologies and user behavior change, so models should follow these changes. This is especially important when we simulate p2p systems since they rely on user presence and their behavior. In previous research we noticed that in a group of users, administrative workers have similar pattern of behavior, and we developed model for this type of user. Our goal in this research is to try to verify this model using much larger dataset then we used in the previous research.

Keywords: modeling users, digital file collection, file size, file generation

I. INTRODUCTION

Simulators are main tool for creating systems blueprint and for proof of concepts for many researchers. Some simulators are designed and built heaving in mind specific use, like parallel systems, distributed systems, computer networks and so on. Sulistio et al. [1] analyzed 75 simulation tools and their characteristics and they proposed classification of simulation tools. They classified simulators based on modeling framework to entity-based and event-based. We agree with Ciprian et al. [2] since they concluded that distributed system simulation uses both modeling frameworks and that distributed system simulation should calibrate models using data collected from real environment [3]. Some simulators like Query Cycle, developed by Stanford University, allow us to configure model peer behavior [4] and others like Sim Grid allow import of real-world data using dumps (captured traffic from real environment). Many researchers [5,6] analyzed dynamic aspect of peers in order to recognize peer behavior and to properly configure models. In large complex distributed system, researchers are trying to simplify model, using generic peer models that often do not reflect real behavior of nodes.

In our previous research we proposed including user behavior that is different from churn behavior of a node. Churn reflects node behavior pattern of availability for distributed system, and user behavior reflects usage of node by user. We can have node that is constantly active, but user generates traffic just during the work hours.[7].

II. METHODOLOGY

In order to produce simulation that corresponds to real life environment, researchers monitor existing systems and collect data. Collecting data is a challenging task, researchers usually collect data from home networks or test bed [8] or gather from some network repositories [9]. These datasets that are available on Internet allow researcher to repeat experiments and verify someone's research but very often datasets are obsolete and don't reflect current characteristics of a certain type of traffic. Second option gives us much more realistic data, but there is a huge concern about privacy and security as noticed by Jia at al. [10]. After a few months we managed to get dataset from one enterprise where majority of users correspond to our user profile that we trying to verify. Dataset with censored data was used to conduct this research. Censored data are data from which administrator removed sensitive information that could be misused, data like folder and subfolder structure, names of users (real usernames are replaced with code UserX), some filenames are crypted and so on. This showed us that gathering data from real world is difficult to achieve, and censored data lack of some useful variables that could reveal some interesting facts about the observed phenomenon.

Collected data are from a microcredit organization in Bosnia and Herzegovina, from its headquarter and several branch offices. We believe that this is good for a dataset since in this way we can say that our dataset is not homogenous and affected by locality of place from where we collected data. Dataset contained data from 128 users / workstations, about file system and user data.

Our goal was to confirm that data of a certain type of users (administrative workers) follow negative binomial distributions in file generation, comparing

file size and file structures. We were aware that personal digital collection (user files) can be affected by company culture, since some enterprise policy could forbid music, video or picture collections. During research while we were seeking for an enterprise that was willing to share data, we discovered that some companies do not allow users to store any personal files, or to visit social networks and so on. The goal of using statistical tools like RStudio, MS Excel is to explore dataset, to try to fit empirical data to probability distribution models, and to find one that best matches the collected data in order to compare it with our previous research.

III. RESEARCH

Total number of collected datasets we discarded is 53 since these datasets contained data from period that was shorter than two years. Reason could be related to the fact that user either got a new PC or was employed recently. And since we wanted results comparable with our previous research, we took the same period of time for our datasets, so we reduced all records to same time period.

A. File generation pattern

For the remaining datasets (75) we conducted statistical analysis and tried to fit empirical data to probability distributions suitable for this type of data. We tested five distributions: Poisson distribution, Negative binomial distribution, Zero inflated poison distribution, Zero inflated negative binomial distribution and Hurdle distribution. During statistical modeling phase, we included Hudrle and Zero inflated distributions since, based on the histogram, we concluded that datasets have high percentage of zeros and do not have typical histogram shape for the Poisson distribution.

Zero inflated negative binomial distribution treat data as they come from a combination of two distributions (zero part – Bernaulli distribution and second could be Poisson, or some other distribution). We will not elaborate theoretical aspects of the distribution since there are many papers related to this [11,12,13]. ZINB distribution relies on a predictor variable to model zero part.

Hurdle model treats data as they come from two separated processes, first those that generate zeros - binary outcome of whether a count variate has a zero or positive realization - Bernaulli distribution and if outcome is positive, and other that generate count data. [14]

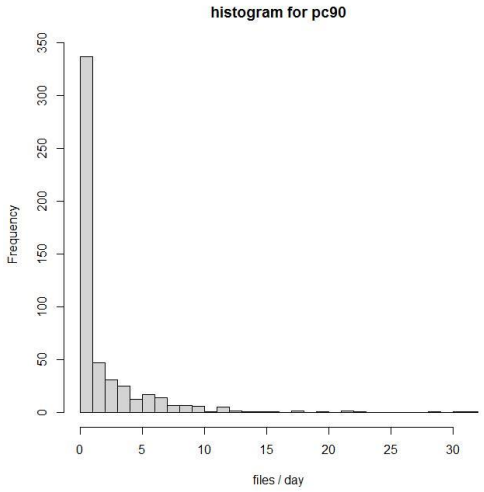

Figure 1. Histogram for PC90

Histogram clearly showed that these data do not fit to Poisson distribution but since many researchers use Poisson for discrete count data we also included this distribution. Using goodness of fit (GOF), we tested all datasets with the proposed model. We compared all models using Akaike information criterion - AIC parameters and summarized results.

TABLE I. AIC CLASSIFICATION FOR OBSERVED DATASETS

AIC	Total
NB < ZINB	49
NB > ZINB	18
NB > ZINB (0 – max 2)	8

According to Burnham and Andersons, if a difference between two models is less or equal to 2 then the difference between models is minimal and it is recommended to take a simpler model [15]. They also mention that AIC values from 5 to 10 constitute certain differences between models, and AIC value higher than 10 is a clear evidence that model with a lower AIC should be the preferred model. Since the majority of data sets follow negative binomial we chose to use negative binomial distribution for modeling datasets.

In our datasets we found a dataset of PC90 with ZINB and NB model differences of AIC values close to 2, so we used a rootagram to visually compare those two models (NB – figure 2 and ZINB - figure 3). Diagrams show minimum difference between the two models. For models that AIC designated better fit to ZINB distribution, we increased time of observation for the whole dataset. We discovered that some of datasets converged to NB after some additional time (more than our sample of 2 years).

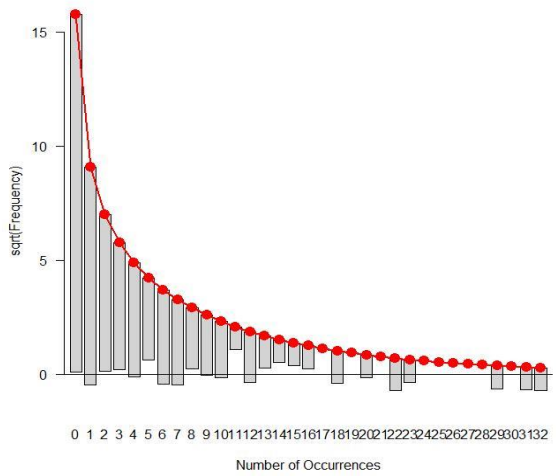

Figure 2. Rootagram for NB model of PC90

For model development we used statistical tool RStudio with R – programing language combined with libraries fitdistrplus (MASS package), zeroinfl (PSCL package) and library hurdl (package hurdler and VGAM). Developed model provided us with two parameters for pseudo generator (rnbinom). Parameters derived from NB model for PC90 dataset are *size* = 0.38916697 (0.03473193) and *mu* = 2.25049908 (0.17071406). Using this parameter, we generated our dataset. Frequency table of generated dataset was used to calculate expected frequencies. Using chisq.test we compared frequencies from the empirical dataset and expected frequencies from the generated dataset and based on the P parameter we concluded that there is no statistically significant difference between these datasets.

After we analyzed all datasets and generated models, we got 75 different parameter *size* and *mu* for our models. We wanted to find average parameters for the "mean model". As we mentioned earlier, our dataset was limited, and we could not conduct statistical merging of models but simple arithmetic mean of parameters. Merging all data points failed to produce model that follows negative binomial distribution.

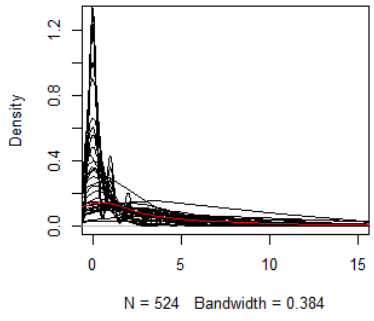

Figure 4. Average (mean) model

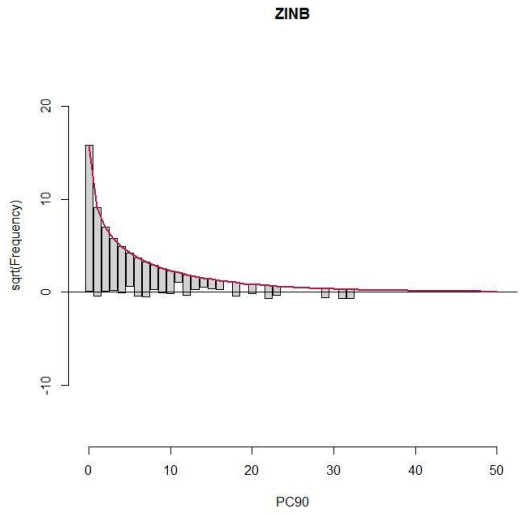

Figure 3. Rootogram for ZINB of PC90

Arithmetic mean of parameters from all models resulted with the following values mu = 5.397567 and size = 0.4061394. We generated the dataset using these parameters and produced density graph and histogram.

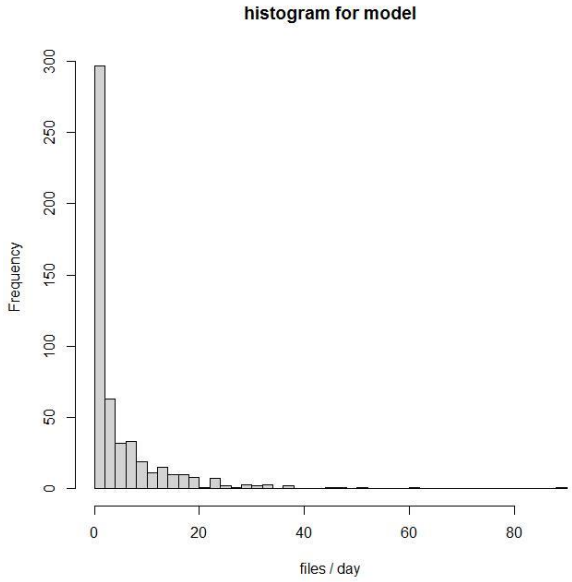

Figure 5. Histogram of data generated by average model

B. Structure of files

Second part of research is related to file structure of collected data. We analyzed file extension from all users that were used in modeling. Collected data are presented in Table 5. (using percentage of total files).

TABLE II. STRUCTURE OF USER FILES

Ext	Pdf	Xls	Doc	Zip	Jpg	Ppt	Txt	Mp3
%	45,20	27,74	12,2	0,66	12,27	0,08	0,02	1,8

Comparing to our previous research [7] it's clear that dominant file extension is different. Structure is definitely lead by company profile, since it s microcredit organization, employees use different reports (pdf) to make some calculations (xls) and to document that (doc), so we can say that this file structure is expected.

C. File creation time

We analyzed time stamps from collected datasets, we were interested in file generation time patterns.

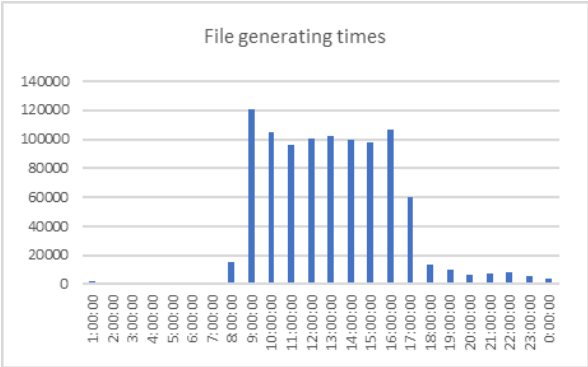

Figure 6 Times of file generation

Results corresponded to working hours and based on the histogram we could conclude that this data generation pattern followed normal distribution. Using statistical analysis KS test, we confirmed that this time generation followed normal distribution. This confirmed results from our previous research [7].

D. file size

Total number of files collected showed that 75% of files fall in a size range from 64 KB – 4 MB, what is slightly different then what we found out from our previous research [13]. Graph shows PDF of files size. Average file size from collected dataset is 240,59 KB and it is different than the forecasts found in similar research [16, 17] even comparing to our research. Our previous research included limited number of workstations, so that is not comparable with this dataset.

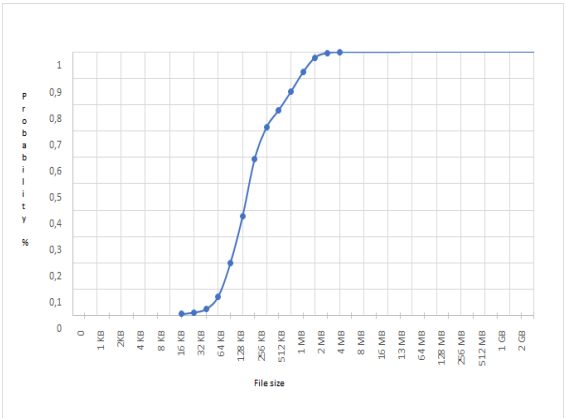

Figure 7. Probability distribution function for file size of collected datasets

IV. CONCLUSION

Goal of our research was to verify our previous research result. In order to do that we had to find a representative dataset. We got dataset from real enterprise environment where majority of users belong to target group of users (administrative workers). Datasets were analyzed and from available datasets we chose 75 datasets for further processing.

First goal was to determine if dataset from this type of users really follows negative binomial distribution. Datasets were compared with several distributions (Poisson, Negative binomial, Zero inflated poisson, Zero inflated negative binomial and Hurdle distributions). Results of model comparison confirmed that this type of user can be modeled using Negative binomial distribution, with small percentage of users that follow Zero inflated negative binomial distribution. Lack of additional information in datasets disabled us from doing deeper analytics for this group of users, but we noticed that some of them converge to Negative binomial if we increase observation time. Final result is producing of the "default" model for modeling this type of users.

Second part of research was related to filetype structure, file creation time and file size. We noticed some difference in file structure since dominant file extension is pdf. while in our previous research that was .doc extension. Conclusion is that file structure is related to company portfolio of activities, and also to company culture since we noticed that only additional category of file was mp3 with 1,8 %, and in our previous research "other file extension" was around 8%.

File creation time confirmed results from the previous research but this was expected since company working hours is from 08:00 – 17:00 and majority of files were created during this period and our research confirmed that file creation follows normal distribution as we concluded in our previous research.

Last part of our research was related to file size. We noticed that there is increase in average file size, but not as expected from other researches. Thus, we can conclude that average file size increases with a time but with different rate than expected. This can be related to certain type of users and observer file types. Other researchers analyzed file system as a

whole and not just user files, so we can't confirm that their findings are incorrect.

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Comparison of Software Application Development Procedures in C++ and C# Programming Languages

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Abstract - The topic covered in this paper aims to present the creative application and development of a software application in the C # programming language. The motive that is crucial for processing this topic is that the process of programming and development of software applications need to be presented in an interesting and tempting way, in order to motivate other students to use and apply programming languages and programming in general. In order to make learning a new programming language more interesting, it is necessary to emphasize the practical application of each step. By emphasizing loops and logical procedures as well as their application, we can more easily understand and accept.

I. INTRODUCTION

The motivation is the primary fact in this paper. When we got creative interpretation and using of some programming languages the students are more interested in that topic and they have better concetration on the class. Making some games or other project can show them how programming is easy and how it can be usefull. Programming like mathematical example can be understood by some students, but not to all of them.

In this day and age we are expected to follow the new daily technological advances. Everything on ours phones, computers or some other gadgets are interactive, funciolan and full of colours.

Children of this days in the first 3 years of their lives learned how to use a mobile phone. Our mobile phones are interactive and full of colours. We can present our class of programming in the same way.

In this paper is that one way how easy and fast students can understand and use procedures in C++ and C# programming languages. The game ,,Pac-Man" is made in Unity with C# programming language. Unity allowed us to make animation of our actors, control audio sound and to see visual use of some procedures.

II. PREVIOUS WORK

The key to object-oriented programming is that the data contains not only the properties of the entities but also the operations on them. When the work with one class is finished, only then does the work with another class begin, and only when everything is finished does the programmer return to the initial problem. The characteristic of object-oriented programming is expressed precisely by the brevity of the main program. The goal is to create classes that will not be rewritten, but used over and over again. [1]

An object represents the uniqueness of the properties by which it stands out from other objects and by which it is recognizable, it is called identity. If we enter in a library, we will realize that the library is made up of shelves and books. Books can be classified into categories: classics, tragedies, novels, poetry, prose… Each book is characterized by a certain author, publisher, genre, date of publication, circulation, main characters, number of pages, short description of the work but also criticism. In this case, the book represents an object, and all these characteristics or attributes represent what makes it unique.[5]

C ++ is a higher level programming language. It arose in response to the need to create objects. It provides an easy and safe way to manage the fields of an object, more precisely attributes. Inheritance solves the problems of concretization and specificity of each algorithmic problem. C ++ is an upgrade of the C programming language. The difference between the C ++ and C programming languages is the way how data is input and output and the ability to manipulate objects through the introduction of classes.

The C # programming language is a language that allows you to write console and Windows

applications, and even Web applications. It is one of the younger programming languages. It was created in 2002 and is an integral part of MS .NET Framework 1.0. [2]

The C++ programming language is a low level programming language that adds object-oriented features to its base language C whereas C# is a high level language. The C++ compiles down to machine code whereas C# compiles down to Common Language Runtime, which is interpreted by JIT in ASP.NET. The C++ programming language is an object-oriented language while C# is considered a component-oriented programming language. In C++ is nessesery to manage memory manually whereas C# runs in a virtual machine, which performs memory management automatically. In C++ development should follow any specific architecture and must be portable whereas C# development should be simple, modern, general-purpose, object-oriented programming language. [3]

III. SOFTWARE APPLICATION DEVELOPMENT

PacMan is an arcade game developed by Namco. The game was first released by Midway in Japan on May 22, 1980. The original name of the game was Puck-Man, but that name was changed due to the European standard. The game can be played by a maximum of two players, alternately. Movement was enabled then through the joystick, and now also through the computer keyboard in four directions (up, down, left and right).

The main character is called PacMan, he is yellow. He has three lives in the game, his goal is to collect all the so-called pills that are on the screen. The pills are arranged around a maze and PacMan moves through that maze. The obstacle that poses a problem for passing the game are the ghosts chasing PacMan. The ghosts are called: Blinky, Pinky, Inky and Clyde.

The begin of creating our software aplication is a map. Map is place in game where our actor Pac-Man is moving all around. In this part of the paper is important to know one field of math. Pac-Man way is based on vecotrs. The points should be distributed the same in relation to the X or Y axis. It is important that they stand in the appropriate plane and that the vectors match adequately. In case there is a deviation, our hero will not be able to move later. The movement of the heroes is based on vectors, more precisely on the directions of the vectors. And that is made possible thanks to those points that we will place over the entire map of our game.

On the map we distinguish: nodes, portals, pills and super pills. A knot is any pill that has a turn, we look at it as a crossroads. Portals are those pills that do not bring points, but therefore allow you to move from one end of the map to the other end of the map. Pills are all pills that are visible on the map and assign a certain number of points. Super pills are those pills that change the state of our heroes and they also change roles. By consuming the super pill, the points are doubled, PacMan has the ability to attack ghosts, PacMan moves faster, but that is why ghosts move slower.

A Tile script is added to each pill. The Tile script allows object identification. More precisely, it allows us to assign any pill, whatever role we want. *(Figure 1)*

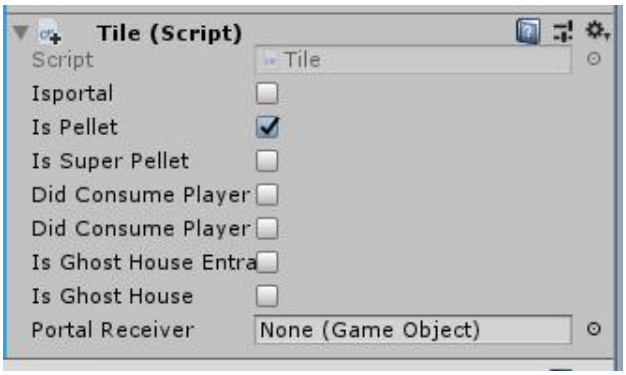

Figure 1- Using of Tile script

If we mark that the so-called pill is a node or intersection, it is necessary to join the Node script. Using the Node script, we indicate which nodes are adjacent to a given node and how many adjacent nodes there are. Each pill has its own unique number. When we draw nodes with given unique numbers, we get a grid of motion. *(Figure 2)*

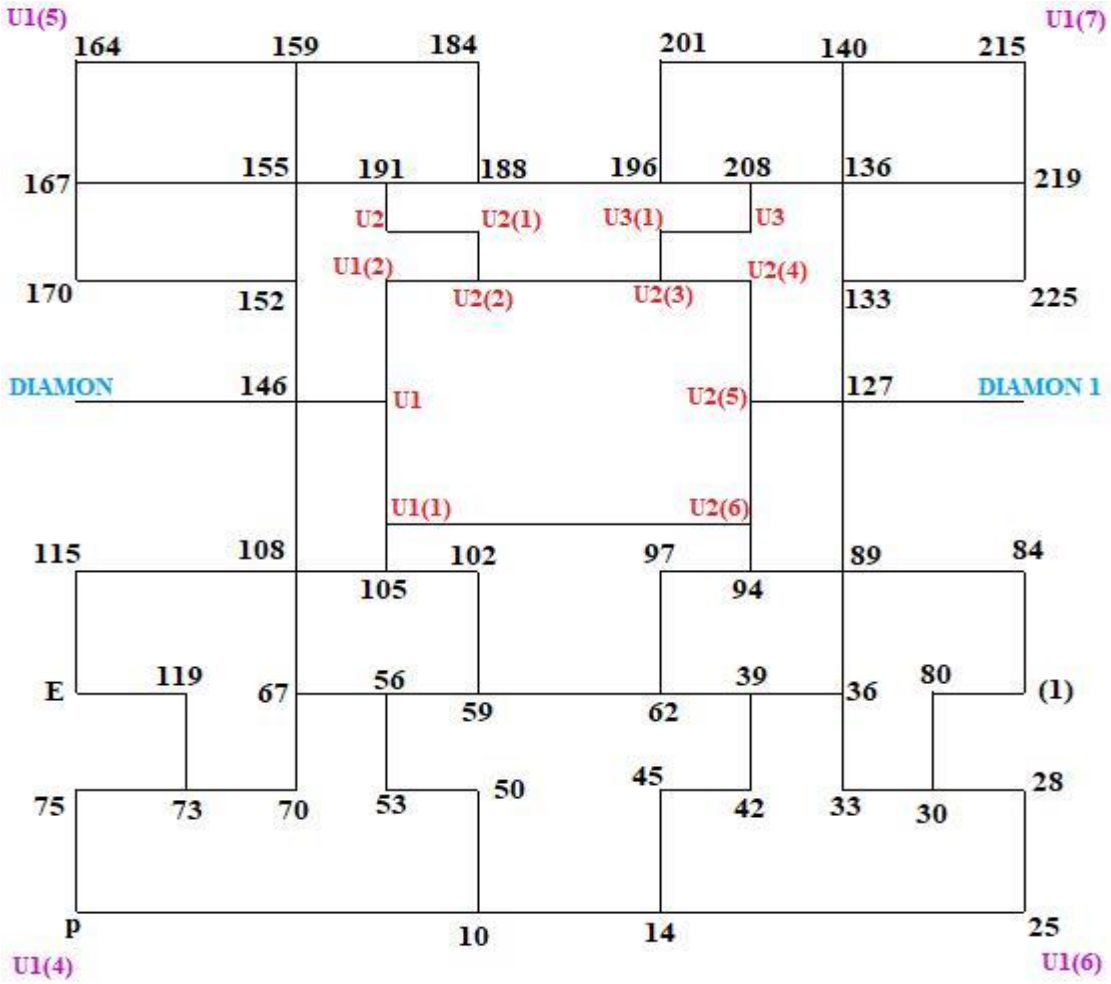

Figure 2- The Grid of map's nodes

Each node needs to define its size (number of neighbors), name the neighbors and define the direction of movement towards those neighbors. The definition of the direction of movement of the neighbors is determined on the basis of the X and Y axes. If the movement is in the direction of the X axis or the right movement is defined on the number 1, if the movement is opposite to the X axis or the left movement is defined with the number -1. If the movement is defined upwards in the direction of movement of the Y axis, it is defined by the number 1, and if the movement is performed downwards opposite to the direction of movement of the Y axis, it is defined by the number -1.For example, if we consider pill 89. Pill 89 has 4 adjacent nodes. Adjacent nodes are 127, 84, 94 and 36. Node 127 determines the upward movement and the value is along the Y axis 1, and along the X axis 0. Node 84 determines the movement to the right and it indicates movement along the X axis 1, and along the Y axis 0. The downward movement is defined by the adjacent node 36 and its value along the Y axis is -1, and along the X axis 0. Node 94 denotes the movement to the left and its value along the Y axis is -1, and along the X axis 0. *(Figure 3)*

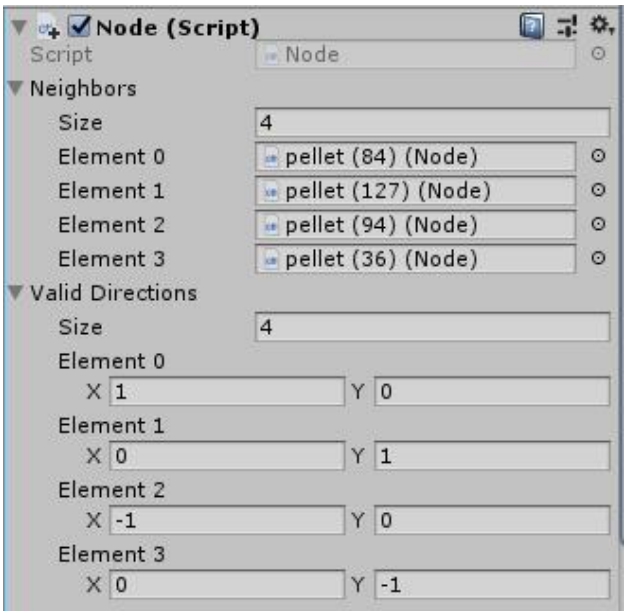

Figure 3- Using of Node script

The super pill has the task of making the game more fun. There are only four super pills on the

whole map. Super Pills are defined using the Tile script where the Super Pellet option is checked. By consuming super pills the spirits transition into their Frightened mode. This means that they change their animation into a timid and blue ghost and their speed of movement slows down. PacMan accelerates its movement and has the ability to eat the ghosts. When PacMan consumes ghost, extra points are earned and each subsequent point gets its own specific bonus. After consuming ghosts, the ghost passes from its timid state to Consumed mode, more precisely to a state where only the eyes appear and at high speed they go to their initial position where they return to their normal shape with normal speed of movement. *(Code 1)*

```
        if (tile.isSuperPellet) {
                        GameObject[] ghosts
                    =
GameObject.FindGameObjectsWithTag("Ghost");
                        foreach (GameObject
            go in ghosts)
                                {

go.GetComponent<Ghosts>().StartFrightenedMod
                  e();
                                }
                              }
```

Code 1 – The part of code when Pac-Man consumed a super pill and ghosts change into frightened mode

IV. CONCLUSION

This task software application has to motivate the reader to perfect his programming and apply it effectively. Shaping our acquired knowledge into something applicable and creative can contribute to beginners in object-oriented programming to develop their logic and look at things in perspective. So that each of their newly created software applications has the opportunity to be further developed and perfected.

The PacMan software application can be refined and improved with a few tweaks. First of all, in order to attract new users of the application, it is necessary to add a new scene in which each user would enter their data and record their own result. This data would be stored in a specific database and could be shared on social networks.

When the PacMan software application gets its final look, it is necessary to surprise users with some thematic look. If the holidays are followed in the place and surroundings where this software application is represented, it is possible to create a menu and heroes in that spirit. In that way, we get the possibility of constant renewal.

Programming as a wide range can play a key role in the development of our logic, but also the imagination itself. Through the creation of such a project, in addition to the development of the mentioned items, we can conclude that the application of mathematics itself is crucial in the process of programming and creating some new ideas.

ACKNOWLEDGMENT

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Teachers' and Students' Attitudes Towards Doing Homework Assignments Online

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Abstract – Today, information and communication technology has a multiple role in teaching and is a source of various possibilities for organizing daily teaching, classes, but also homework assignments, which can now be done using digital tools. The authors explore the attitudes of students, but also teachers, regarding doing homework assignments online, and their perception of the importance of having online homework assignments. The method by which the research was conducted is a survey. Based on the results of the research, it was determined that over 70% of students accept online homework, because they gave the highest grades for this type of work. However, only 8.6% of teachers said that they fully agree, and 34.3% mostly agree that the online way of doing homework contributes to higher quantity and quality of completed assignments, which would ultimately contribute to better student knowledge.

I. INTRODUCTION

Modern society is a society of advanced technologies, which require knowledge, understanding and competence. That is why the progress of modern society in many ways depends on the ability to continuously learn, develop and apply new knowledge. Modern society is a society of knowledge, and thus, knowledge and competence (1) are basic assumptions of its development (2). In addition to that, technological progress over time has led to inevitable changes in education, which include electronic learning (e-learning). E-learning refers to learning with the use of information and communications technology (ICT), which has been present in teaching practice for over two decades. According to the definition of the *American Society for Trainers and Development* (ASTD), e-learning is a methodology used to deliver or enable the instructional content or learning experience by the use of electronic technology (3).

Based on research on the use of ICT in the Republic of Serbia, in 2019, the data obtained from the *Statistical Office* of the Republic of Serbia shows that 80.1% of households own an internet connector – which constitutes a 7.2% increase when compared to 2018 (4). It is also interesting that as much as 93.7% own a mobile phone. Thus, the fact is that the generation being educated today is growing up in a digital environment.

The emergence of ICT demands new forms of interaction between student and teacher. The teacher is the main implementer of innovation in the field of teaching. As the result of scientific knowledge and technological development, it is rapidly changing, and it requires individuals constantly learning and improving - the acquisition of new knowledge, skills, competencies, and their applications in practice (5). The New Age is asking for a new strategy for organizing the teaching process, so the management of that process should be viewed in an interdisciplinary way, having in mind cybernetics, communication theory, new learning theories, the didactic doctrine about independent and research work of students, and so on (6).

The basic goal of implementing modern technology in teaching is to facilitate the acquisition of knowledge and make that knowledge more permanent. This depends not only on technical possibilities, but also on teachers, i.e. their readiness and expertise when it comes to working with modern technologies (7). Considering the fact that schoolwork continues in the form of homework, for twenty years research has been conducted to answer the question of whether traditional paper-and-pencil homework can be replaced by web-based assignments, and to what extent.

In 2020, despite the unusual situation the pandemic resulted in, teachers and students gave a very responsible and dedicated response. Namely, due to the announcement of the emergency situation in the whole country, web-based teaching has become part of our everyday life and enabled people to learn new things, work with modern educational applications, as well as communicate with colleagues and students in a different way. Even though it was unplanned, at least in this moment and form, it has become possible to see the advantages and disadvantages of this kind of teaching, already covered theoretically through research, in practice. The research of the authors Bulić, M, Jelaska, I,

Jelaska Mandić, P, confirms that e-learning is as successful as traditional teaching, so it can surely be used under the conditions when pupils cannot be present in the regular classes in the classroom (8).

The results of our research, done in First Obrenovac Elementary School in Obrenovac, show the readiness of teachers, as well as students, to adapt to the new situation and use it to further the accomplishment of their educational goals. The potential of web-based teaching and web-based homework has certainly not been realized to its full extent, but two and a half months of this kind of approach has been a valuable experience for both groups, as well as an opportunity to assess its pros and cons.

Research has been done on 113 students and 35 teachers within the framework of this paper. The research method was a survey. The attitudes of students and teachers when it comes to doing web-based homework were assessed, since the human factor cannot be separated neither from these kinds of relationships with the world, nor from their practical outcomes.

II. LITERATURE REVIEW

Theory states that homework assignments and studying at home are "connected to students' schoolwork, thus making classes and homework a didactic unity" (9). Independent work, studying and doing different kinds of assignments of varying levels of difficulty either continue the teaching process, or encourage and prepare the student for it (10). In order for the didactic function of homework assignments to be fulfilled, the assignments have to be looked over and checked. The author Kyriacou thus believes that "the teacher should check the homework to indicate the need to correct possible inaccuracies and to provide feedback to the students themselves as well as their parents" (11).

Theory offers different opinions; one of the opponents of homework is Glasser, who sees „it as a coercion against the student, burdened in her/his free time" (12). In contrast, Painter believes that „homework is *an extension of the classroom* learning that allows students to process the information they receive in class" (13). However, Cooper believes that students can do homework when they want in their free time outside of school (14).

ICT has a manifold role in teaching today and offers endless possibilities for organizing everyday teaching and classes, but also homework assignments, which can now be done using digital tools. Even though this practice is widespread in some countries, in some states it has not been fully researched or applied.

Web-based homework systems can provide an affordable alternative to traditional approaches to administering homework (15). As part of this trend, many software packages have been developed, allowing students to complete homework assignments on-line (16).

Web-based homework as a course element has even more positive effects than paper-and-pencil homework affirm by some researchers (17)(18). For example, Dufrense *et al* compared the effect of the web-based homework and the paper-and-pencil homework on student achievement as measured by exam performance (17). They found both that web-based homework led to higher overall exam performance. However, the study conducted by Bonham *et al* found that no significant differences in student performance were found that could be attributed to the homework method used (19).

The research by the author Demirez encompassed a physics course, with 37 students who did their homework in the traditional way, and 41 students who did e-homework. In this study, web-based homework system is developed to assess students' introductory physics course performance. Later on, these results are compared with paper-based homework performance for mid enrollment physics courses. One of two identical sections of introductory physics course students received paper-based, hand graded group homework while the other received the individual web-based homework. Then two groups' on conceptual and problem-solving performance measures are compared. No significant differences were found in students' *Force Concept Inventory* (FCI) test scores. However, average homework performance scores were significant that could be attributed to the homework method used in favor of paper-based homework group (20).

The author Deminez (20) stresses that the possible constraints to paper-based assessments may be compensated by technology:

1. The constraint is that there is a problem of displaying multimedia works using pens and paper.
2. Computers could make possible the effectiveness in recording and compiling the results of scoring/commentary. In addition, coupled with appropriate computation functions, it can even do speedy calculations as well as make quick summaries and presentations of the records of assessment to provide users immediate feedback.

3. Web-technology could provide students with more opportunities of peer interaction beyond the constraints from time and locations. The web-based environment is characterized by its accessibility at any time; however, it is possible to conduct activities either within the classroom or in after-class situations.
4. It can be increased the diversity of teachers' implementation of self- and peerassessment.

The positive characteristics of web-based homework assessment system could be summarized as follows (19)(20) (21)(22):

- **Pedagogical approaches.** Using automated submission and scoring of assignments, teachers, can give students more frequent assignments and more questions on each assignment than is possible with traditional methods, thus increasing the time that students spend studying material, answering questions and solving problems.
- **Immediate feedback.** With computer-aided assessment, students can receive immediate feedback about their progress. Surveys given to students indicate that immediate feedback is one of the most appreciated aspects of web-based assessment.
- **Decreased administrative effort**. Automated grading makes possible continual administration of homework, thus increasing the amount of time students spend on academic assignments (23).
- **Multimedia-enhanced questions.** The web's capabilities allow questions that include video, animation, simulation, or audio (23).

The negative characteristics of web-based homework assessment system could be summarized as follows (20)(21)(22):

- **Failure of observing students works.** When grading, it is useful for teachers, to view students' work, check their diagrams, and follow their reasoning.
- **Less variety of questions and grading methods.** Automating the grading process eliminates certain types of questioning and grading. However, there are new types of questions that can be delivered online that cannot be delivered on a piece of paper.
- **Security issues.** If the web is used for evaluation, security issues inevitably arise.
- **Technical difficulties.** When using the web for assessment, teachers, must realize that technical problems could occur.

The research by authors Jeremy Roschelle *at al* which was published in 2016, "Web-based math homework increases students' accomplishments" (24), was done on 2850 students. In a randomized field trial with seventh-grade mathematics students, this authors evaluated whether an educational technology intervention increased mathematics learning. Authors predicted that combining an web based homework tool with teacher training could increase learning. They used the online tool ASSISTments which: (a) provides timely feedback and hints to students as they do homework and (b) gives teachers timely, organized information about students' work. This authors analyzed data from 43 schools in Maine (USA), a state that provides every seventh-grade student with a laptop to take home. Results showed that the intervention significantly increased student scores on an end-of-the-year standardized mathematics assessment as compared with a control group that continued with existing homework practices. The authors conclude that students with low prior mathematics achievement benefited most.

The research done by authors M. Bulić and V. Kostović Vranješ (25) in order to determine the impact of the application of e-learning on student self-responsibility in general, and in particular in completing homework assignments in Science and Biology classes, a study was conducted on a sample of eight primary school classes divided into two groups: the experimental, using fully online e-learning resources, and the control group, using modern forms of active learning. The homework assignments for the students of both groups were the same, while the way of receiving homework assignments, carrying them out and submitting them was different, either in e-surrounding or traditionally. Although the analysis of the results of the homework assignments done by the students of both groups shows equal student success, the study registers a complete self-responsibility of the students involved in e-learning via Moodle platform. The research findings presented in this paper indicate that Moodle e-learning has a greater impact on student self-responsibility in doing their homework, and can therefore serve as a stimulus for teachers practitioners to apply e-learning systems in the teaching process in general, and in particular for independent student activities such as homework assignments (24).

Author T. Gok, assessed the effects of web-based homework and paper-and-pencil homework on student achievement and compared them in his

paper by conducting conceptual tests, exams, and homework assignments. The study was performed with two groups (287 students) during three semesters at a public university (23). Of the two identical sections of an introductory calculus-based course, students in one section received paper-and-pencil homework, while the students in the other section received web-based homework. The results obtained from the study were evaluated statistically, and it was found that there was not any significant difference in conceptual test and exam scores between the two groups (throughout the three semesters). However, the homework performance scores for the web-based homework group were higher than the performance scores of the paper-and-pencil homework group students.

Paper "Online homework, help or hindrance: What students think and how they perform", by M. Richards-Babb, J. Drelick, Z. Henry and Robertson-Honecker, Department of Chemistry, West Virginia University, gave the results of the conducted research and survey on student achievement (26). Research has shown a significant increase in student test performance after putting online homework into practice. Namely, the authors M. Richards-Babb, J. Drelick, Z. Henry and Robertson-Honecker decided to introduce online homework in their department and examine the results of the success of such a practice. During the semester, 18 mandatory online homework assignments were determined. Each homework consisted of 19-20 questions of different format (rounding off the correct answer, correct / incorrect, text entry, etc.). Students had the possibility to try and give their answers for three times, and each homework was available online for 3-7 days after the first publication. After the semester, students completed a survey assessing their experience of this practice based on their knowledge and achievement evaluation mark.

III. RESEARCH METHODOLOGY

Doing homework online has a dual role. On the one hand, students get the opportunity for more creative expression and a large space for improving their knowledge while doing their school obligations. The teaching staff, on the other hand, gets the opportunity to have an insight into students work at any time and in any situation, which certainly contributes to a more objective view of knowledge and student progress.

The subject of the research is students and teachers attitudes towards doing homework online, i.e. their perception of the importance of doing homework online. The aim of the research is to determine the attitudes and behavior of teachers and students in the context of the new life environment and obligations at school and awareness of the need for online participation in it, in order to prevent and find new ways of communication caused by new needs.

The quantitative method by which the research was conducted is a survey in a narrower sense about the attitudes and opinions of the mentioned respondents. By conducting quantitative research, accurate measurement and quantification of relevant indicators has been enabled. The value of this survey is limited, because the information obtained depends on the sincerity of the respondents and their ability to answer the questions objectively. It is possible that the survey is subject to epistemological and social limitations, in the sense that the respondents do not answer what they really think, but give answers that are in line with social values or their ignorance of the matter. That is why we consider the survey as only one of the phases of the research process and in that way we do not neglect other aspects of the research.

The technique of collecting information is an indirect survey, i.e. a paper questionnaire in which several questions are asked, mostly of closed-ended type, of which the first few questions are personal data about the respondent (such as the gender of the respondent). In addition, teachers and students were asked to answer the type of devices they used to access the Internet while doing homework online and which devices were most commonly used to send and receive homework.

It was then examined which application was chosen by the teachers and which by the students. A group of important questions follows. Students were asked if they used the Internet to expand their knowledge beyond what was required while doing their homework. Also, students answer to one question in the survey is important, and that was whether the availability of materials on the Internet and this way of doing homework can be helpful during regular classes. While on the other hand, the teachers were asked whether this way of doing homework can be of great help to students during regular classes.

What is the core of the survey is the question to teachers whether they think that this way of doing homework would contribute to a higher quantity and quality of completed assignments, and which would ultimately contribute to students better knowledge.

The questions are closed-ended with multiple choice answers. However, in one question, the respondents were asked with which grade from 1 to 5 they would rate the online way of doing homework.

III. RESEARCH RESULTS

35 teachers and 112 students of the First Obrenovac School in Obrenovac participated in the research.

For the purposes of this research, two surveys were conducted in order to determine, on the one hand, the attitude of teachers, and on the other hand, students. Both surveys have ten questions. For certain questions, respondents were given the opportunity to mark more than one offered answer.

112 students participated in the survey, as follows: 34.8% of fifth grade students, 20.5% of sixth grade students, 27.7% of seventh grade students and 17% of eighth grade students. Of that, 48.2% are girls and 51.8% are boys.

On the other hand, 35 teachers participated, 57.1% of subject course teachers and 40% of primary school teachers, in addition to the principal and professional associates. It is important to note that as many as 51.4% of teachers are with 15 or more years of experience in education, 17.1% with experience between 10 and 15 years and 14.3% with experience between 5 and 10 years.

In addition to questions about personal data about the respondent, the following questions related to the type of devices used to access the Internet while doing online homework and to which devices were most commonly used to send and receive homework. Research data show that both teachers and students used e-mail the most to send and receive homework. But there is a difference when it comes to the devices they used to access the Internet during the whole teaching process. As many as 91.4% of teachers used a computer, while 71.4% of students used a mobile phone.

When asked which application they chose, the data show that 58% of students chose the Google classroom and 51.8% the e-mail, while only 12.5% opted for Viber. Teachers answered the same question differently. Email was chosen in 48.6% of cases, Google classroom in 40%. Based on these data, we learn that students are more adaptable to new technologies. The students were interested in the Google classroom, while most of the teachers decided to use the "familiar" application in the form of e-mail.

When asked which grade from 1 to 5 they would rate the online way of doing homework, 35.7% of students gave a grade of 5, and 37.5% a grade of 4. So, even over 70% of students rated this type of work with the highest grades.

The next question is: did they use the Internet during their work to expand their knowledge beyond what was required, and as many as 78.6% of students gave an affirmative answer.

Then, the students answer to the next question in the survey is important, that is whether the availability of materials on the Internet and this way of doing homework can be helpful during regular classes too, 85% of students gave an affirmative answer.

When asked whether this way of doing homework can be helpful during regular classes, because they would have permanent access to students' assignments, over 45% of teachers said yes, while 31.4% were not sure.

To the next direct question to teachers whether this way of doing homework can be of great help to students during regular classes, only 8.6% answered that they agree completely, 37.1% that they mostly agree and 25.7% that they are not sure. Of these, 8.6% of teachers completely disagree with this type of work. We learn that the data given by teachers in their answers are different. This can be attributed to many years of teaching experience, but on the other hand, the years spent in the education of the surveyed teachers should also be taken into account. The question arises whether the answers would be different if the respondendents were younger teachers who use modern information technologies more.

To the final question for teachers, whether they think that this way of doing homework would contribute to higher quantity and quality of completed assignments, which would ultimately contribute to better knowledge of students, only 8.6% said they fully agree, while 34, 3% mostly agree, 28.6% of teachers are not sure, and 11.4% of teachers absolutely disagree with this view.

IV. CONCLUSION

It is needed to implement ICT and e-learning not only in the teaching process in schools, but to use them in designing different homework which students will receive, complete, send for correction, and receive feedback electronically.

The results of the research show a high level of students' knowledge when it comes to the use of modern technologies, whether they are devices or applications intended for education. In the survey, over 70% of students gave the highest grade for the online way of doing homework. That confirms that there is an adaptability of students to changes in the teaching process. Also, 85% of students think that the availability of materials on the Internet and the

online way of doing homework can be helpful during regular classes.

However, the data show that the opinion of teachers is different, because only 45% of teachers stated that this way of doing homework can be helpful during regular classes, because they would have permanent access to students' work. Also, when asked whether they think that the online way of doing homework would contribute to higher quantity and quality of completed tasks, which would ultimately contribute to better knowledge of students, only 8.6% said they agree completely, while 34.3 % mostly agree.

By introducing and continuing to use existing online teaching resources, traditional teaching can be greatly enriched, more diverse, and thus more interesting to younger generations accustomed to information technologies. However, by combining the highest quality elements of both types of teaching, the entire education system can be significantly improved.

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Significance and Application Web Technologies in a Time of Pandemic

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Abstract - This paper presents an application for connecting people who are willing to donate blood plasma after recovery from Covid 19 and those who need blood plasma in medical treatment.

I. INTRODUCTION

A web application is a software solution and usually consists of one or more linked pages. It is located on a web server and is accessed through a web browser.

There are two types of web applications:

1. Static: Their content can't be changed in a simple way and they serve to place information that doesn't change for a long time.

2. Dynamic: Those that are more commonly used and whose content is regularly improved (added, changed, removed).

The very advantage of web applications over desktop applications is that their download is not necessary for their use. Therefore, they do not require adaptation to operating systems.

The most commonly used web applications are of informative character as well as e-commerce web applications used for online shopping, commercial and personal web applications, social networks, blogs, forums...

Web applications are accessed through their URL (Uniform Resource Locator) which is also called a web address. The different URLs of the linked pages of one web application are organized in a hierarchy, of which the home page is usually accessed first, and the other pages are listed in the header.

The basis of creating a web application in this work is to provide dynamic content guided by the open source framework (Bootstrap technology).

The COVID-19 virus caused a pandemic worldwide and caused a large number of infected patients. This web application aims to enable a simple flow of information in order to cure newly ill patients with the COVID-19 virus in our country.

Information as a word represented the giving of form, shaping, representation and described the thought action as a notification. In cybernetics, it means a data or set of data on the basis of which a phenomenon or a process is managed and is one of the basic concepts of cybernetics.

The concept of information is a message that has different meanings in different contexts. Thus, the concept of information has become closely related to the concepts of limitation, communication, control, data, form, education, knowledge, meaning, understanding, stimulation, pattern, perception, representation as well as entropy.

Information is useful only when:

1. Correct
2. Complete
3. Relevant
4. Timely

Today, the notion of data and information is often equated, and the difference is actually immeasurable.

For example, the number 1 is data and as such it has no special meaning, however, "It is now 1 pm" is information, because the data has been assigned some meaning. This recognizes that the information consists of the data and the meaning assigned to it.

There are two basic methods for recording information:

1) Manual: Represents manual recording of information.

2) Electronic: Bar codes, RFID identification marks via radio frequency, electronic scanners, optical character recognition (OCR).

Information protection is a process that provides authorized users with reliable and constant access to data and contains two key steps:

1. Identity verification;
2. Authorization;
3. Many companies use:

a) Double authentication (Password + identification card)

b) Biometrics (Fingerprint and iris scan)

4. Firewall - A hardware or software device that is placed between computers on an internal network and external networks;

5. Virus - Is a program or part of program code that binds to other programs on our computer without our knowledge, which can cause the entire network to crash;

6. Data Encryption - Converting data into complex, encrypted, digital records that can only be read by authorized users;

7. SSL encryption;

Virtual Private Networks (VPNs) - Enable secure encryption of data sent by employees whose computers are outside the company's computer network.

II. TECHNOLOGIES USED

1. Bootstrap is a framework for creating web pages and web applications. It contains a built-in set of tools and libraries for creating flexible but also responsible web forms with all their elements.

2. HTML (HyperText Markup Language) is a descriptive language used to create web pages and to edit web page elements. HTML is a descriptive language. If an HTML page is opened using an editor, the HTML code (text) is opened and displayed. When we launch that same page in a web browser, it interprets and displays it in the right way.

3. CSS (Cascading Style Sheets) is a "style sheet" language used to describe the presentation semantics of a document written in a descriptive language (Markup language). If the formal definition is ignored, CSS describes - edits the appearance and formatting of any element on the page.

4. JavaScript is a scripting language that is responsible for displaying dynamic web applications. In essence, it loads data from a web server and displays it through a user interface. JavaScript is based on prototypes with first-order functions that support object-oriented programming. It does not support Input/Output functionality such as: Connectivity, data storage, or graphical functionality, for which it relies on the environment in which it runs.

5. PHP (Personal Home Pages) is a scripting language whose primary, but not the only function (because it is a general purpose language) is the processing of data on a web server and their implementation in HTML code. Also, it is a language that is interpreted, and it cannot work without an interpretation program. It is a direct derivative of the C language and most of the syntax is identical to this programming language. It cannot broadcast HTML pages without a web server, but can be executed on different web servers. The PHP programming language can be written in any text editing tool, and in order for a document to be passed to PHP, it must have the extension ".php".

6. MySQL is a database management system. MySQL comes without any graphical user environment tool for data manipulation. Users can use the integrated console, or command interface (CLI) or use some of the tools with a graphical user environment that come separately from the MySQL system itself. Databases are used for data storage. Systems that enable the manipulation of databases and data are called DBMS (Database management systems) and the language in which this is specifically achieved is SQL.

7. WAMP is a free application related to the Microsoft Windows operating system, and contains multiple servers such as Apache, Open SSL for SSL support, MySQL databases and PHP programming language. All these technologies are integrated and each server can be configured separately.

8. Visual Studio Code is one of the most popular tools for creating web content. It was developed by Microsoft and is used to program websites, web applications, web services and programs on the Microsoft Windows operating system, but it also works on Linux and Mac OS.

III. DESCRIPTION OF THE IMPLEMENTED SOFTWARE

The goal of this web application is to enable a simple and fast flow of information, in order to connect the cured and newly ill patients with the COVID-19 virus, and thus the cure of those newly ill patients. Access to this web application is very easy and features an accessible user interface. Without the necessary any previous experience or knowledge, the user accesses a web application, where he can search for donated blood plasma, but also register as a donor. It can also keep up with the latest news and current events concerning the mentioned virus, both in the country and in the world. The site is of a humane character and in essence, that is the most important goal.

IV. WEB APPLICATION LAYOUT AND USER GUIDE

After entering the address of the web application in the browser, the home page of the web application is accessed, where visitors can get more information about donating blood plasma. Also, on the home page, there are three photos that change at a certain

time interval. The web application is responsive - adaptable, so that it fits into all screen sizes of computers, mobile phones and tablets.

Figure 1. Home screen layout

By clicking on "Become a donor" located in the upper right corner of the page header, you access the page where the visitor has the opportunity to apply for blood donation.

The visitor must enter the required data, which are marked with a red asterisk, and if he doesn't enter it, he can't apply for blood plasma donation. Also, if he doesn't check the box related to the acceptance of data processing he entered, he won't be able to log in, as well as if he doesn't check the box below, which refers to Google reCAPTCHA and that the visitor confirms that he is not a robot.

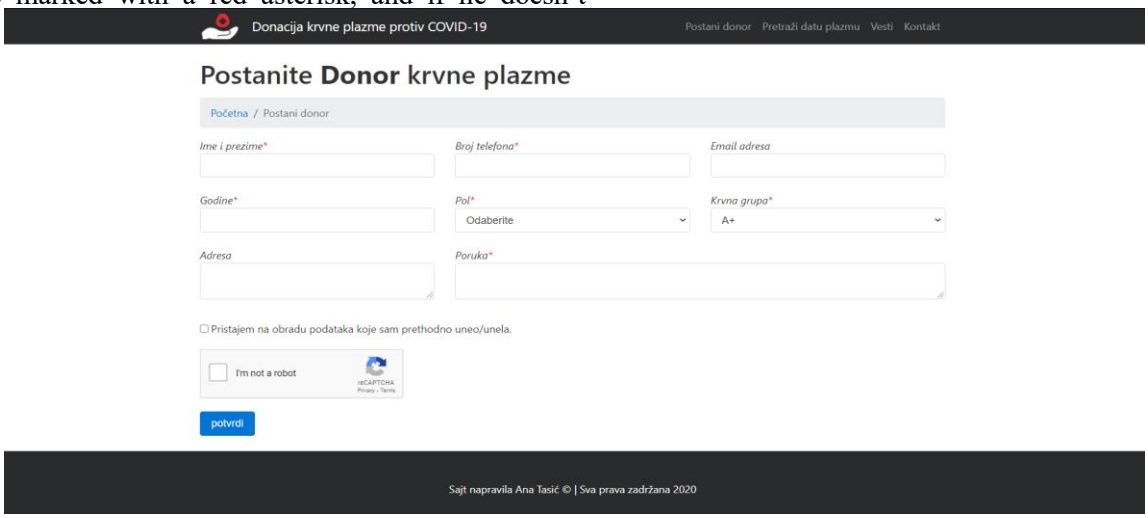

Figure 2. Become a donor page layout

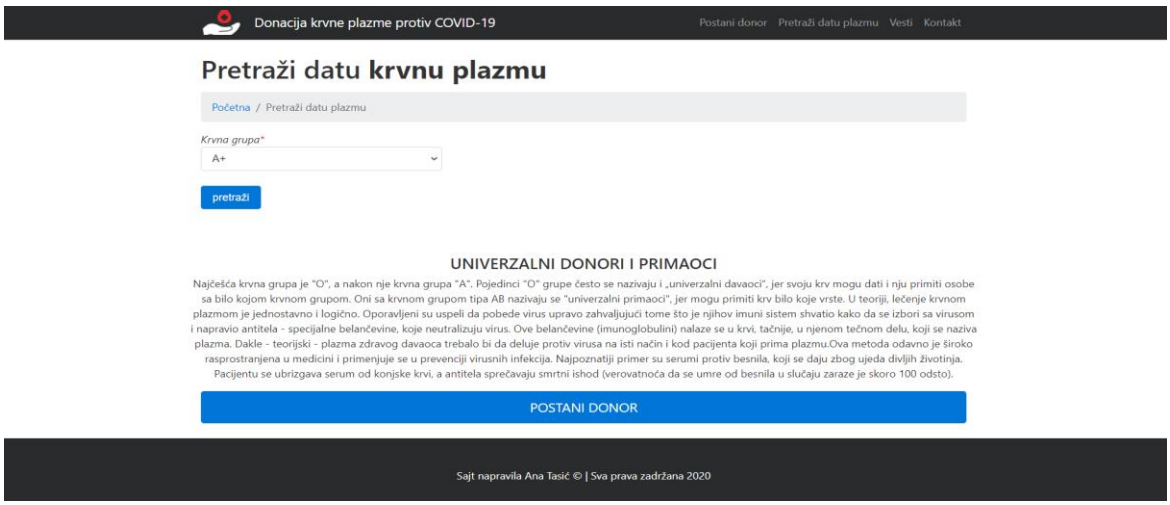

Figure 3. Search blood plasma page layout

By selecting the "Search for given plasma" section, the visitor can search for donated blood plasma.

In addition to the highlighted features the user has the ability to access the "news" and "contact" pages where he can search all current news related to the COVID-19 virus, as well as to make contact and send a message by entering basic data and message text.

V. CONCLUSION

The aim of this work is the importance and application of web technologies during the pandemic, which was realized in the work itself through a web application whose purpose is to provide basic information about the COVID-19 virus, but also the importance of donating blood plasma that can save many lives.

After stabilizing the situation caused by the COVID-19 virus, this application can also be used to promote the blood transfusion and transfusion blood impurities in order to save human lives.

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Correlation Between School Success and Students' Digital Competencies

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Abstract – At the beginning of the 21st century, the European Framework for Key Competences was established, which should be developed by the end of compulsory schooling and represent the basis for further learning as part of lifelong learning. Among the key competencies is the digital competence, which includes independent and critical use of information and communication technologies for work, leisure and communication. This work refers to the connection between students' digital literacy and students' school success, i.e. it shows that students with a higher level of digital literacy have better success in school. The research was conducted among final year high school students in schools in Vojvodina. The obtained results show that there is a correlation between students' digital literacy and the achieved school success. This suggests the need for students' digital competencies to be developed not only in computer science classes, but also the teachers of other subjects should be involved in the process of developing students' digital competencies..

I. INTRODUCTION – STUDENT COMPETENCIES

In the world of education, competences are introduced as a concept in the last decades of the XX and the beginning of the XXI century. This is especially due to changes and demands on the labor market. Education responds to change by developing a concept of competence-oriented education and, based on them, outcomes. The entire education system is organized around what is essential for students - what they can do at the end of the education process.

Competence means a complex combination of knowledge, skills, abilities and attitudes required to perform a certain activity in a given context, in real circumstances where the person should be able to interpret the situation in a particular context and have a repertoire of possible actions he can take and is able to perform.

"The rapid technological progress of human civilization initiates the need for changes in the educational concept as well. New standards in the field of education have been accepted in the world, which have significantly shifted traditional understandings and models of teaching. "[1].

At the beginning of the 21st century, facing the changes and needs of the new age, the European Union (through the Council, the Commission and working groups) is taking steps to establish a European framework for key competences. This shifts earlier "basic skills" necessary for "survival" and make up the basic "life skills" - language and numerical literacy - to key competencies, which can be defined as follows: "Key competencies are transferable, multifunctional knowledge, skills and attitudes packages, needed by all persons for personal achievement and development, inclusion and employment. They should be developed by the end of compulsory schooling or training and should form the basis for further learning as part of lifelong learning. "[2].

A. Key competencies for lifelong learning

Key competencies are a set of integrated knowledge, skills and attitudes that are needed by each individual for personal fulfillment and development, inclusion in social life and employment.

Key competencies for lifelong learning include:

- Communication in the native language that includes the ability to express and interpret concepts, thoughts, feelings, facts and opinions orally or in writing,
- Communication in a foreign language that includes the ability to express and interpret concepts, thoughts, feelings, facts and opinions orally or in writing, including mediation skills by summarizing, interpreting, translating, paraphrasing and otherwise, as well as intercultural understanding,
- Mathematical, scientific and technological competencies that include basic numerical reasoning, understanding of the world of nature, as well as the ability to apply knowledge and technology for human needs (e.g. medicine, communications, transport...),

- Digital competence that includes confident and critical use of information and communication technologies for work, rest and communication,
- Learning how to learn which represents the ability to effectively manage one's own learning with the aim of planning, managing time and information, as well as the ability to overcome obstacles in order to learn successfully using previously acquired knowledge and skills and their application in different situations, individually and / or in the group,
- Social and civic competencies that represent the ability to participate effectively and constructively in social and working life and engage in active and democratic participation in diverse communities,
- Sense of initiative and entrepreneurship that develops the ability to turn ideas into action through creativity, innovation and risk-taking, as well as the ability to plan and manage projects,
- Cultural awareness and expression that includes developing the ability to understand the meaning of creative ideas, experiences and emotions in various media such as music, dance, literature, fine arts and others.

"Competences referred to in paragraph 1 of this Article, in addition to the framework of traditional school subjects, include and engage school knowledge in preparing students to be competitive and functional in current and future educational and professional space and to competently and actively fulfill their civic roles." [5].

The general goals of education are defined by the Strategy of Education and the interpretation of the given goals of education "clearly shows the strategic orientation of the entire educational system towards modernization and modern exit competencies." [1].

B. General interdisciplinary competencies

General interdisciplinary competencies are based on key competencies and are developed through the teaching of all subjects. They are applicable in different situations and contexts in solving different problems and tasks. They are necessary for all students for personal achievement and development, as well as for their inclusion in social environment and employment and form the basis for lifelong learning.

The goal of orientation towards general interdisciplinary competencies and key competencies is to combine knowledge, skills and attitudes relevant to different real contexts that require their functional application. In 2013, standards for general interdisciplinary competencies for the end of secondary education were developed in Serbia, including digital competence.

General interdisciplinary competencies for the end of compulsory primary education in the Republic of Serbia are:

1. Learning competence
2. Responsible participation in a democratic society
3. Aesthetic competence
4. Communication
5. Responsible attitude towards the environment
6. Responsible attitude towards health
7. Entrepreneurship and orientation towards entrepreneurship
8. Working with data and information
9. Troubleshooting
10. Cooperation
11. Digital competence

These interdisciplinary competencies are defined as mandatory, and the expected outcomes are defined only at the basic level. Digital competence is defined through the following outcomes where a student can:

- search, evaluate the relevance and reliability of data sources;
- analyze and systematize information in electronic form using appropriate ICT tools (devices, software products and electronic services);
- express in electronic form using appropriate ICT means, including multimedia expression and expression with elements of formally defined notations characteristic for the used ICT means (e.g. addresses, queries, commands, formulas, procedures, expressed in appropriate notation);
- present, organize, structure and format information using the possibilities of a given ICT tool in an efficient way;
- select appropriate ICT tools when solving problems, as well as to adapt the way of solving problems to the possibilities of those ICT tools;

- effectively use ICT for communication and cooperation;
- recognize the risks and dangers of using ICT and acts responsibly in this regard.

These outcomes can be grouped into five areas of digital competence: information literacy and data comprehension, communication and collaboration, digital content creation, security, and problem solving.

"Teaching and education are oriented towards general interdisciplinary and key competencies, because in that way a more dynamic combination of knowledge, skills and attitudes that are relevant to different real contexts that require functional application of knowledge and skills is enabled." [3].

C. Digital competence (digital literacy)

Digital literacy (or digital competence) is one of the eight key competences for lifelong learning and development in today's global, informational, digitalized society. It is an interdisciplinary competence that enables the acquisition of other key competencies. It is also a prerequisite for personal (social, professional, cultural) development of each individual. The right to acquire digital literacy skills is considered one of the basic rights of today's children and youth. The importance of digital literacy was recognized more than a decade ago in international educational documents. Although much time has passed since then, no theoretically sound and empirically valid definition of digital literacy can be found in the literature. It is a concept that is theoretically complex and multidimensional and has its foundation in several scientific disciplines.

During the 1990s, several authors used the term digital literacy to denote the ability to read and understand hypertext and multimedia texts. Thus Lenham (1995) equates digital literacy with "multimedia literacy", which is essentially different from traditional literacy, because it implies deciphering information given in different symbolic modalities (language, sound, image). In 1997, Paul Gilster, in his book Digital Literacy, was the first to define and popularize the concept of digital literacy. He defined digital literacy as "literacy of digital age" which is the ability to understand and use information from a variety of digital sources. Gilster believes that it is about "mastering ideas, not typing on the keyboard", thus emphasizing the importance of critical thinking skills, instead of reducing digital literacy to technical knowledge and skills.

Despite numerous studies, there is still no well-founded and empirically valid concept of digital literacy. The search for answers to the questions of what digital literacy is, how it develops, what is the role of formal and non-formal education in its development is still being sought. According to proponents of new literacy, "digital technology has not only changed existing social practices, but has created new forms of practice." [4]. Literacy does not only mean reading, writing and arithmetic skills, but the term literacy is extended to the understanding of numbers, signs, various symbols, audio and video.

In addition to the term digital literacy, the term digital competence is often used in the literature. These two terms are most commonly used as synonyms, however some authors define digital literacy as a term that is superior to the term digital competence. According to one interpretation, digital literacy is a necessary ICT skill and it is the basis for acquiring digital competencies that are more specific and context-related [2]. Digital literacy within the project (DigEuLit) started in 2005 is defined as "awareness, attitude and ability of an individual to adequately use digital tools and skills to identify, access, manage, integrate, evaluate, analyze and synthesize digital resources, construct new knowledge and communication with others in the context of specific life situations, in order to enable constructive social action. "[16].

There are three levels in the development of digital literacy:

- digital competence,
- use of digital competence,
- digital transformation.

The first level, the level of digital competence, includes skills, from visual recognition through critical and conceptual approaches, to attitudes and awareness. The application of digital competence in professional and life contexts represents a key level in the development of digital literacy. It involves the use of digital tools to search, find and process information, develop products or solve problems. At the highest level is the application of digital competence, which is reflected through innovation and creativity. [17].

During 2011, the Digital Competence Framework for Citizens project was launched within the Institute for Prospective Technological Studies of the European Commission's Joint Research Center (JRC-IPTS), abbreviated DigComp. Based on the data collected in 2013, the conceptual framework of digital competence was developed (DigComp 1.0).

In June 2016, this framework was revised and five domains of digital literacy were defined (Within each domain, a list of competencies is defined, a total of 21 competencies):

- literacy in the field of data information and digital content,
- communication and collaboration,
- creating digital content,
- security,
- Troubleshooting.

II. RESEARCH OF THE CONNECTION BETWEEN SCHOOL SUCCESS AND STUDENT COMPETENCIES

In addition to the digitalization of society, the development of digital literacy is becoming an important and very popular topic in academic and educational-political circles, within which the potential benefits of digital literacy for society but also for individuals are considered.

Although digital literacy can be conceptualized in different ways in terms of the components that are an integral part of it, it should not be insisted that the concept of digital literacy be limited to a linear set of skills that will suit all people for all time. Digital literacy is changing in line with the development of technology, digital tools are understood as technologies for giving and receiving meaning, such as language. These meanings are determined by social, cultural, historical and institutional practices, which usually, in addition to the use of language and digital technologies, include behavior, interaction, evaluation, beliefs and knowledge. For this reason, literacy is seen as a three-dimensional quantity, which complements functional literacy and technical competencies by contextualizing them in relation to culture, history, and power concentrations.

"The development of digital literacy is a gradual and continuous process, which involves several phases. The starting point in this process is the acquisition of instrumental skills, i.e. basic computer skills, after which we move towards the development of productive and strategic personal competencies. "[18] The lowest level in the process of developing digital literacy is mastering basic computer skills, in terms of acquiring basic skills and speed of performing actions with digital technologies that enable access to information, as well as collecting and exchanging information with others. Skills and competencies for the use of digital technologies are necessary, but not sufficient to master higher levels of digital literacy. It is also necessary to develop higher-order cognitive competencies that enable critical evaluation of information available through digital technologies.

Even if one accepts the view that today's generations are "digital natives", it is unreasonable to expect them to develop their digital competencies independently in the absence of systemic support from schools and school programs. Traditional teaching "is foreign to a young man, not motivating, uninteresting and cannot give the desired outcomes." [1].

This requires that within the institutions there are basic conditions for organizing teaching through digital technologies - availability of equipment, internet access, technical support, but also time and space for teaching and learning through digital technologies. When we talk about the school context, we primarily mean the availability and ways of using digital technologies in school, the support for access and use of digital technologies and the frequency of digital technologies usage by students and teachers, as well as the vision of the school on the application of digital technologies in teaching and learning processes. In this research, data on the school success of final grade students and their grades in informatics were collected, which represent the level of their digital literacy.

A. Research problem

There is an opinion in society that students develop digital literacy on their own because they use digital technologies every day, grow up with them and are therefore considered to be digitally literate. Also, it is believed that students who are digitally literate have better achievements in school because they can use digital technologies to find additional information that can help them fulfill school obligations and solve school tasks at school, as well as to acquire knowledge in various fields.

Since none of the existing questionnaires, nor the instrument for assessing digital competence that the author would create himself, would be objective, the author believes that the grade in informatics during high school is a good indicator of digital competence, although it does not cover all areas of digital competence. Existing instruments for assessing digital competencies rely mostly on self-assessment of digital abilities of respondents, which in most cases does not give objective results. This research looks at the relationship between students' digital competencies (in this case, grades in informatics course) and students' school success during high school.

B. Research goal

The goal of the research is to determine whether there is a statistically significant correlation between school success and students' digital competencies and whether there are differences in students' school success according to gender criteria.

C. Hypothesis

Focusing on the set goal of this research, the hypothesis of this research is:

H1: Students who have developed digital competencies achieve better success in school.

The derived hypotheses are:

H1.1 There is a linear correlation between students' digital competencies and student achievement in school.

H1.2 There is no difference in the school success of boys and girls which is conditioned by the level of digital literacy of students.

D. Research results

The research checked whether there is a dependence of students' school success on the development of their digital competencies by calculating the correlation coefficient. Based on the obtained value of the correlation coefficient and the interval to which it belongs, a conclusion was made about the connection between school success and digital competencies. Based on the collected data and their processing, the value of the correlation coefficient (Pearson's coefficient) of 0.854 (r) was obtained.

If we use the Pearson coefficient as a decision-making tool, the following statistical inference is common (Table 1):

Table I. PEARSON COEFFICIENT VALUES

The interval to which the value | r | belongs	Interpretation
[0.00,0.40)	Weak correlation
[0.40,0.75)	Moderate correlation
[0.75,0.85)	Good correlation
[0.85,1.00]	Excellent correlation

By comparing the obtained value with the data in the table, we can conclude that there is an excellent correlation of students 'digital literacy with their school success, i.e. that students' school success largely depends on the digital competencies level of development.

The coefficient of determination, i.e. the percentage of dependence of one variable on another (obtained by squaring the value of correlation) is 72.93%, which means that school success depends on digital literacy of students with 72.93%, while other phenomena (motivation, time spent learning, presentation, teaching content, readiness of teachers to help students in case of difficulties) with 27.06% affect the success of students in school.

The data can also be represented graphically using diagrams. The data presented are student achievement and their grades. Based on the drawn points, a trend of lines of the linear type was inserted, which indicates that there is a linear dependence among the presented data (Figure 1).

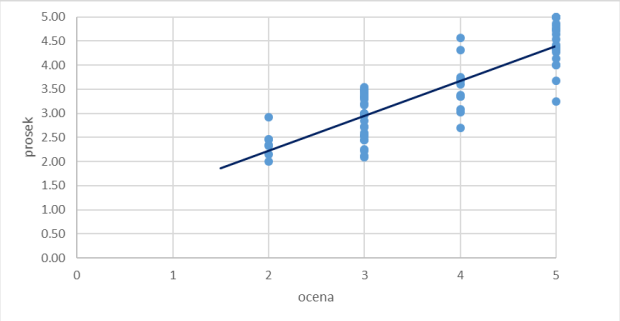

Figure 1. Linear dependence between student achievement and their grades

Interpreting the chart, we can say that if a student has a higher grade in informatics, he will have a higher school success, i.e. that the success of students in most cases depends on digital competencies.

Data analysis showed that in 70.83% of students (51 students) in the sample, the success of students coincides with the grade in informatics (a measure of digital competence in work), while in 29.17% (21 students) there is a deviation of success from the grade in informatics. When we present these deviations graphically, it can be seen that in as many as 25% of students the school success is lower than the grade in informatics and only three students have higher school success than the grade in informatics.

III. CONCLUSION

This research proved the hypothesis "There is a linear correlation between digital competencies of students and student achievement in school" to be correct based on the obtained correlation coefficient of 0.854 which corresponds to the interval of excellent correlation, which means that student success directly depends on digital competencies and 72.93% (obtained using the coefficient of determination) depends on the digital literacy of students, while other phenomena (motivation, time spent in learning, way of presenting teaching content, readiness of teachers to help students in case of difficulties) with 27.06% affect student success in school.

The development of digital literacy within formal education should be viewed strategically and as a

whole, individual steps should be combined into one project that needs to be gradually implemented in order to reach an adequate practice of developing digital literacy. It is necessary to start systematically, from the level of educational policy; regulations and other legal documents to regulate the obligation, but also the manner of introduction and implementation of the practice of developing digital literacy among students; formulate goals and concretize tasks; provide appropriate opportunities for professional development of teachers in the field of digital technologies; and provide appropriate and necessary technical and other conditions for the development of digital literacy in students.

Teachers also need to change their way of working in order to achieve teaching efficiency, to form a positive attitude towards integrating technology into teaching and to adopt a model of e-learning that causes students to be more motivated to learn and maintain attention to the teaching material. [1].

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Analyzing the Digital Education Revolution

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Abstract – With the development of information-communication technologies (ICTs) the educational system experiences gradual digitalization. Due to the COVID-19 pandemic this process has been intensified and it became an imperative aspect of future education. Educators and students had to adapt to the new ICT-based education system. This transition to this new digitalized system is not complete and government institutions as well as educational institutions have to yet develop a sustainable long-term strategy. Now, in this paper the digital education revolution is analyzed. The main goal of the paper is to identify the challenges and barriers of education digitalization. Additionally, future trends in the digital education revolution are addressed. The paper provides a thorough insight into the dynamics of how the digitalization of education affects educators and students as well. The paper provides significant insight and presents an adequate basis for future research in the domain of education digitalization.

I.INTRODUCTION

In the last two decades there is process of transformation of education. More precisely, with the advancement of modern information-communication technologies (ICTs) teachers and professors face challenges and they are under increasing pressure when it comes to teaching with digitally enhanced methods [1]. This may be due to the lack of adequate technical skills as well as due to the lack of adequate equipment for online teaching. The digital education revolution focuses on improving skill in the domain of standardized testing, numeracy, and literacy. Further, such digital education revolution includes the implementation of national professional accreditation standard and national curriculums. Such improvement to the education system can contribute to country's productivity and competitiveness [2]. Therefore it can be argued that the process of education digitalization is becoming an imperative when it comes to creating skills and adequate knowledge that will create value on the market, effectively contributing to the competitiveness of the country.

Furthermore, Internet of Things (IoT) brings a new approach to education and learning. IoT alongside with other technologies such as mass distribution and storage of teaching material, digital publishing, 3D distance teaching, remote experimental teaching, virtual classrooms, control over digital resources etc., have the potential to improve the concept of traditional education as well as to enhance the teaching process [3]. When the COVID-19 pandemic is taken into consideration, online learning and modern ICT application in education as well as the overall digital reform of education is becoming an imperative. Such reform includes the implementation of flexible and active online platforms [4]. When teachers introduced laptops in their science classes for senior students as a push forward in the digital education revolution, a few contradictions appeared. The first included barriers to innovative science. Next, there were issues when it comes to maintaining adequate connectivity with the school and classrooms. The third contradiction rose from the differences between students' and teachers' expectations. The final contradiction included the changes in overall classroom management [5].

In this paper the concept of digital education revolution is reviewed. The main goal is to identify and analyze the potential positive and negative outcomes of education reform in the "spirit" of digitalization. The paper analyzes the framework of digital education, the process of digitalizing education and future trends in the domain of digitalizing education. In addition, guidelines and propositions for improving the process digitalization and the existing digital systems are proposed. The paper includes four main sections (excluding the Introduction, and Conclusion sections). The first section presents the framework of digital education. In the second section the concept of education digitalization is addressed. The third section analyzes future trends in the domain of education and the use of ICTs for teaching and learning. Finally, in the fourth section the guidelines and proposition for improving the process of digitalization of education are discussed.

II. THE FRAMEWORK OF DIGITAL EDUCATION

In developing countries, the digital education revolution faces barriers, as traditional teaching methods prevail. The digitalization of education involves the integration of users and platforms on personal computers, smartphones and other devices. There are set of technologies that encapsulate the framework of digital education. These emphases are technologies that aim at redefining the process of teaching and learning through the implementation

and application of various modern ICTs; attempts at reshaping the learning and teaching process through the adaptation and effective change of learning resources; technologies which aim at improving the teachers', or better say educators', knowledge, their skills and approach to teaching; set of technologies which aim at improving the learning environment (classrooms, conference rooms, online classrooms etc.) [6]. Technological advancement as the cornerstone of education digitalization, represents the driving force of development. Alongside with the worldwide COVID-19 pandemic, the rapid development of ICTs have exponentially increased the speed of education reform and the process of digitalization of various aspects and levels of educations.

In order for the digital education reform to take place in an effective and efficient manner, the concept of digital education governance is a crucial element that manages the changes in the educational system. The digital education governance takes up the role of managing, monitoring, evaluating and defining standard for individuals and institutions in the process of implementing and applying digital systems in teaching [7]. Without digital education governance, there would be chaos regarding the intensity and direction of education digitalization. As this process is dynamic, there must be strong control mechanisms put in place in order to reduce dissipation from the main goal, and that is an effective educational system (fully digitalized and scalable). The control mechanisms further require clearly defined policies. Focus areas of digital education policies include infrastructure, leadership and governance practices, collaboration and networking, content and curricula, and teaching and learning practices [8]. In the same study it was noted that even though the digitalization of education can improve the learning and teaching process, if overall poor teaching is conducted, then there is practically no technology which can compensate such drawback. This practically means that the digitalization of educational systems requires not only human resources in the form of educators, but skilled and learning-ready human resources (educators, consultants, teachers on all levels of education).

When it comes to a broader view on digital learning which can include one or several concepts and approaches. These approaches may include adaptive learning, blended learning, e-textbooks, virtual classrooms, open education resources, mobile learning, and online personalized learning [9]. Human resources have to improve their knowledge in the noted domains of approaches in order to increase the probability of positive outcome of education digitalization. Online learning platforms which present the core of online and digital education may include one or more approaches and they can fulfill various learning a and teaching roles (sharing, distribution, hosting, improving, etc.). Further, on Figure 1, a simplified overview of the digital education revolution process framework is presented.

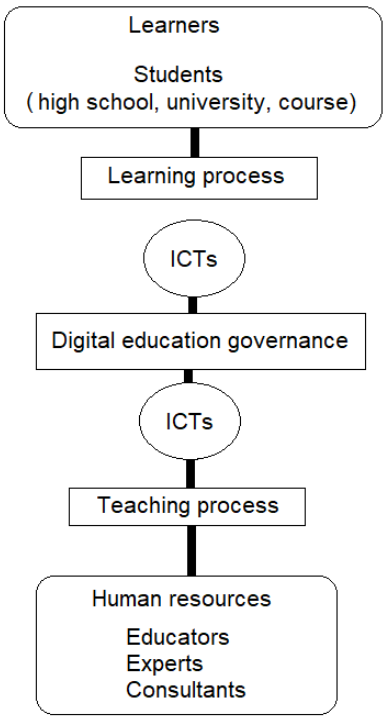

Figure 1. Simplified education digitalization framework

As seen on Figure 1., digital education governance is at the center of the digitalization process. Both from the teaching and learning process standpoints ICTs are the main element that connect educators and learners.

It is important to note that digital education modelling in the context of governance, can be driven by complex social, economic and even political agendas. Therefore, the digitalization of education shouldn't be accepted narrowly as an instrument which only brings prosperity, but rather it is necessary to promote critical assessment as well. Through this critical assessment the integrity of digital educational systems would be secured [10].

III. DIGITALIZING EDUCATION

As noted earlier the rapid development of ICTs and Industry 4.0 bring a new paradigm on multiple frontiers. One of those frontiers is education. The data and research conducted by previous researchers

[11] indicated high mean values when participants were interviewed regarding the application of digital learning. More precisely, the participants evaluated that the use of mobile phones, desktop computers and tablets made learning easier and more efficient. Now, this is one aspect of the digitalization process, and it can be viewed as a positive outcome of digitalizing education systems. However, the concept of the whole digitalization process is not that simple. There are surely negative effects as well. For example, there is lack of sufficient face-to-face time spent with students. In addition, the process of adaptation of educators as well as students to new online platforms is not instant nor it is "smooth". Therefore, when discussing the digitalization of education, the complexity and the sheer amount of factors that affect the learning and teaching process has to be addressed. More precisely, The process of digitalization od education can't be pinpointed to clearly defined actions, but rather it involves the dynamic synergy of governance, ICTs, and educational institutions alongside with educators and learners.

Further, when it comes to distance learning in Serbia, a developing country, the number of accredited undergraduate and graduate courses at universities in 2016 was 1.85%. It was expected that by 2020 this number would increase, however this is not yet the case [12]. It is evident that the process of education digitalization is not an ready-to-roll-out solution and that varies across countries. Organizing the process of education digitalization requires, as noted earlier, and effective digital education governance. This element of the digitalization process can experience bottlenecks, especially in countries where there is a lack of strong initiative and skilled experts in the domain of education and ICTs.

Furthermore, the main criteria for distance learning accreditation and standardization include scientific criteria, pedagogical, methodological and didactical criteria, ethical and moral criteria, language barriers, technological and graphical criteria, and security criteria. It can be argued that these represent the basis for distance learning and the devices, which are used for distance learning should fulfill the specific requirements of the noted criteria [13]. Besides the noted criteria, digital repositories will be a necessity. In these repositories teaching and learning resources would be stored [14]. In addition the repositories would include functions such as search, remote-access, editing and managing information, and interface personalization [15].

For an effective digitalization of education to take place, governments, institutions and even local communities should aim at developing a technological infrastructure for distance learning, adapting curriculums for online learning, permanently developing new curriculums which would answer to the needs of the job market, researching and developing new laboratories and online classroom concepts for effective distance learning [16]. In the next section, future trends in the domain of education digitalization and overcoming challenges in the process of education digitalization are discussed.

IV. FUTURE TRENDS AND OVERCOMING CHALLENGES

It can be argued that future trends in education will include the standardization and accreditation of Massive Open Online Courses (MOOCs) and Small Private Online Courses (SPOCs). This kind of online learning environment has to include a framework for motivating students in an intrinsic manner. This framework includes the creation of feeling of belonging thus increasing the feeling of participation and commitment; adaptive learning and creating moderate challenges for students in order to provide adequate value; a manageable and controllable learning environment where students can personalize their learning interface; the possibility for competition between participants; and timely updates of teaching resources. Besides this framework, the teaching staff has to have charisma, competence, and consistency [17].

Furthermore, the digital education revolution brought up the question of digital literacy and the concept of digital citizenship. To acquire such "citizenship" there would be standardized test in digital literacy put in place. This would require skills and knowledge for navigating across the digital world [18]. If the fourth industrial revolution - Industry 4.0 is also considered, then there is a clear "picture" when it comes to ICT application in education. Namely, the quality of education has to increase in order to increase the knowledge and skills of workers in Industry 4.0 [19]. Namely, the era of Industry 4.0 requires higher levels of ICT knowledge in various domains. Hence, people have to possess adequate knowledge and higher base knowledge when aiming at a job opening. Therefore, improved curriculums are becoming a necessity, not for the sake of digitalization, but for the sake of future potential employees, which face difficulties in multiple industries. Another important factors of improved education is the notion that the mass spread of education around the world has been proven to increase overall cognitive performance of the population. There is also sound evidence that schooled individuals have more pronounced neuro-development [20].

Furthermore, Big Data Technology (BDT) which aims at optimizing education by analyzing, detecting and predicting learners' behaviors. Through such analysis, risk of failure can be reduced and personalized approaches to teaching can be defined [21]. This modern ICT approach and other similar advanced ICTs will become the new norm when it comes to conceptualizing and defining curriculums in the digital education revolution.

V. GUIDELINES AND SUGGESTIONS

Based on the analyzed literature in the domain of education digitalization and modern ICT application in curriculums, the following guidelines and suggestions for improving the overall education system in the Republic of Serbia in accordance with the digital education revolution, are proposed:

- a unique and scalable online platform should be developed for the majority of educational institutions;
- integrated curriculums on faculties should be considered in order to reduce the need for extensive face-to-face communication between the educator and learner;
- accreditation of newly formed educational systems should be supervised by a formed digital governance institution;
- educators should improve lacking knowledge and skills when it comes to online teaching;
- start a nation-wide project for enabling every student on all levels of education to attend online classes;
- develop a unified platform for effective reporting on the situation in individual educational institutions;
- implement digital platforms for reducing bureaucratic procedures in educational and governing institutions.

Overall, the main guideline and suggestion is to increase efficiency of digital education governance while maintaining integrity and education quality. Educators and learners have to actively participate in the process of digitalization and to acquire the necessary skills and knowledge for effective distance learning solutions. The government should actively and strategically plan for the mass adoption of online learning and online teaching, by providing support for households and educators.

VI. CONCLUSION

This paper analyzed the digital education revolution and the process of education digitalization. The main goal was to identify challenges and barriers of education digitalization and to discuss guidelines and suggestions for an effective education digitalization process on a national level. Based on the conducted review of literature in the domain of digital education revolution and the process of education digitalization, it can be concluded that it presents a complex concept that requires synergic actions from the government, educational institutions, and educators and learners as well.

The main limitation of this paper is the lack of an empirical study. However, the goal of the paper was to review and analyze the main aspects of the digital education revolution and the process of education digitalization, thus the limitation is not severe. For future research it is recommended to conduct an empirical study in educational institutions. The study should include educators and learners as well as members of digital education governance teams. This way a more thorough insight can be achieved. For now, this current paper provides a solid basis for future research in this domain.

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Measuring the Impact of Online Learning on Students' Satisfaction and Student Outcomes Using Integrated Model

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Abstract – the COVID-19 pandemic has forced the universities to close face-to-face (f2f) education and move all activities online. Online learning has become essential for students to continue their education. But the shift from traditional f2f to online learning, has raised some questions about the quality and success of the learning process. This study developed an integrated model based on both the TAM and ISS model which is best suited for investigating the impact of online learning systems on students' satisfaction and student outcomes. The results showed that good system quality and information quality will motivate the students to use the online learning system more actively. On the other hand, the system should be ease of use, and students should perceive it as useful for fulfilling their tasks. Such system will provide high level of satisfaction for students, which in turn will lead to positive student outcomes.

I. INTRODUCTION

The Covid-19 pandemic has raised significant challenges for the education community worldwide. The unexpected closure of educational institutions disrupted teaching and learning activities, which were usually carried out in a direct meeting, and caused a shift of these activities online.

Online learning has become essential in this period, in order to continue the teaching and learning processes. Online learning refers to the type of learning that people take a professional or educational course using web-based technologies [1]. Online learning also refers to the delivery of educational material via any electronic media such as the internet, intranet, extranets, satellite broadcast, audio/video materials, video conferencing and computer-based training. In the context of higher education, the phrase "online learning is often interpreted as referencing courses that are offered completely online" [2].

Flexibility regarding independence of time, place and pace is one of the positive aspects of online learning [3, 4, 5, 6, 7]. The accessibility, affordability, learning pedagogy, life-long learning and policy are other arguments related to online learning. Online learning is primarily aimed to foster students to be independent at certain times and take responsibility for their learning. Besides, it allows students to play a more active role in their learning because it focuses on personalization, which includes the ability to adapt to the level of learners' skills and collecting knowledge resources as mutual support. Also, students' adaptive attitude can provide space and flexibility in regulating themselves, which might lead to success and achievement in learning.

However, the "shift" from traditional face-to-face to online learning has raised some questions about the quality of learning process as well as students' satisfaction and student outcomes [8]. Despite the notable examples of utilization of online learning in teaching and learning, its impact on user satisfaction and learning outcomes remain difficult to predict and measure [9, 10]. Limited research has been conducted on learning outcomes for university students, when practicing online learning. Therefore, an investigation of the determinants of students' satisfaction and student outcomes is significant to do.

This study tries to investigate the effect of various factors toward students' satisfaction and student outcomes. The acceptance-success model approach was chosen as a solution to this research problem. We have applied and integrated model composed of Technology Acceptance Model (TAM) and Information System Success (ISS) to explore student outcomes in the context of online learning.

II. BACKGROUND

A. TAM

The Technology Acceptance Model (TAM) proposed by Davis and Bagozzi [11] is the most widely used innovation adoption model. It has been extensively tested and validated empirically by scholars in various fields and contexts to explore the factors affecting individual's use of new technology [12]. Based on the Theory of Reasoned Action

(TRA) [13] and the Theory of Planned Behavior (TPB) [14], the TAM model use perceived usefulness and perceived ease of use to determine an actual use of the system, through the individual's attitudes towards using the system and behavioral intention of use. The system acceptance process is determined by 5 constructs:

• Perceived usefulness (PU) - is "defined as the prospective user's subjective probability that using a specific application system will increase his or her job performance within an organizational context" [15].

• Perceived ease of use (PEOU) - "refers to the degree to which the prospective user expects the target system to be free of effort" [15].

• Attitude towards use (ATU) - it designates "an individual's positive or negative feelings (evaluative affect) about performing the target behavior" [15].

• Behavioral intention (BI) - is conceived as "a measure of the strength of one's intention to perform a specified behavior", in this case the use of the information system [15].

• Actual use (AU) - is the level of actual use of the information system.

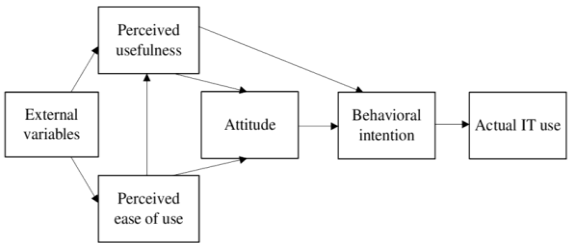


Fig. 1. Technology Acceptance Model - TAM

Recent research established that ATU is a weak mediator between PEOU, PU, and ITU [12]. Also, PU and PEOU are hypothesized to be the fundamental determinants of user acceptance, a notion verified through empirical support [16].

B. ISS

The Information System (IS) Success model is among the most influential models in both predicting and explaining system use and user satisfaction [17, 18]. This model theoretically supports the associations between determinants-satisfaction-behavior-outcomes of a system usage [19]. The original IS success model [20] consists of 6 constructs: System quality, Information quality, Use, User satisfaction, Individual impact and Organizational impact. In response to the progresses in IS applications, DeLone and McLean refined their original model and proposed an updated version in 2003 [21]. Service quality was added into the success model, and the individual impact and organizational impact were combined into a single variable named Net Benefits, as shown in Figure 2.

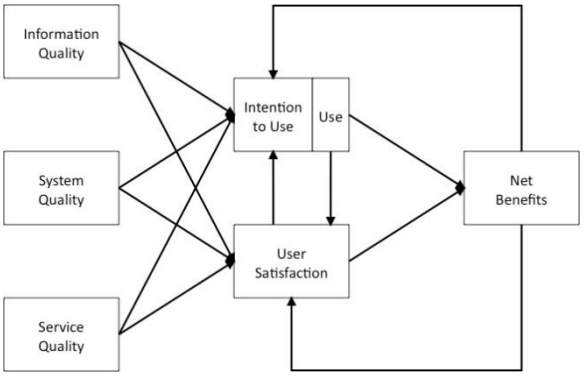


Fig. 2. Updated IS success model

• Information quality (IQ) - refers to the quality of the information that systems produce. When used with online learning systems this construct utilizes accuracy, completeness, relevance, content needs, and timeliness. We can say that IQ is the output of the system that meets user needs.

• System quality (SysQ) – is degree to which a system meets expectations. The characteristics of an online learning system that contribute to its system quality include user friendliness, availability, ease of learning, response time etc.

• Service quality (SerQ) – refers to the quality of the service or support that users receive from the IS organization and IT support personnel.

• System Use/Intention to use (SysUse) - represents the degree and manner in which an IS is utilized by its users.

• User satisfaction (US) - is considered as one of the most important measures of IS success. US represents the user's level of satisfaction when utilizing an information system. Measuring user satisfaction becomes especially useful, when the use of an IS is mandatory.

• Net Benefits (NetB) – is the extent to which information system are contributing to the success of individuals, groups, organizations and industries.

C. Students' satisfaction and student outcomes

User satisfaction is defined as user's subjective assessment of the found information, compared to the expected information that exceeds the evaluation of internal standards. It is considered as one of the most important measures of IS success. Measuring user satisfaction becomes especially useful, when the use of an IS is mandatory. In this study we will measure students' satisfaction (SS), when using the online learning system.

Student outcomes (SO) are descriptions of the abilities, skills and knowledge that are used for assessing student learning. Student outcomes should outline what students have learned and what they can demonstrate upon completion of a course. Various approaches in the current literature exist for measuring student outcomes. In our study we used grades as an assessment of individual students' performance.

III. RESEARCH MODEL AND HYPOTHESES

Based on the theoretical support from IS success model and TAM researches, we have decided to use an integrated research model to determine the impact of online learning on student outcomes (Figure 3.). This study examines relationships among IQ, SysQ, PEUO, PU, SysUse, SS and SO in an online learning environment based on the TAM and ISS model. Accordingly, the following research hypotheses were proposed:

H1: Information quality will positively contribute to system use.

H2: Information quality will positively contribute to higher students' satisfaction.

H3: System quality will positively contribute to system use.

H4: System quality will positively contribute to higher students' satisfaction.

H5: Perceive ease of use will positively contribute to system use.

H6: Perceive ease of use will positively contribute to higher students' satisfaction.

H7: Perceive ease of use will positively contribute to perceive usefulness.

H8: Perceive usefulness will positively contribute to system use.

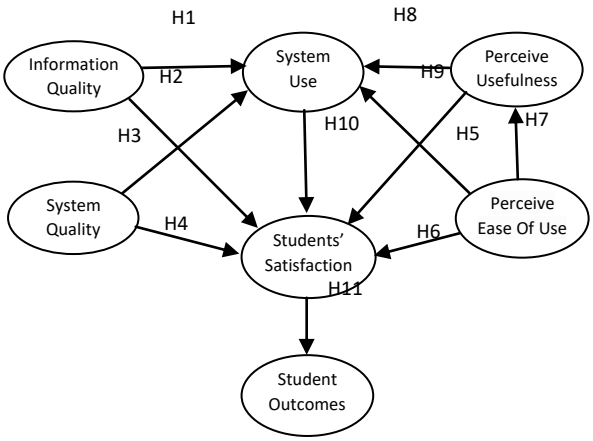
H9: Perceive usefulness will positively contribute to higher students' satisfaction.

H10: System use will positively contribute to higher students' satisfaction.

H11: Students' satisfaction will positively contribute to student outcome.

The research model of the present study and the hypotheses are illustrated in Fig.3.

Fig.3. Research model



IV. RESEARCH METHOD

A. Context

This study was carried out at the University "Goce Delcev" – Stip, In Republic of North Macedonia. The distribution of learning materials, as well as the interaction and collaboration between students and teachers, was performed via Moodle LMS. Students were also encouraged to use communication tools such as forum and chat to support their educational interaction with other colleagues. The online teaching activities were carried out using Microsoft Teams videoconferencing application. Exams were also taken online, due to the pandemic, in order to avoid any physical contact.

B. Measurement instrument

A mixed-methods survey research design was employed. The survey research design was appropriate for this study, because it aims to reveal the causal relationship between the identified constructs. All survey items used a 5-point Likert scale ranging from 1 "strongly disagree" to 5 "strongly agree." The grades from final exam range from 5 to 10.

C. Participants

This study targeted undergraduate computer science students who attended several online courses, during the summer semester of academic year 2019-2020. The average age of the participants was 21, and 65% of them were female. In total, 80 valid questionnaires with valid data were collected and included in the analyses.

V. DATA ANALYSES

Path analysis was carried out to test the hypothesis. Structural equation modeling (SEM) by SmartPL software was used to test the

structural model and validate the proposed hypotheses.

The first step of data analysis was to evaluate the reliability and validity of the measurement model. Convergent validity measures whether items can effectively reflect their corresponding factors, while discriminant validity measures whether two factors are statistically different from each other.

To verify the convergent validity of the constructs we employed the composite reliability (CR) and the average variance extracted (AVE). Composite reliability (CR) ranges from 0.822 to 1.000, which is above the suggested value of 0.70, while average variance extracted (AVE), ranges from 0.701 to 1.000, which is above the suggested value of 0.50. Cronbach's α for all constructs exhibited acceptable reliability of 0.70, and ranges from 0.703 to 1.000 (Table 1).

To determine discriminant validity the Fornell-Larcker criterion was used [22]. According to this there is discriminant validity when the variance among the constructs of a model is lower than the variance that each construct shares with its items. The results of this analysis are presented in Table 1.

Once the reliability and validity of the measurement model have been established, we performed an analysis of the structural model. The structural model was assessed by checking the significance of path coefficients between different factors (Table 2). As it can be seen from the table, all path coefficients were positive, but not all of them were significant. Table 2 also shows which of the proposed hypotheses are supported (with a significance level $p < 0.05$) and which are not.

TABLE 1. CONVERGENT AND DISCRIMINANT VALIDITY

Variable	AVE (>0.5)	CR (>0.7)	Cronbach's *α*	Discriminant validity						
				IQ	PEOU	PU	SysQ	SO	SS	SysUse
IQ	0.865	0.928	0.845	0.930						
PEOU	0.712	0.822	0.703	0.422	0.843					
PU	0.874	0.933	0.856	0.485	0.661	0.935				
SysQ	0.871	0.931	0.862	0.012	0.367	0.187	0.933			
SO	1.000	1.000	1.000	0.743	0.561	0.618	0.362	1.000		
SS	0.896	0.945	0.884	0.680	0.831	0.722	0.301	0.768	0.947	
SysUse	0.701	0.875	0.785	0.603	0.732	0.671	0.364	0.796	0.862	0.837

TABLE 2. PATH ANALYSIS

Hypothesis	Path	Path coefficient	*t*-value	Finding
H1	IQ → SysUse	0.331	4.203*	Supported
H2	IQ → SS	0.254	7.887*	Supported
H3	SysQ → SysUse	0.179	2.406*	Supported
H4	SysQ → SS	0.006	0.143	Not supported
H5	PEOU → SysUse	0.376	4.139*	Supported
H6	PEOU → PU	0.661	10.680*	Supported
H7	PEOU → SS	0.404	7.782*	Supported
H8	PU → SysUse	0.228	2.687*	Supported
H9	PU → SS	0.100	1.612	Not supported
H10	SysUse → SS	0.344	6.258 *	Supported
H11	SS → SO	0.768	15.886*	Supported

IQ – information quality, SysQ – system quality, PEOU – Perceived ease of use, PU – Perceived usefulness, SysUse – System use, SS – Students' satisfaction, SO – student outcomes.

* $p < 0.05$

VI. RESULTS AND DISCUSSION

The primary objective of this study was to measure the impact of online learning system on students' satisfaction and student outcomes. Students' satisfaction was predicted (R2 = 0.879) better than student outcomes (R2 = 0.590). This can be explained with the fact that there are other factors that influence student learning outcomes, like motivation, prior experience or skills.

Information quality has significant impact on system use and students' satisfaction. From students' perspectives, the supported materials are essential for acquiring desirable knowledge [23]. These findings are consistent with prior studies, which highlight the fact that it is not enough to

provide students with some materials, but it is much more important that those materials are of good quality, and that the course itself is well structured to present them correctly [24, 25]. The online system that supports multiple ways of delivering materials, is likely to be more wildly used.

System quality has significant impact only on system use. This is to be expected given the fact that it is important for students to use user-friendly system that is both reliable and offers a quick response time. So, we can state that the quality of the system should always be maintained.

Perceived ease of use (PEOU) is significant factor for perceive usefulness, system use and students' satisfaction. PEOU is an essential determinant of perceived usefulness in information systems. It is an important factor related to the acceptance of information technology (according to TAM model), which proved to be true in our case as well. In general, PEOU has a positive effect that can lead to system use. It encourage the students to use the system in order to continue the learning process and to complete their tasks faster and with high quality. Although in our case the use of online system was mandatory, this claim was confirmed in our research as well. Path analyses show that PEOU also has a significant positive impact on students' satisfaction. Students have a positive impression of using online learning system, they find it easy to use and they feel comfortable interacting online with colleagues and educators.

In accordance with other research, perceive usefulness has direct and significant impact on system use [26, 27, 28]. Our research is in agreement with these studies. This is probably due to the fact that the students perceived that the system would be useful for accomplishing their tasks, so they actively used it.

A significant relationship was discovered between system use and students' satisfaction, a result consistent with Park et al. [29], who found that the use of information systems influenced user satisfaction. This indicates that online learning system enhance students' satisfaction, even when its use is mandatory, like in our study. One possible interpretation is that participants in this study are computer science students, who are already familiar with online learning technology and have used it to some degree before.

System use also exhibited a strong influence on student outcomes by means of students' satisfaction, demonstrating that the active use of online learning system influences user satisfaction, which subsequently leads to better student outcomes, for students who obtained passing grades. This finding is supported by recent studies indicating that students' satisfaction is significantly related to student outcomes, in terms of examination scores.

VII. CONCLUSION

With the arrival of COVID 19 pandemic, there has been a paradigm shift from traditional face-to-face teaching and learning, to online technology enhanced learning. As predicted this transformation in the educational environment will bring long-lasting effects on teaching and learning process.

The present study is significant in that it comprehensively examined factors partly considered by the TAM and IS success model. It tries to investigate the effect of information quality, system quality, system use, perceived usefulness and perceived ease of use toward students' satisfaction and student outcomes.

The results showed that to increase system use, educators should focus on both system quality and information quality. Good system quality, such as availability, usability, user friendliness and response time will motivate the students to use the system more actively. On the other hand, the system should be ease of use, and students should perceive it as useful for fulfilling their tasks. Such system will provide high level of satisfaction for students, which in turn will lead to positive student outcomes.

With the continuous trend in the increase of utilizing online learning systems in higher education, a need for a better understanding of the effective use of such systems and factors that influence students' satisfaction and student outcomes, will always be appreciated.

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Using World Reference Level (WRL) in the Process of Recognizing the Learning Outcomes – Case study

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Abstract: It is greatly important for the international knowledge recognition processes to understand the structure and importance of the learning outcomes, as well as qualification frameworks in different states, thus allowing easier knowledge mobility. European Union works a lot in this field, adopting conventions and regulations to be followed by the member states and aspirants. Probably the most important one is the Lisbon Recognition Convention (1997), concerning the higher education in Europe. Through UNESCO, a specific tool is created in order to suggest completely new approach in translating the qualifications gained in an understandable format for the countries, thus enabling easier and more precisely done mobility knowledge mobility between the countries. In this paper, the tool is applied to concrete study program at the GDU in Stip, MK.

I. PRESENT CONDITION IN EDUCATION

Analyzing the education systems and National Qualifications Frameworks (NQF) among countries in European Union, it is pretty sure that the differences are getting decreased. Still, there is a lot to be done and differences exist between some countries, but this seems to be reduced with the accessing processes and compliances of the domestic regulations with the ones from EU. National HE systems are organized in three cycles (European Qualification Framework – EQF levels 6-8) as defined by the Bologna Process (there are slight differences in some systems, such as Latvia and UK, having EQF level 5 – short cycle of HE programs (120-180ECTS), more focused on the acquisition of professional skills needed in labor market. In general, the workload of first cycle (EQF level 6) studies varies from 180 to 240 ECTS credits, known as Bachelor level studies. Holders of first cycle qualification have access to the second cycle studies in any field of study. The workload of second cycle (EQF level 7) studies is in the interval between 60 and 120 ECTS credits, and the titles of awarded qualifications varies. For Master's degree in Europe, the overall workload of studies in first and second cycles is not less than 300 ECTS credits. Graduates of the second cycle have access rights to doctoral level studies. The third cycle (EQF level 8) qualifications are awarded on the basis of original research. Although the nominal length of doctoral studies is three to four years, workload also can vary by country.

II. COUNTRIES' NQF SYSTEMS

All the countries have developed their NQF and have already harmonized (or are in a process) their NQF systems to the EQF, with respect to all of the conventions, regulations and documentation. In almost all of the countries, higher education qualifications are located on EQF 6-8 levels. The scope of all NQF is pretty comprehensive and includes the specific levels of qualifications that are conducted within the education and/or training process of the student. For indication of the particular qualification, level descriptors are used. Level descriptors give the necessary information to the learners, education and training providers, and of course the employers to position and value a specific qualification in relation to other qualifications. Most of the European countries have designed level descriptors for a comprehensive national qualification framework (NQF), covering multiple types and different levels of qualifications. This allows the level descriptors to embrace a wide range of institutions, stakeholders and their interests, traditions, cultures and values. In terms of fundamental level descriptors, we speak about:

- Knowledge (knowledge and understanding and its application, understanding and level of practice);
- Skills (generic cognitive skills communication numeracy and ICT skills);
- Competences (personal, professional, autonomy and responsibility, learning skills etc.).

A. What are learning outcomes?

Learning outcomes (LO) describe precisely what students will be able to demonstrate in terms of

knowledge, skills, competencies and values upon completion of a course, a span of several courses, or a complete study program. Clear articulation of learning outcomes serves as the foundation to evaluating the effectiveness of the teaching and learning process. According to the Bologna Process, it is mainly focused on pushing students in the process of acquiring knowledge, skills and competences that are favorable for their study program, thus making them meeting their self-development goals and social needs as good as it is possible. Therefore, LO are the main tool of the Bologna Process for improving mobility, transparency and recognition in the European Higher Education Area (EHEA). Certainly, in this direction are the familiar tools used in the process of mobility and awards recognition years backward, such as ECTS system of evaluation, Diploma Supplement (DS) and quality assurance processes. Practically, LO can be taken as a basis for a common understanding when comparing, assessing and recognizing qualifications offered in different education and qualification systems, needed for HE harmonization at international level.

There are several aspects that need to be met regarding LO:

- LO visibility – necessary information about all the sources (online or others) where the provided learning outcomes are published or are available to be seen and examined;
- LO definition – necessary information about the author who defines, body that approves and/or owns the provided learning outcomes;
- LO and QA - Information whether the learning outcomes are subject to quality assurance – positive or negative reply;
- LO vocabulary - Information about the terminology of learning outcomes – concepts or categories used when formulating the provided learning outcomes.

There are two categories of learning outcomes that can be analyzed: generic and specific. Researches have shown that generic learning outcomes have broader usage than the specific learning outcomes. Generic learning outcomes are referred to being transversal, soft or social knowledge, skills or competences whereas specific learning outcomes are more related to the particular field or subject of qualification. The most significant differences may be observed in terms of cases when learning outcomes are used and sources of learning outcomes differ by different countries and different education systems. Thus, the conclusion may be drawn that more attention should be paid to clear identification of sources for learning outcomes that may be used in recognition.

B. Stakeholders in knowledge mobility

The recognition of learning across boundaries is urgent and challenging for multiple different stakeholders in the process of knowledge mobility, as shown in figure 1.

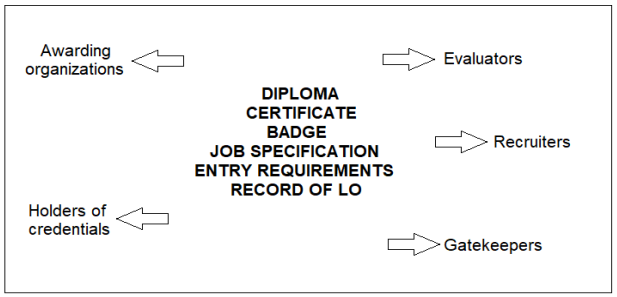

Figure 1. Knowledge mobility stakeholders

The largest goal to be achieved is automated (as it can be) international recognition, that embraces the need to work with different categories, types and levels of achievement, such as:

- life skills;
- application and responsibility;
- practicing knowledge gained;
- personal autonomy;
- context and systems;
- knowledge;
- skills;
- competences;
- learning;
- know-how etc.

So, this clearly goes above the concept of only knowledge, skills and competencies, into a broader (as it can be) picture of the person, both personal and professional, giving clear information about his ability to respond as qualified for something. Not only the specific skill or knowledge or competence is important, but also the level of achieving it, leading to the measurement of the difference between intended learning outcomes (what a learner is expected to know, be able to do and understand after having completed the learning process) and achieved learning outcomes (represented by the set of knowledge, skills and/or competences the learner has achieved and/or is able to demonstrate after completion of the learning process).

Two different recognition concepts can be analyzed:

- Recognition for the purpose of continuation of education (academic recognition), and
- Recognition for the purpose of professional engagement / employment (professional recognition).

Usually, authorities responsible for the different types of recognition differs on a state level, as well for the process of recognition of professional qualifications.

III. APPLICATION OF WRL TO A SPECIFIC STUDY PROGRAM

Countries need an international system (tool) which will be broad enough in several important spots:

- Speaking in a common language. This means that countries need establishment of a common (unique) path for comparison between the achievements and requirements (what we have vs. what we need);
- Tool needs to be pretty comprehensive, in order to be able to match any descriptors and different kind of levels;
- Should be a combination of factual information, professional judgements and supporting evidence;
- Has to produce uniform format (for example, report) which will not require any alterations in terms of regional, national or local arrangements (enabling not regulatory) and will be easy to read.

The tool should combine all the data that one study program offers, in terms of learning outcomes, general and specific, together with the gradation system or more general, levels of achievements specific to the countries, into concept that will offer unique way of awarding the learner with a report that will clearly show the quality and quantity of the learned and gained through the learning process, which will be base for further recognition. Since different countries still deals with a tremendously big set of different terms and levels describing the "skillset", there is a need of a translation system (black box) that will give the answer about the quality and quantity of the learner being subject of recognition process.

For this purpose, several broad fields needs to me examined in order of creating convergence between the data specific for each field, regarding the need of recognition:

- National qualification frameworks;
- Regional qualification frameworks;
- Sectoral qualification frameworks;
- Competence frameworks;
- Job evaluation systems;
- Job specifications;
- Program entry requirements.

As a result, this system should translate any descriptors (learning outcomes) into internationally recognized form. This is in parallel with the global growth regarding the need to be able to measure everything, such as the kinds and levels of achievement. It should be able to work with any outcome-based structure (qualification, credential, study program, job specification or even framework level). The system should translate them into an internationally recognized form of description which can be used to compare achievements and/or requirements.

UNESCO has developed solid starting system regarding this issue, named World Reference levels (WRLs). The WRL Tool is designed to work with any outcomes-based qualification, credential, set of entry requirements, job specification or framework level. It translates them into an internationally recognized form of description which can be used to compare achievements and/or requirements. It is consisted of:

- 11 (eleven) different ways of describing achievement, which are elements of capability
  - Accountabilities:
    - Activities;
    - Responsibilities;
    - Working with others;
    - Quality;
  - Capacities:
    - Skills and procedures;
    - Communication;
    - Data;
    - Knowledge and know-how;
  - Contingencies:
    - Context;
    - Problems and issues;
    - Values.
- 8 (eight) different levels of describing the stage of progression, regarding each element of capability (A1 – D2).

The system deals with 51 (fifty-one) different indicators of progression.

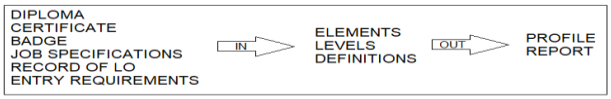

Figure 2. WRL conversing LO inputs in WRL outputs

The WRL tool is created to:

- Support owners and users to describe credentials, job specifications or entry requirements in a common language.
- Produce a WRL Profile based on the WRL Elements of Capacity and Stages of Progression for any achievements or requirements.

- Produce a WRL Report giving vital information on any quality assured credential.
- Combine factual information, professional judgements & supporting evidence.
- Use a standardized way of representing outcomes without changing them

A. WRL application to a specific study program

Subject of profiling in this paper is the accreditation elaborate for the study program of Business Economy at the Faculty of Economy, 2020, Goce Delcev University in Stip, Republic of North Macedonia. Title gained through this study program is BACHELOR OF ECONOMIC SCIENCE IN THE AREA OF BUSINESS ECONOMICS VI A (NQF). Documents that are considered to be important for this work are the main elaborate book of the study program and the additional common study programs book, containing the necessary information about the knowledges, skills, competences and values that students are supposed to gain through the study program and all the courses passed. The part of the documents containing this issue is well examined and translated into the terminology used into the WRL tool. In tis context, all the steps are followed in creating the final WRL report and profile – documents that are crucial in the process of recognition of knowledge, skills and competences.

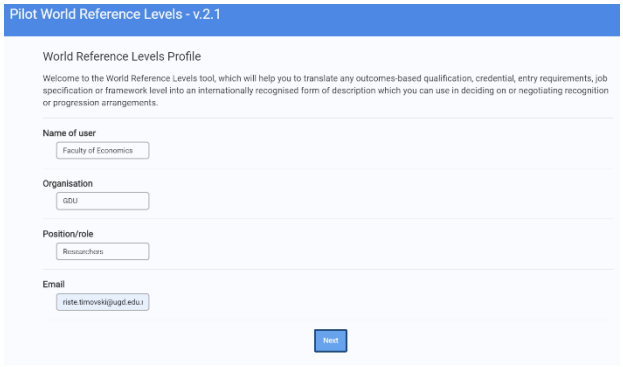

Figure 3. Creating profile in WRL

Three of the overall eleven elements of capability were examined in this research (one of each of the three general fields of capability that WRL deals with):

- Accountabilities:
  - Activities;
- Capacities:
  - Communication;
- Contingencies:
  - Problems and issues;

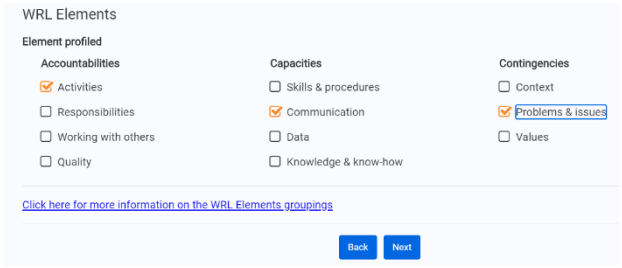

Figure 4. Choosing elements of capability for examining

Precise translation of the skills, competences and knowledges section from the documents available is done into the terminology used by the WRL tool, in order of answering all of the questions in the application. After selection of the elements regarding the subject, for each element the user will have to provide answer to a specific series of questions, each of which is accompanied by a list of possible answers. Many of the terms in the options are linked to a WRL definition in the WRL directory. The appropriate answers should be selected by the user (one or more). The possible answers contain one or more of 51 terms which indicate changes of technical difficulty, scope or autonomy. After this process, the tool generated level description and information about all of the three capability fields, describing the level and the skillset gained at that level to the study program. All the stage choices generated with the tool are shown at figure 5:

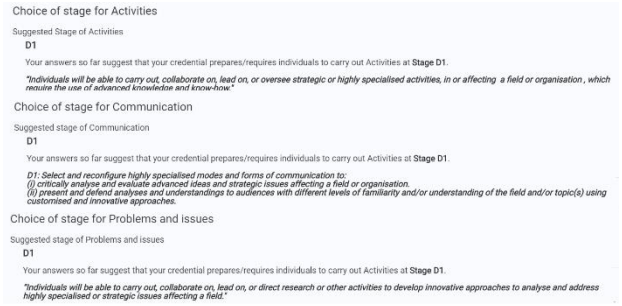

Figure 5: General WRL descriptors

At the end, we generated the final picture (profile and report) of the system. The final report is as shown in the following figure, containing the stage of progress of every different element chosen to represent the subject of profiling.

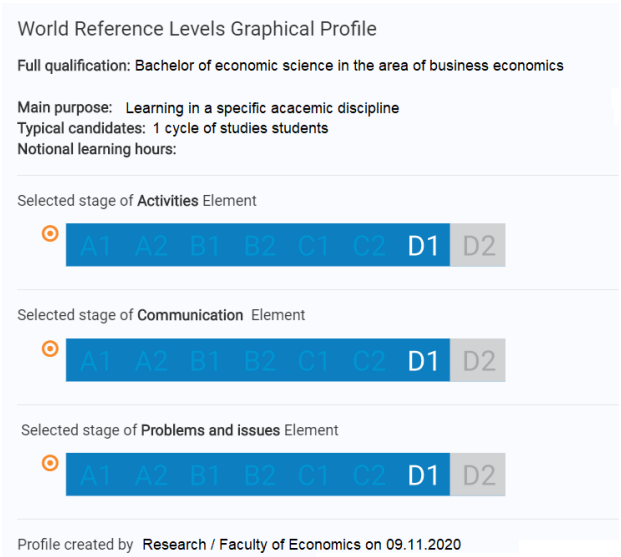

Figure 6. Final report

It is clear from the report that all three descriptors are at level D1, with appropriate explanation for each of them. Sure, the application offers possibility to choose from the neighbor levels of progression if found more close to the reality.

IV. CONCLUSIONS AND RECOMMENDATIONS

Conducted analysis on the use of learning outcomes in the process of recognition indicate that states/institutions use generic learning outcomes (more), but not specific learning outcomes. We have to note that this is also situation in our work here, but is directly corelated with the structure of the official documents we had do examine. However, the issue of how the learning outcomes of qualifications are used in recognition should be explored in more detail. Therefore, several challenges are identified as regards the use of learning outcomes in recognition, e.g., poorly articulated learning outcomes are subject to interpretation, variety in terminology and phrasing (including the issues of translation of learning outcomes), as well as lack of trustful sources of learning outcomes.

The following recommendations about learning outcomes are provided:

- The structure, formulation of learning outcomes should be improved by creating common guidelines on how higher education institutions (HEIs) should write learning outcomes in relation to the recognition practice. The content of the learning outcomes (topics, themes) would remain at the discretion of each provider.
- The availability of learning outcomes and its sources should be at a high level (and their translation into a commonly language).
- Permanent update relevant institutions and HEIs about the relevance and importance of learning outcomes of qualifications to ensure comparability and recognition of qualifications.
- Permanent level descriptors of NQFs.
- Regular trainings and methodological guidance for credential evaluators about learning outcomes and their use in recognition should be provide.
- Implementing and presenting standardized learning outcome analysis methods and tools to relevant institutions included in the recognition process for their use of analyzing the learning outcomes in recognition.

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Parallel Programming with CUDA and MPI

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Abstract – Nowadays parallel programming is stepping up on the big door and slowly surpasses the traditional sequential programming model. The main idea here is to show how it can combine two parallel programming models in order to use effectively all available computing resources. Parallel programming models of interest here are MPI and CUDA. By combining both models we could use potentially all available processing resources.

I. INTRODUCTION

Modern computer systems consist of more and more parallel processing resources which is due to the latest achievements in computing technologies. On the other hand, to be able to use these parallel processing capabilities we need to imply a suitable programming model. Nowadays computing systems combine two main computation resources with significantly pronounced parallel computing capabilities. The main building component of every computer system is Central Processing Unit (CPU) which is low latency oriented while the other significant component represents Graphic Processing Units (GPU) which is throughput oriented and owns massive parallel processing capability.

Trends in computing technologies will inevitably introduce high education Computer Science subjects that cover parallel computing and programming. The strength of the CPU is in the efficient low latency-oriented design. They contain few cores and can handle few threads at a time. On the other hand, the recent GPU have high throughput-oriented design and are composed from thousands of cores that can handle execution of thousands of threads simultaneously. Combining MPI (Message Passing Interface) and CUDA (Compute Unified Device Architecture) programming models allows utilization of all available computation resources. Through the short guide we will show how it is possible to achieve that. Building the application which will combine those two programming models could ensure utilization of the whole computation resources available in one computer system. Knowledge about this issue only can help the students easily to step forward and to acquire new skills and learn new and highly demanded modern technologies. Modern multicore computer systems brought parallel computing to wide use general-purpose PC, embedded system, game consoles, smart phones, smart TV etc.

Because of the educational purpose of this paper we will focus on giving step by step guidelines for combining MPI and CUDA programming models by exploiting initial programming examples. Recommended prerequisites that are needed before starting to write combined MPI and CUDA programs are a knowledge of C/C++, knowledge of computer architectures and operating systems. It is not necessary to have knowledge of computer graphics or parallel programming. There are many factors for writing efficient programs that will help exploiting all computation resources. Here we will cover some basics without going deeper or showing optimizations techniques for writing efficient parallel programming code.

Growing computing application demand naturally leads to change from traditional sequential computation to more promising parallel computing. To fill this gap there is a need for massive parallel processing capability units. Latest GPU have a highly parallel structure that makes them more effective for algorithms where processing of large blocks of data is done in parallel [1] [2]. With the passing of time GPU have surpassed the CPU in many ways. Improvements of the GPU go side by side with a growing range of applications from the traditional computation, signal processing, irregular computations to Machine Learning, Deep Learning, AI, Computer Vision, Supercomputing and more. It is very important for students to get familiar with GPU technologies. However, combining programming models that ensures usage of the whole available computation resources is of a completely different magnitude.

Various approaches and techniques exist for combining CPU and GPU resources. Most of the approaches are intended for computer cluster

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systems while others are for writing programs intended for heterogeneous platforms. These approaches can be separated into specific programming languages, API (Application Programming Interface) and frameworks [3]. There are also techniques for reclaiming lost performance and inefficient resources use. Some of them examine GPU utilization of individual kernels and design algorithmic techniques for maximizing resource utilization. Our intentions are to show a general method for utilizing simultaneously CPU and GPU resources and to achieve this MPI and CUDA programming models are used.

The paper is organized as follows. The general principles of MPI and CUDA programming models are given in section 2. Section 3 is devoted to describing the possibility for combining both programming models in a single program. Initial programming examples and compile instructions are presented in section 4. A few conclusion sentences are given in the end.

II. CPU AND GPU COMPUTING MODEL

One of the main differences between CPU and GPU computing models is how they execute tasks. The CPU is optimized for sequential execution while the GPU can execute thousands of tasks simultaneously.

A. CPU computing with MPI

MPI is a portable message-passing standard API designed by a group of researchers from academia and industry and is intended for a wide variety of parallel architectures. It is a standard for data communication via messages between distributed processes and is often used in HPC (High Performance Computing) for building scale applications on computer clusters. There are several well tested and efficient implementations of MPI that are fully compatible with CUDA, CUDA Fortran, and OpenACC designed for parallel computing. There are several CUDA-aware MPI open source and commercial implementations and some of them are MVAPICH2, OpenMPI, CRAY MPI, IBM Platform MPI, SGI MPI. There are a bunch of reasons for writing MPI and CUDA combined parallel programming code. Depending on the hardware or the problem that needs to be solved, the reasons for using these parallel programming approaches may vary. This approach can be applied if there is a problem with very large data size that needs to fit in the memory of a single GPU. Another reason is enabling multi-GPU applications to scale across multiple nodes. Our reason is accelerating an existing sequential application in order to achieve more efficient use of all available computing resources.

MPI standard defines syntax and semantics of library routines used for writing a wide range of portable message passing programs in C, C++, and Fortran. Other languages can also interface with such libraries. Parallel programs that use MPI can consist of separate processes, each with its own address space in which it is run. Each MPI process has its own rank and for the duration of the program execution there are fixed number of ranks executing the same program. It facilitates the use of SPMD (Single Program, Multiple Data) [4] programming model but it is not required, there are MPI implementations that allow multiple, different, executables to be started in the same MPI job. MPI process rank runs on a different core and own private memory and executes instructions at its own rate. The ranks can copy or move data between private memories via a shared interconnection. The communication can be performed by point-to-point (send/receive) which is communication between two processes, or by collective communication among the group of processes. In general, all ranks perform the same activity - compute or communicate at the same time. It should be noted that ranks workloads are not well balanced. It is important to understand message passing. They are like email with a destination and message body, which can be empty. Communication is bidirectional and requires explicit sender and receiver participation. The messages provide two services as memory to memory copy across address spaces and 2-sided handshake synchronization. If multiple messages are sent to the same destination from the same rank, then the messages will be received in the same order. But if different ranks send messages to the same destination, the order of receipt is not defined across sources. For writing message passing programs a library called MPI is used. There are a few releases of this library and the first one MPI-1 is from 1994. The first release contains 125 routines and there are more than 430 routines in MPI-3. There are at least six routines needed for the most MPI programs: start, end, query MPI execution state, point-to-point message passing. The library has additional tools for launching the MPI program (*mpirun*) and daemon which moves the data across the network.

B. GPU computing with CUDA

CUDA is powerful parallel computing platform created by Nvidia and it allows software developers to use a CUDA-enabled GPU [5] for general purpose computing. This platform allows developers to directly interact with the GPU resources and harness their power for writing efficient parallel programs. The GPU programs contain two parts, there is a

control (sequential) part that is executed by a single CPU thread and there is a parallel GPU executed part that runs thousands threads in parallel on as many cores as possible at each moment. The CUDA platform is designed to work with programming languages such as C, C++ and Fortran. It also supports other computational interfaces such as OpenCL, OpenGL, C++ AMP, and the third-party wrappers are available for Python, Julia, MATLAB, etc. Through the years Nvidia developed different micro-architecture for the various GPU. Depending on the microarchitecture generally Nvidia GPU are organized in SM (Streaming Multiprocessor) with a set of registers cache for constants, texture cache, shared memory (L1 cache) and global memory. Each SM consists of a number of SP (Streaming Processor), and SFU (Special Function Unit) used for transcendental functions. Common name for SP is CUDA core. The SP contains several ALU (Arithmetic Logic Unit) and FPU (Floating Point Unit). Execution model used by the SM is SIMT (Single-Instruction Multiple-Threads) [6] which is similar to the SIMD (Single Instruction Multiple Data) by Flynn's taxonomy [7] of computer architectures classification. The communication between SM is performed through global memory.

CUDA C is essentially a C/C++ programming language with extensions that allow executing of parallel functions on GPU. The CUDA source code consists of a mixture of conventional C/C++ host code and GPU device functions. There is CUDA C compiler *nvcc* that separates the parallel (device) functions from the code. According to this on the top level of the CUDA application there is a master process that runs on the CPU. This process is responsible for data flow between main memory and GPU memory. This process performs several tasks such as GPU initialization, allocation of main and GPU memory, moving data between main to GPU memory, launching of kernels (functions) on the GPU, fetching back processed data, deallocation of the memory and termination.

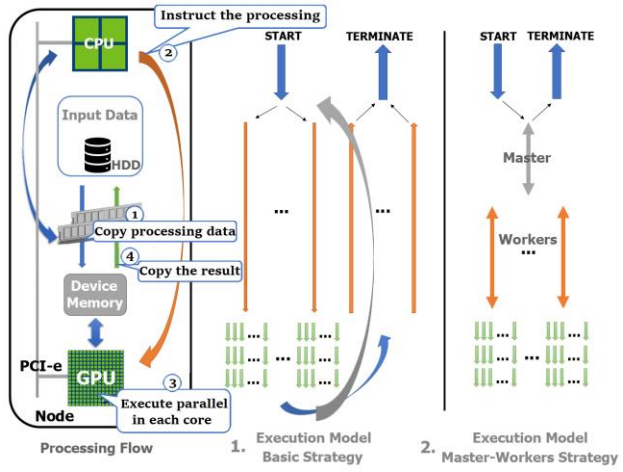

Figure 1. Example of processing flow and execution strategy model

III. BASIC PARALLEL PROGRAMMING STRATEGIES

The common problem in parallel programming is balancing of the computational load among a set of parallel processing resources. It is especially important to use the appropriate parallel programming strategy. The choice of suitable parallel programming strategy highly depends on the problem itself. In this section two widely accepted parallel programming strategies will be presented. These programming strategies are suitable for task parallel programs with no communication between tasks. It is possible to have communications between the tasks. However, it is recommended to be infrequent to reduce negative consequences on efficiency. The two typical strategies will be explained here. The structure of the programs is simple and has several MPI processes that operate with the same GPU. If there are multiple GPU, the MPI process can handle all of them. It is widely known that this programming structure introduces contest switch overheads. The MPI process is handling the main memory while CUDA kernels update the GPU memory.

In order to explain the building of a combined MPI and CUDA program step by step it is important to introduce the parallel programming strategies. On Fig. 1 is shown the general structure of processing flow together with the execution of the strategies.

A. *Basic Parallel Strategy Model*

The Basic Parallel Strategy Model is the first strategy shown on Fig.1 and is marked by 1. As it is implied by the name, this strategy has typical basic characteristics of a simple bound MPI and CUDA program. This strategy presents a simple solution for building MPI and CUDA programs. As it can be seen from Fig 1. all MPI processes run simultaneously and can start CUDA kernel function on the GPU. From Fig. 1 it can be noticed that there is circular execution on MPI – CUDA threads. It is important to have balanced work distribution through the MPI – CUDA threads. Balanced work distribution ensures efficient computation resource use and better computing performance. As already mentioned, there is a master process that runs on the CPU which is responsible for initialization, allocation and computation performing on GPU. In this case there are few MPI process instances that run on the CPU and they are responsible to ensure performance of all essential tasks simultaneously and independently. Because of the use of the same hardware resources there is an introduction of

latency, resource contest, waiting, overheads and slower bandwidth. With the increase of the number of processes the negative effects get more pronounced. It is important to have balance between the number of processes and the scale of the problem. The efficiency of the parallel computation is directly connected to available hardware resources.

B. Master-Workers Parallel Strategy Model

Second strategy that will be described is the Master-Workers Parallel Strategy Model shown on Fig. 1 marked by 2. The effective solution by automatic dynamic load balancing is to define the single master process to manage collection of the tasks and collect the results. Then the set of process workers grab a task, compute the task, send the results back to the master and then grab the next task. This action proceeds until completion of all the tasks. The master process in this case is one MPI process that schedules computational tasks to other MPI worker processes. The worker process is behaving as a top-level process that maintains a CUDA instance. Any worker task is recommended to be with equal computing demand. This way it ensures efficiency and better computing performances. In this case the worker MPI processes run on the CPU and they are responsible for performing all essential tasks simultaneously and independently. The same hardware resources are used as in the first strategy, but there is also an extra master process. Because of this there are negative consequences as input query, task waiting time, and not equal distribution of tasks between the workers. The negative consequences are more expressed with the increase of the number of the processes. There needs to be a balance between hardware resources, process number and the scale of the computing problem.

TABLE I. DESCRIPTION OF THE TEST PLATFORM

Environment	Platform 1	Platform 2
CPU	Intel i7-8565U, 1.80GHz	Intel Xeon E5-2640, 2.50GHz
Memory	8 GB DDR4 2400 MHz	48 GB DDR3 1333 MHz
GPU	GeForce MX150	Nvidia TITAN X (Pascal)
OS	Ubuntu 16.04 LTS 64-bit	Ubuntu 18.04.3 LTS 64-bit
Compiler	gcc 5.4.0	gcc 7.4.0
CUDA compilation tools	10.1	9.1
GPU Driver	V416.56	V430.50
MPI	(Open MPI) 1.10.2	(Open MPI) 3.3a2

IV. PARALLEL PROGRAM EXAMPLES

This section presents parallel program examples. The platforms that are used for testing the examples are described in Table 1. Platform 1, a graphic card NVIDIA GeForce 150MX [8], has 384 cores running at 1.53 GHz and 48 (GB/sec) memory bandwidth. Platform 2, a graphic card NVIDIA TITAN X [9], has 3584 cores running at 1.41 GHz and 480 (GB/sec) memory bandwidth.

CUDA-aware OpenMPI implementation is used for building a single MPI + CUDA program on Ubuntu OS. Open MPI can handle multiple GPU cards but in our case, there is only one GPU. The GPU card is utilized and shared between several MPI processes. Tests are performed on two different classes of parallel processing capability hardware (Table I). It is important computing hardware and software to be compatible, update and properly configured.

A. Examples

The examples represent simple MPI and CUDA programs that are built according to the parallel strategies presented in the previous section. Here the examples represent the basic program skeleton structure of the explained strategies. One way to build a single MPI+CUDA program is to put both code MPI and CUDA code in a single file. This program can be compiled using nvcc, which internally uses gcc/g++ to compile your C/C++ code, and linked to your MPI library. Another way is to have MPI and CUDA code separate in two files, *main.c* and *example.cu* respectively.

The code from the first example is according to the Basic Parallel Strategy Model and contains the mentioned two files *main.c* and *examples.c*u. The *main.c*, containing the call to CUDA file, would look like:

```
#include <mpi.h>
#include <stdio.h>
//Function declaration
void call_kernel(...);

int main(int argc, char *argv[]) {
//variable declarations
int myrank, nProcs;
//Allocate memory
...
/*  Initialize  the  MPI  execution
environment. */
MPI_Init(argc, argv);
/* Get the number of MPI processes
and the rank of this process. */
MPI_Comm_rank(MPI_COMM_WORLD,&myRan
k);
```

```
MPI_Comm_size(MPI_COMM_WORLD,&nProc
s);
/* Call function 'call_kernel()'
from CUDA file example.cu */
call_kernel(...);
// Terminates MPI execution
environment
MPI_Finalize();
//Free memory
...
}
```

In *example.cu*, the *call_kernel()* function is defined with the 'extern' keyword to make it accessible from *main.c*. The code it would look like:

```
#include <cuda.h>
#include <cuda_runtime.h>
#include <stdio.h>
//CUDA kernel
__global__ void __kernel__(...)
{
 ... // Do some work
}
extern "C" void call_kernel(...)
{
//Load CPU data into GPU buffers
__kernel__<<<BlocksPerGrid,
ThreadsPerBlock >>>(...);
//Transfer data from GPU to CPU
//Free device memory
  }
```

The second example is based on the Master-Workers Parallel Strategy Model. It also consists of two files, *main.c* and *example.cu*. The *main.c*, containing the call to CUDA file, would look like:

```
#include <mpi.h>
#include <stdio.h>
#define ROOT 0
//message to processors
#define END_MSG 1
#define GET_TASK 2
#define NEW_TASK 3
#define NO_TASK 4
#define DONE 5

//Function declaration
void call_kernel(...);

int main(int argc, char **argv) {
// Variable declarations
int   myRank,   //id   of   current
processor
    nprocs; //number of processors
int   rc;   //   result   from   MPI
operation
int dummy = 1; // fictive variable
...
//Allocate memory
...
/*  Initialize  the  MPI  execution
environment*/
MPI_Init(&argc, &argv);

/* Get the number of MPI processes
and the id rank of this process. */
MPI_Comm_size(MPI_COMM_WORLD,&nProc
s);
MPI_Comm_rank(MPI_COMM_WORLD,&myRan
k);
// Status of a reception operation
MPI_Status status;
if(myRank == 0) // Root
{
int  hasWork  =  15;  //  number  of
works
while(hasWork >= 0){
/*  Wait  message  (dummy)  from  free
processor (MPI_ANY_SOURCE)*/
rc= MPI_Recv(&dummy, 1, MPI_INT,
MPI_ANY_SOURCE, GET_TASK,
MPI_COMM_WORLD, &status);
// Master send work
rc = MPI_Send(&hasWork, 1, MPI_INT,
status.MPI_SOURCE, NEW_TASK,
MPI_COMM_WORLD);
hasWork--;     //Decrement     work
variable
}
/* When while quit this means that
no more works and Root send message
DONE to all free processors */
int k;
for(k = 0; k < nprocs-1; k++) {
dummy = -100;
rc = MPI_Recv(&dummy, 1, MPI_INT,
MPI_ANY_SOURCE, GET_TASK,
MPI_COMM_WORLD, &status);
rc = MPI_Send(&dummy, 1, MPI_INT,
status.MPI_SOURCE, DONE,
MPI_COMM_WORLD);
} }
if(myRank   !=   0)//   all   other
processors
{
//Must have end case, else not to
work
while(1) {
int work, other;
dummy = myRank;
```

```
/* send to Root (0), that I am
free, and want some work */
rc = MPI_Send(&dummy, 1, MPI_INT,
0, GET_TASK, MPI_COMM_WORLD);
//receive work from Root (int work)
rc = MPI_Recv(&work, 1, MPI_INT, 0,
MPI_ANY_TAG, MPI_COMM_WORLD,
&status);
// quit while
if(status.MPI_TAG == DONE){
break;
}
// Do some work from process
if(status.MPI_TAG == NEW_TASK) {
/* Call function 'call_kernel()'
from CUDA file example.cu */
call_kernel(...);
} } }
// Terminates MPI execution
environment
MPI_Finalize();
}
```

The *example.cu*, contains the same code as Basic Parallel Strategy Model where *call_kernel()* is defined with the '*extern*' keyword to make it accessible from *main.c*.

B. Compile procedure

The described below way of building MPI+CUDA programs contains two files. These two files can be compiled using *mpicc*, and *nvcc* respectively into object files (.o) and combined into a single executable file using *mpicc*. Using *mpicc* means that the CUDA library must be linked.

The program can be build/executed in Debug and Release mode. Making object files, linking, building, and executing the programs were performed by using Ubuntu terminal and suitable commands. The compile instructions for build and execute in Debug mode, would look like:

```
mpicc -c main.c -o main.o
nvcc -c example.cu -o example.o
mpicc main.o example.o -lcudart -L
/usr/local/cuda-10.0/lib64/ -lstdc++ -o
mpicuda
```

It is necessary to carefully link the CUDA library. In the example above is shown linking the CUDA library executed on Platform 1 (see Table I). Compile instruction that look like:

```
mpiexec -n <numprocs> <program>
```

is one way to start `<program>` with the name of the program with an initial MPI_COMM_WORLD whose group contains `<numprocs>` number of processes. Example for request two processes to test the program would look like:

```
mpiexec -np 2 ./mpicuda
```

The compile instructions with additional optimization and customize options [10] [11] [12] for build and execute in Release mode, would look like:

```
mpicc -O3 -Wall -c -fmessage-length=0 -
MMD -MP -MF"main.d" -MT"main.d" -o
"main.o" "main.c"
nvcc -O3 --compile --relocatable-
device-code=false -gencode
arch=compute_50,code=compute_50 -
gencode arch=compute_50,code=sm_50 -
D_FORCE_INLINES -x cu -o "example.o"
"example.cu"
mpicc main.o example.o -lcudart -L
/usr/local/cuda-10.1/lib64/ -lstdc++ -o
mpicuda
```

The compile instruction for executing the by request two processes to test the program would look like:

```
mpiexec -np 2 ./mpicuda
```

If there is a cluster with multiple CPU and GPU it can call different execution configuration. For example, it can request two processes and two GPUs to test the program by using PBS (Portable Batch System) script. Another way to execute the program on more than one GPU is expressly use of CUDA call *cudaSetDevice(number)* to set the current GPU, where *number* is GPU card ID (identifier).

V. CONCLUSIONS

In this paper, a short guideline is given for combining the two parallel programming approaches of MPI and CUDA. There is brief clarification of both parallel programming models. Through the two parallel programming strategies our intention is to get parallel programming closer to the students. In the last section the program skeleton of an example is shown. This example can be a starting point for building complex program structure. In the end of the section is shown how to compile and run the combined MPI and CUDA program.

ACKNOWLEDGMENTS

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Calculating the Surface of a Flat figure–application of the Definite Integral in the GeoGebra Program Package

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Abstract – The possibility to activate students' motivation as well as their ability to work independently is the greatest advantage of using computers in education. The topic of this work is using computers in teaching mathematics shown in the example of the lesson „ Calculating the surface of a flat figure – the application of definite integral. The research was conducted on first-year students of Traffic Engineering. The purpose of this research was to master the same school program in two different methods: the first was the traditional method and the second was using computers, or more precisely, the GeoGebra software. The aim of the testing conducted after teaching the above-mentioned unit was to show the effect of using computers in teaching, and the survey conducted among the students aimed to show their opinion about, and attitude towards, using computers in education.

I. INTRODUCTION

Integral calculus is studied at all technical faculties within the subject of mathematics. The term 'definite integral' can be difficult to understand, which especially refers to students with poor or no previous knowledge of integral calculus. To bring the students closer to the term definite integral and to help them learn this term, as well as other necessary terms easier, we used the GeoGebra mathematics teaching software. The efficient use of new teaching techniques can be very productive for students' progress. Multimedia can be used to encourage students to learn. It is easier to memorize new information if a visual image is present. Baddeley and Hitch [1] have suggested a theory of access memory which consists of two components: visual and verbal. In this way, it was made possible for students to process the information using both eyes and ears. This method of learning approach can be very useful. Pavilio has also suggested that information presented both visually and verbally is easier to memorize, which was applied by Mayer [2, 3].

Tall [4] believes that it is very important to link images with certain conditions so that students could obtain additional knowledge. It is necessary to combine images and methods of defining the matter to improve the existing knowledge. Today, the multimedia approach is greatly involved in education. Some of the papers in which we encounter such an approach to work are [5-10]. It is very useful in teaching mathematics, explaining mathematical ideas, abstract terms, theorems, problems... The purpose of this research is to establish to what extent the application of modern technology can help for making progress in learning, and to what extent students are interested in using new technology.

II. CALCULATION OF THE DEFINITE INTEGRAL USING THE GEOGEBRA SOFTWARE

The definite integral was processed using mathematical software GeoGebra, which was used for calculus and visualization. The software presented pictures and graphics to the students. To use computers in teaching mathematics, we can follow the suggestions given in [4] that can be followed.

The definite integral is a fundamental concept in mathematics and is applied not only in mathematics but also in mechanics, physics, and technics. The problems of the calculating path, workforce, and moment of inertia are reduced to the concept of the definite integral, i.e. integral sum and its limit value.

A. The problem of defining and calculating a curvilinear trapezium

Let's limit a given figure by the graphic of continuous, non-negative function $f:[a,b]\to\mathbb{R}$, x-axis and lines $x=a, x=b$ (Figure 1.). Such a figure is called the curvilinear trapezium.

To get a definition of its surface, we'll observe the following:

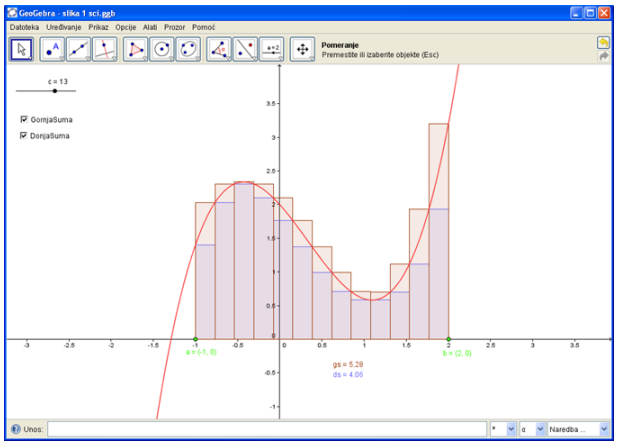
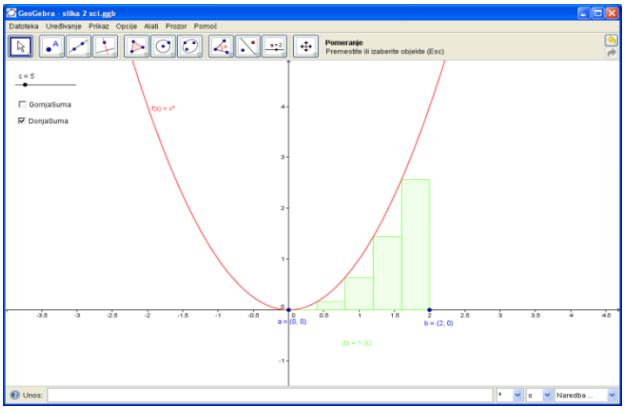


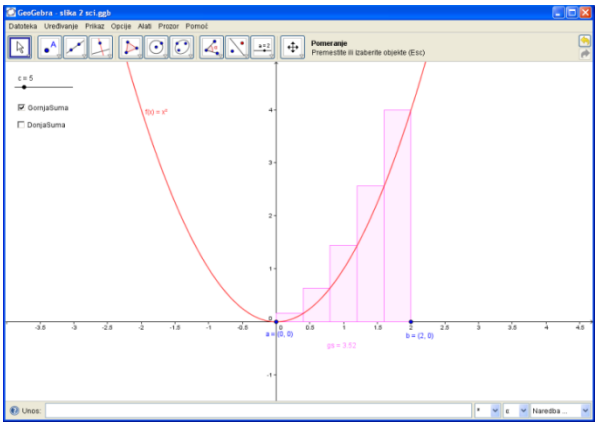
Figure 1. Curvilinear trapezium

Interval $[a,b]$ is divided with points $x_0,x_1,\ldots,x_{n-1},x_n$, in such a way that $x_0=a<x_1<x_2<\ldots<x_{n-1}<x_n=b$, in n subintervals $[a,x_1],[x_1,x_2],\ldots,[x_{n-1},b]$ and their lengths are marked as $\Delta x_1=x_1-a,\Delta x_2=x_2-x_1,\ldots,\Delta x_n=x_n-x_{n-1}$. In each subintegral $[x_{i-1},x_i]$, $i=1,2,\ldots,n$, we choose a random point ξ_i , then we form the products $f(\xi_i)\Delta x_i$ and sum $s_n=\sum_{i=1}^{n} f(\xi_i)\Delta x_i$. The sum s_n is an integral sum of function f for the given intervals $[a,b]$ and the chosen points ξ_i. The integral sum represents the sum of the surface of rectangles, with sides $f(\xi_i)\ \Delta x_i$, $i=1,2,\ldots,n$.

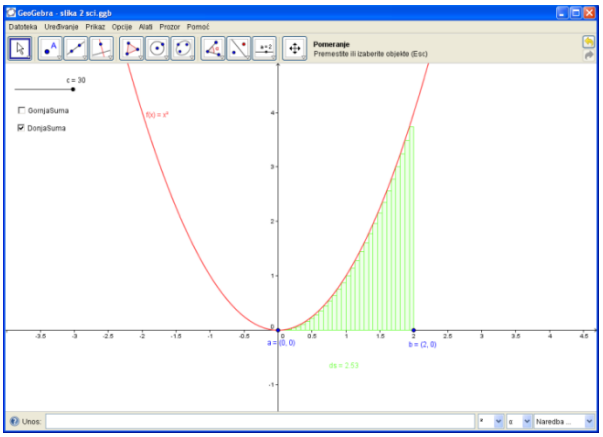
The integral sum is an approximate value of the surface of a curvilinear trapezium. The smaller the lengths of the subinterval, the more accurate are the surface of the curvilinear trapezium.



2 a. The approximation of a curved line $y=x^2$ on the interval of $[0,2]$ Interval divided into 5 parts (lower sum)



2 b. The approximation of the curved line $y=x^2$ on the interval of $[0,2]$Interval divided into 5 parts (upper sum)



2 c. The approximation of the curved line $y=x^2$ on the interval of $[0,2]$ Interval divided in30 parts (lower sum)

The number S is the limit value of the integral sum s_n when the maximum value approaches zero if there is a $\delta>0$ for every $\varepsilon>0$ so that for any division where there is $\max\Delta x_i<\delta$ and for any choice of points ξ_i the condition $|s_n-S|<\varepsilon$ is fulfilled. The number defined as $S=\lim_{\max\Delta x_i\to 0}\sum_{i=1}^{n} f(\xi_i)\Delta x_i$ represents the surface of the curvilinear trapeze.

B. Definition of definite integral

Let $f:[a,b]\to\mathbb{R}$ be a limited function of the integral $[a,b]$, $a<b$. Let's use points $a=x_0<x_1<x_2<\ldots<x_{n-1}<x_n=b$ to divide the interval $[a,b]$ into subintervals $[x_0,x_1],[x_1,x_2],\ldots,[x_{n-1},x_n]$ and mark their length as

$\Delta x_1 = x_1 - x_0, \Delta x_2 = x_2 - x_1, \ldots, \Delta x_n = x_n - x_{n-1}$.

Let's choose a random point ξ_i in each subinterval $[x_{i-1}, x_i]$, $i = 1,2,\ldots,n$ and form the products $f(\xi_i)\Delta x_i$. The sum $\sigma = \sum_{i=1}^{n} f(\xi_i)\Delta x_i$ is the integral sum of function f on the interval $[a,b]$. It depends on the division of intervals and the selected points ξ_i .

The number S is the limiting value of the integral sum when $\max \Delta x_i \to 0$, if for every $\varepsilon > 0$ there is a $\delta > 0$ so that $|\sigma - S| < \varepsilon$, for every integral sum σ where we have $\max \Delta x_i < \delta$ and all selected points ξ_i . The limiting value of the integral sum $\sigma = \sum_{i=1}^{n} f(\xi_i)\Delta x_i$, if it exists, is the definite integral of a function f on the interval $[a,b]$ and is marked as

$$\int_a^b f(x)dx = \lim_{\max \Delta x \to 0} \sum_{i=1}^{n} f(\xi_i)\Delta x_i \qquad (1)$$

C. Application of the definite integral-The surface of a flat figure

Let f be a positive continuous function on $[a,b]$. The area P of a figure bounded by the curve $y = f(x)$, the lines $x = a$, $x = b$ and the $x-$ axsis define as

$$P = \int_a^b f(x)dx \qquad (2)$$

If the function $f(x)$ changes the sing on the $[a,b]$

For example the surface P formed by this function with x -axis and the line $x = a$ and $x = b$

$$P = \int_a^c f(x)dx - \int_c^d f(x)dx + \int_d^b f(x)dx \qquad (3)$$

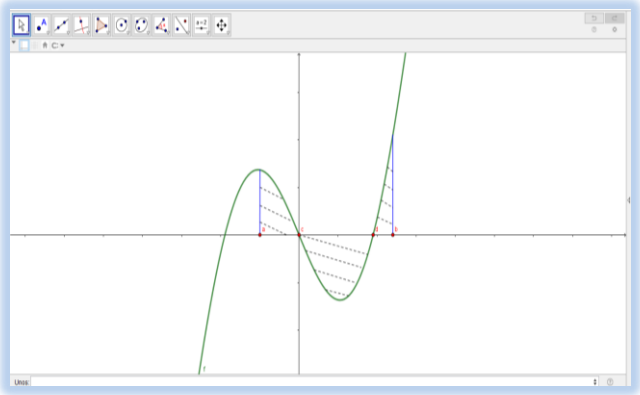


Figure 3. The surface of a flat figure is curved $y = f(x)$, lines $x = a$, $x = b$ and Ox - axis

Let f and g be continuous functions on $[a,b]$ and let it be $f(x) \geq g(x)$ for each $x \in [a,b]$, then the surface of the plane figure is curved $y = f(x)$, $y = g(x)$ and lines $x = a, x = b$ define as (Fig.4.)

$$P = \int_a^b (f(x) - g(x))dx \qquad (4)$$

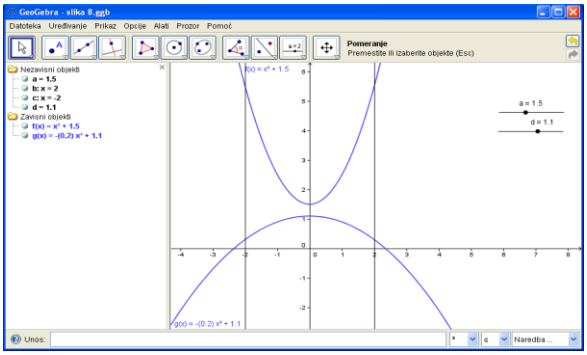


Figure 4. The surface of a flat figure is curved $y = f(x)$ $y = g(x)$ lines $x = a$ and $x = b$

D. The examples of animation in the GeoGebra program

After the processed theoretical part using software, ie applets on which the contents are mentioned and presented, a series of examples follow, some of which are given here. In the following example, the observed area is bounded by the curve $y = x^4 - 5x^2 + 4$ and Ox -axis. Using the slider, we play an animation where the given function can be seen (Fig.5.), then for example the upper sum (Fig. 6.), or the observed area (Fig. 7.)

and finally we have the calculated area of the observed surface (Fig. 8).

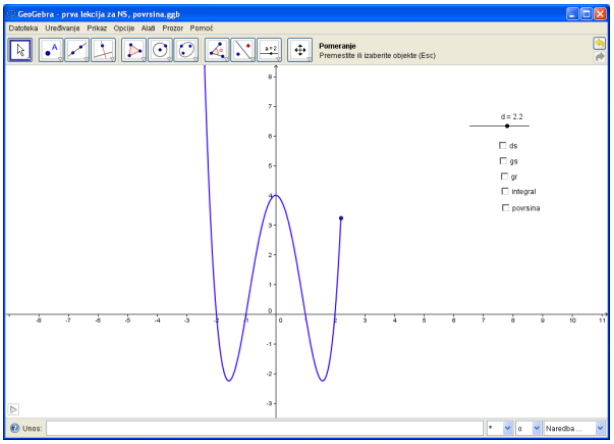


Figure 5. Function $y = x^4 - 5x^2 + 4$

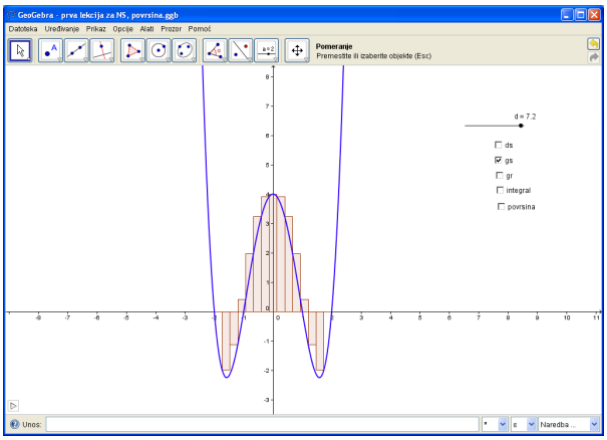


Figure 6. Upper sum curvilinear trapezium

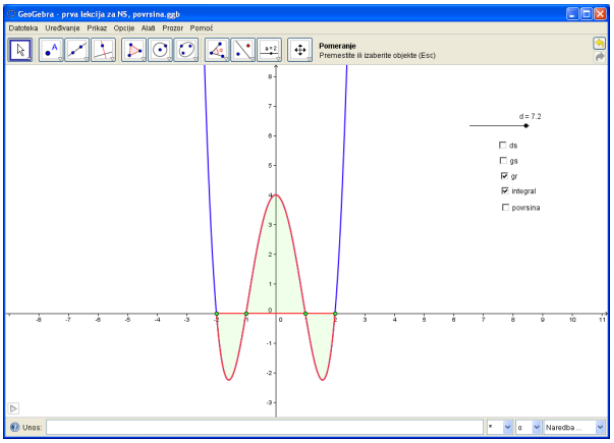


Figure 7. The surface of the observed surface

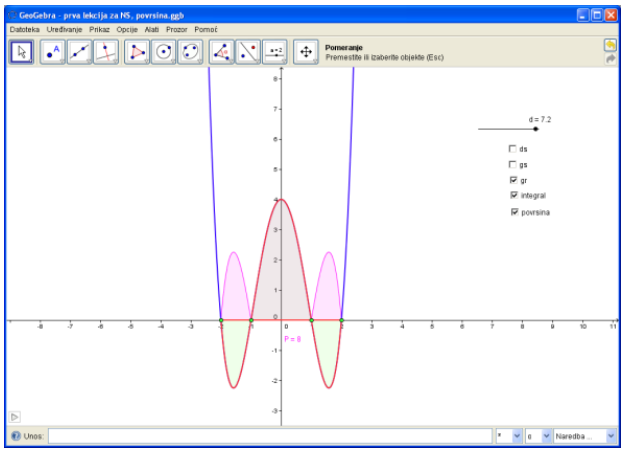


Figure 8.The surface is limited by the cure $y = x^4 - 5x^2 + 4$ and Ox - axis

GeoGebra software allows us to change the function using the slider. The table is, say, quite good for working in groups. In Figures 9. and 10. it is clear that by moving the slider we obtained two different surfaces, in Fig.9. we observe the area bounded by the curve $y = x^2 - 1$, axis Ox, lines $x = 1$, and $x = 2$, while in the image, the value of the parameter was changed using the slider, and we obtained a new function and thus a new observed surface. GeoGebra software allows you to see and set more examples in a shorter time, and if students are given access to a computer or if they work in a computer room, they can explore on their own.

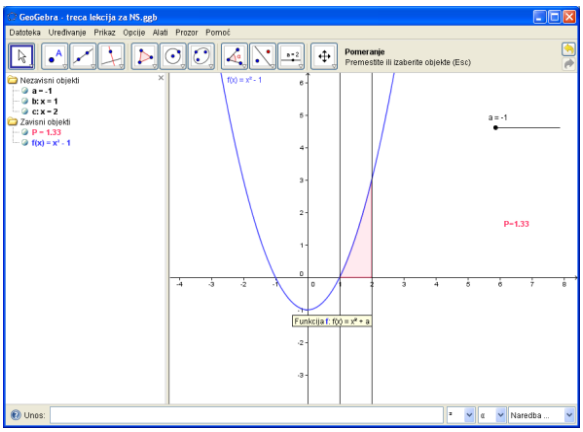


Figure 9. The surface is limited by the curve $y = x^2 + a$, for $a = 1$, Ox - axis, lines $x = 1$ and $x = 2$

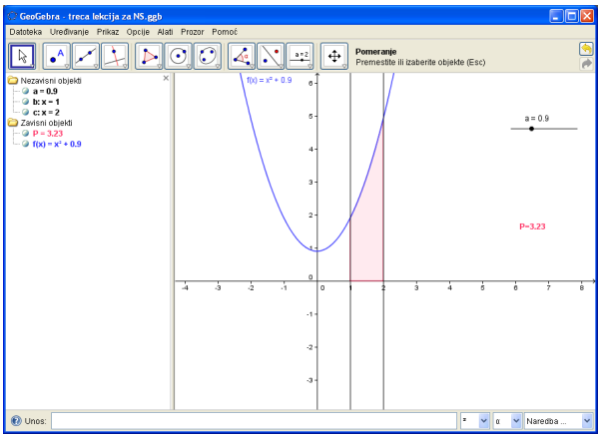


Figure 10. The surface is limited by the curve $y = x^2 + a$ for $a = 0,9$ Ox - axis, lines $x = 1$ and $x = 2$

III. METHODOLOGY OF RESEARCH

The research was conducted at the Faculty of Traffic Engineering in Doboj, The University of East Sarajevo. The research aimed to master the same program in two different ways and, after the testing, to compare the achieved results. The students were divided into two groups of 20 members. The groups were balanced in terms of prior knowledge. The first group was taught interactively using computer software, where the computer was used to present pictures, graphs, and interactive illustrations.

After the lectures, the students did a survey whose purpose was to determine the interest of students in this way of teaching. The second group of students was taught traditionally, using blackboard and chalk. The graphs were manually drawn on the blackboard. It is necessary to emphasize that the lessons that were taught were the same; they were only presented in two different ways.

A. Results and discussion

The research was conducted during the school year 2015/16. Passing grades are from 6 to 10, grade 5 is not a passing grade. The results of the research are presented in Tables I, II, and Figure 10.

TABLE I. THE GRADES DURING THE SCHOOL YEAR 2015/16

Student groups	The average grade from the previous lesson (indefinite integral)	Test results (definite integral)							
		10	9	8	7	6	5	Average grade	σ
The first group	6,91	1	4	-	4	7	4	6,8	1,45
The second group	7,04	1	-	1	8	5	5	6,45	1,23

The research was conducted during the school year 2016/17.

TABLE II. THE GRADES DURING THE SCHOOL YEAR 2016/17

Student groups	The average grade from the previous lesson (indefinite integral)	Test results (definite integral)							
		10	9	8	7	6	5	Average grade	σ
The first group	7,76	3	2	2	9	4	-	7,55	1,32
The second group	7,81	-	4	3	6	3	4	7,00	1,37

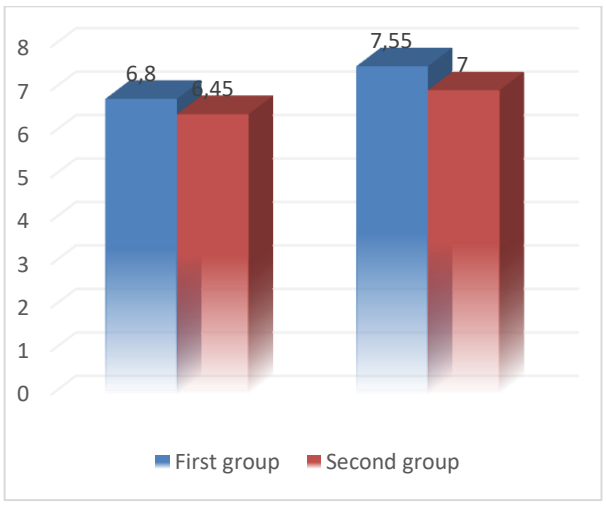


Figure 10. The grades for first and second groups

From the data provided, we can see that the student groups who were taught using the computer achieved better results.

In the research conducted in the school year 2015/16 (Table I), we can see that the first group achieved an average grade 6,8, with a standard deviation of 1,45, while the group taught in the traditional method achieved an average grade 6,45 with a standard deviation of 1,23.

In the research conducted in the school year 2016/17 (Table II), we can see that the first group achieved an average grade 7,55, with a standard deviation of 1,32 while the group taught in the traditional method achieved an average grade 7,00 with a standard deviation 1,37.

The results of the survey conducted among the forty students (the groups of students who used the computer software in the learning process) were as follows: 37 students (92,5%) find that learning with the help of computers is better than the traditional method of teaching, and 3 students (7,5%) said that learning with the help of computers did not improve their learning outcome.

IV. CONCLUSION

The results of the research suggest the necessity to introduce changes in the education system and to adjust to the new, modern standards of teaching.

The multimedia approach is successfully used in the creative process, making decisions, solving problems, active participation of students in the class, while the traditional approach is based on the passive position of students concentrated merely on memorizing information.

Modern mathematics teaching relies on the use of computers and educational software. The introduction of educational software in teaching mathematics has made traditional teaching more modern in terms of speed, quality, and quantity of tasks performed.

Mathematics software package GeoGebra enables a more creative approach to mathematics teaching and better visualization of terms introduced. With the help of mathematical educational software, the students have to adapt to the new circumstances, in which they build mathematical concepts and rules with the help of teachers, but also reveal the required properties independently.

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Mathematical Problems in Final Exams Through the PISA Perspective

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Abstract – Assessing student's knowledge is a challenge of global interest for general prosperity. Its outcomes are primarily used for educational strategy development. A particular PISA assessment program will be presented. The PISA principles will be employed in the analysis of the mathematical problems in final exams intended for the end of primary/compulsory educational cycle in Serbia.

I. INTRODUCTION

In many occasions we are proud for the achievements of Serbian students in various international scientific competitions [14-22]. In the same time, experiences from the immediate environment indicate Mathematics as an unpopular subject in Serbian educational system [23]. Most people have forgotten ordinary mathematical facts useful in daily routine. This means that gained mathematical knowledge is not functional.

The problem is not local. The surrounding countries, and the others all over the word face the similar situation [3,6,24]. Mathematical content knowledge is not enough for solving real problems and people rely on ever-available technology too often.

The Organization for Economic Co-operation and Development (OECD) is an international organization that aims to increase prosperity, equality, opportunity and well-being for all. Global progress is closely related with capabilities as products of education, hence the OECD Program for International Student Assessment (PISA) has been founded in 1997. The primary purpose of the PISA is systematically monitoring quality adequacy of education [1,6]. PISA outcomes could be benefit for government and should guideline educational strategy.

By the decision of the government, Serbia is included in PISA testing since 2001 [5]. PISA achievements of Serbian students are significantly below the average PISA achievements [5,7]. According to PISA 2012 data, mathematical literacy of almost 40% students in Serbia is not functional, i.e. their achievements are at the first or below the first level of knowledge. Less than 5% of students reach the highest achievements in mathematics, which indicates that our educational system does not provide enough incentives to students with high potential [2].

PISA framework is usually employed in assessing student's knowledge, and quality and equity of education. Having Mathematical literacy in focus, this article considers mathematical problems in the PISA tests, thoughtfully designed to reflect the goals. Each problem has specific mathematical content and context, demands particular process in solving procedure and reflects the level of student's capabilities. PISA framework implies various types of classifications for mathematical problems.

PISA classification/methodology will be used for analyzing mathematical problems in final exams at the end of compulsory education in Serbia. PISA test and final exam are comparable, because both are intended to students of the age 15 for validation of their mathematical knowledge.

II. ON PISA PROGRAM

Throughout various questionnaires intended to students, school principals, teachers and parents, PISA systematically monitors trends in the student's knowledge and skills, and entire social perspective influencing educational process. PISA determines the influence of various social factors on the students' educational achievements (features of the education system, family environment, characteristics of the school and teachers, traits of students…) [5]. The PISA assessment provides three main types of outcomes [1]:

1. Basic indicators on the knowledge and skills of students
2. Indicators that show how the skills relate to various demographic, social, economic and educational variables
3. Indicators on trends that show changes in outcomes and their distributions, and in relationships between student-, school- and

system-level background variables and outcomes.

The first outcome reflects educational quality, while the other two indicates two dimensions of equity: inclusion (ensuring that all students attain essential foundational skills) and fairness (distribution of opportunities to acquire a quality education and, more specifically, to the degree to which background circumstances are related to students' education outcomes) [6].

Major domains for testing student's capabilities are reading, mathematics and science. Within each of the domains, questions/problems are particularly chosen to reflect three aspects of literacy and hence, the specific framework is created.

III. MATHEMATICAL LITERACY

Elementary mathematical knowledge is actually the mathematical content knowledge i.e. problem-solving skill [8,10]. In the teaching process focus is on employing the knowledge of arithmetic, algebra, geometry and data for solving as much wide as possible range of mathematical problems (usually posted in a predicted form).

Mathematical literacy is defined by OECD, but the definition is generally accepted. Mathematical literacy is as an individual's capacity to identify and understand the role that mathematics plays in the world, to make well-founded judgments and to use and engage with mathematics in ways that meet the needs of that individual's life as a constructive, concerned and reflective citizen. Mathematical literacy is concerned with the ability of students to analyze, reason, and communicate ideas effectively as they pose, formulate, solve, and interpret solutions to mathematical problems in a variety of situations [1,6].

Mathematical literacy is an important intermediate stage towards the mathematical maturity that imposes the quality of general understanding and operating mathematics. Mathematical maturity is not rigorously defined, but it reflects ability to do the following [9]:

- Make and use connections with other problems and other disciplines
- Fill in missing details
- Spot, correct and learn from mistakes
- Winnow the chaff from the wheat, get to the crux, identify intent
- Recognize and appreciate elegance
- Think abstractly
- Read, write and critique formal proofs
- Draw a line between what you know and what you don't know
- Recognize patterns, themes, currents and eddies
- Apply what you know in creative ways
- Approximate appropriately
- Teach yourself
- Generalize
- Remain focused
- Bring instinct and intuition to bear when needed.

Student's achievements in content knowledge and maturity are mutually independent [10]. Mathematical literacy, with all its achievements' levels, is major conjunction between them showing slow but permanent student's progress.

A. Mathematics in Serbian educational system

Aims and objectives of teaching mathematics in Serbia are declared by government, Ministry of Education, Science and Technological Development. Students' achievements are also determined by the government in the rule book on standards of achievement [4]. Educational standards are expressed throughout general capabilities: elementary, middle and advanced. Each of them is precisely described by adverbs explaining what student can do in each of the five mathematical content category: **N**umbers and operations with them, **A**lgebra and functions, **G**eometry, **M**easurement and **D**ata Processing. Specific mathematical capabilities are defined separately for three various mathematical domains: **M**athematical knowledge and reasoning, **A**pplication of mathematical knowledge and skills to problem solving and **M**athematical communication [11].

Definition of educational goals and learning outcomes is based on Bloom's taxonomy according to which achievement levels are divided into three areas: cognitive, psychomotor and afective [12]. Cognitive and psychomotor achievements are closely related with mathematical content knowledge. The areas are systematized hierarchically and levels of each category contain key verbs which defines qualitative and quantitative learning outcomes.

B. PISA mathematical framework

In the domain of mathematics the three aspects of literacy, present in the posted problems, are the following:

- Content – numbers, algebra and geometry, as familiar curricular subjects, are mixed and overlapped, and settled in one of the four content categories: **Q**uantity, **C**hange and relationships, **S**pace and shapes, **U**ncertainty and data.

- Context – it determines an environment in which the problem is placed; and it can be: **P**ersonal, **O**ccupational, **So**cietal and **Sc**ientific.
- Processes – they describe what students do in problem solving. There are three categories: **F**ormulating situations mathematically; **E**mploying mathematical concepts, facts, procedures and reasoning; and **I**nterpreting, applying and evaluating mathematical outcomes.

The processes are draw on seven fundamental mathematical capabilities (explained in [1].):

1. communicating;
2. mathematising;
3. representing;
4. reasoning and arguing;
5. devising strategies for solving problems;
6. using symbolic, formal and technical language and operations; and
7. using mathematical tools.

The capabilities related with the processes are crucial in defining what it means to be at different levels of the mathematical literacy scales. The six levels of the scale are described through student's ability of doing [1, Chapter 3.]. The first level is the lowest one, and the sixth one is the best. Students are categorized within the levels according to the questionnaire score.

The levels are comparable with the achievement's levels in Serbian educational nomenclature, but more precise.

PISA recommends each mathematical questionnaire to have optimal attendance/distribution of problems within the various aspects:

$$\text{Content: } \begin{pmatrix} Q & C & S & U \\ 25\% & 25\% & 25\% & 25\% \end{pmatrix}$$

$$\text{Context: } \begin{pmatrix} P & O & So & Sc \\ 25\% & 25\% & 25\% & 25\% \end{pmatrix}$$

$$\text{Processes: } \begin{pmatrix} F & E & I \\ 25\% & 50\% & 25\% \end{pmatrix}.$$

IV. PISA PROGRAM AND MATHEMATICS IN SERBIAN EDUCATIONAL SYSTEM

In Serbia, primary school graduates need to take a final exam, which is consisted of three parts. Mathematics makes one of them. The mathematics test is consisted of 20 problems.

The aim of the research proposed here is to analyze structure of mathematics final exam tests according to three aspects of literacy which PISA recommended.

Research covers the sample of 60 mathematical problems, from school years 2016/2017, 2017/2018. and 2018/2019.

The research results are presented below.

C. Mathematical content

In all three observed years the problems from the categories of *Change and relationships* and *Space and shape* are noticed as most frequent, more than other two remaining categories in *Mathematical content* aspect. In the category *Change and relationships* the problems that appear the most are the problems such as manipulating algebraic expressions, solving equations and, in general, traditional mathematical content. In the category *Space and shape*, we have observed traditional geometry,calculating areas and volumes, to be most common. However, the other problems, like the problem of symmetry, also occurs. The next table presents the categorical distribution, i.e. percentage of the share of each category in the aspect of *Mathematical content*.

	Q	C	S	U
2016/17.	10%	25%	40%	15%
2017/18.	20%	35%	40%	5%
2018/19.	15%	40%	30%	15%

D. Mathematical context

In the next table we present the share percentage of the categories in the aspect of *Context* in final exams. In all three years observed, the category *Scientific* is the most common. This category can be roughly divided into two separate parts. Namely, the one part represents the problems concerning the application of mathematics in other fields of science and technology, while the other part presents simply mathematics as such, irrespective of the world around us [1]. In all three tests the problems of the other part are the most frequent. Aside of that, it is noticeable that the problems from the category *Occupational* are barely represented. Among others, this category encompasses work related problems, like accounting, scheduling, design and job-related decision making [1].

	P	O	So	Sc
2016/17.	30%	5%	20%	45%
2017/18.	15%	10%	4%	55%
2018/19.	35%	0%	15%	50%

E. Mathematical process

In the aspect of *Mathematical process* PISA recommends a higher representation of the category

Employing mathematical concepts, facts, procedures and reasoning, which was met by us, though significantly more than recommended. Problems that occur quite often are the problems concerning manipulating numbers, algebraic expressions, as well as the ones related to the application of mathematical facts, rules and algorithms when finding solutions. All of these activities, among others, define *Employing* category [1]. Table below shows percentage of each category in the aspect of *Mathematical process*.

	F	E	I
2016/17.	5%	80%	15%
2017/18.	25%	65%	10%
2018/19.	10%	75%	15%

V. CONCLUSION

The research confirms significant deviation between aspectual structures of the final exam tests and PISA tests.

According to the mathematical content, the most represented problems are the ones related to the traditional algebraic and geometric concepts. This may cause students to always expect the same patterns in dealing with problems in mathematics.

The context is an aspect where the deviation is the largest. Within the whole sample a half posted problems is settled in scientific context. The most problems have purely abstract formulation: solve the equation, simplify the expression, determine *x*,… It could be hard and tedious for students to even consider the problems. This fact supports low level of applicability of gained mathematical knowledge. On the other hand, simple and short formulations enable recognition of suitable procedure for problem solving and therefore, teachers resort to this method. Absence of real situations related to problems, inhibits the infiltration of mathematics into everyday life.

Context of a problem imposes solving procedure and determines necessary mathematical processes. The simple and short formulations commonly imply single and simple process, which comes down to employing mathematical concepts, facts, procedures and reasoning. Remaining types of mathematical processes cannot come to the fore without compound problem formulation. Hence, domination of scientific context is obviously significantly correlated with large representation of only one type of mathematical process.

Educational system in Serbia mostly supports mathematical content knowledge. Problems and tasks are commonly settled in scientific context, very abstract and far from reality. Students are encouraged for gaining routine within mathematics as a subject. More evident problems in teaching mathematics are emphasized in [13]. Therefore, mathematical maturity and literacy are achievable to a small number of students – to those who have natural predispositions for mathematics.

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The Use of Python in the Field of Artifical Intelligence

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Abstract – This paper presents the role of artificial intelligence and Python programming language. Examples of Python application in AI fields are described. The advantages and disadvantages of the Python programming languages are listed. Because there are a large number of programming languages used for programming in AI, a comparison of selected AI programming languages was performed.

I. INTRODUCTION

College students spend a lot of time learning programming languages, but they are still not familiar with all the programming languages that exist. One of the most popular programing languages is Python. Python has a wide application, and as such is often taught in various faculties through subjects.

In the late 1980s, Guido Van Rossum created Python, which is a powerful, procedural, object-oriented, and functional programming language. The language is used in different application domains. These include software development, web development, Desktop GUI development, education, and scientific applications. It thus encompasses all aspects of development and has gained popularity thanks to its simplicity and robustness. Python can be easily learned and understood. Removing the brackets make the code short. Some tasks in Python are quite simple, while learning advanced functions is a bit more complex. The project written in Python is easy to understand. Python code is concise, efficient, understandable, and manageable [1].

Artificial intelligence (AI) is widespread field and is one of the most common subjects in colleges, where the goal is to introduce students to AI.

John McCarthy is considered the father of artificial intelligence, and he believes that artificial intelligence is the science and engineering of making intelligent machines, especially intelligent computer programs. AI is a way to make a computer, a computer-controlled robot, or software that thinks intelligently, in a similar way that intelligent people do. By harnessing the power of computer systems, it has led man to question whether a machine can think and behave like humans. The development of AI is intended to create similar intelligence in machines found in humans [2].

AI is a way to make machines think and behave intelligently. Machines can be controlled by the software contained in them, which means that AI has to do with software programs that control machines. AI is a science that finds theories and methodologies that will help machines understand the world and react to situations in the same ways as humans. AI is used in many different forms around the world. Scientists want to make machines feel, judge thoughts and act, as well as be rational. It is believed that by understanding how the human brain works, one can achieve results in the field of AI. A machine can be built if it imitates the way the human brain learns, thinks, and acts. All this can be used as a platform for the development of intelligent systems capable of learning [3].

Artificial intelligence is considered a trend technology of the future. There are several applications that are made on it. It is very interesting for companies and researchers and raises the question of which programming language can be used to develop AI applications. There are various programming languages such as Lisp, Prolog, C++, Java, Python, which can be used to develop AI applications. Among them, the Python programming language is gaining in popularity, and some of the reasons are that Python includes very little coding and simple syntax among other programming languages that can be developed for AI application development. Testing for this reason can be easier and can focus more on programming itself. The main advantage of using Python for AI is that it comes with built-in libraries. Python has libraries for almost all types of AI projects. For example, NumPy, SciPy, matplotlib, nltk, SimpleAI are some of the important embedded Python libraries [2].

II. RELATED WORK

Artificial intelligence (AI) as a subfield of computer science focuses on designing computer

programs and machines capable of performing task in which people are naturally good, such as understanding natural language, understanding speech, and recognizing images [4].

AI strives to create machines are intelligent as human beings. There are many reasons to study AI. Nowadays, it works with a huge amount of data, which the human brain cannot keep track. That is why it is necessary to automate things. To do automation, it is necessary to study AI, because it can learn from data and can perform tasks with precision, accuracy and without tiredness. It is necessary for the system to teach itself because the data itself changes, and the knowledge that results from such data must constantly updated. That is why AI is used, because an AI enabled system can teach itself. With the help of neural networks, AI can analyze data more deeply, as well as achieve tremendous accuracy. AI can think and respond to the situations which are based on the conditions in real time. For systems that use self-learning algorithms, the data is intellectual property. AI is needed to be indexed and organized in a way that always gives the best results [5].

Intelligence is the ability of a system to calculate, reason, perceive relationships and analogies, to learn from experience, store and retrieve information from memory, solve problems, understand complex ideas, use natural language fluently, classify, generalize, and adapt new situations. According to American development psychologist Howard Gardner, intelligence comes in many forms: linguistic intelligence, musical intelligence, logical-mathematical intelligence, spatial intelligence, bodily-kinesthetic intelligence, intra-personal intelligence, interpersonal intelligence. A machine or artificial intelligence system is considered intelligent if it possesses at least one of the intelligences. Intelligence is intangible and consists of reasoning, learning, problem solving, perception, linguistic intelligence [2].

AI is a large field of study and helps find solutions to real-world problems. Fields of study in AI are machine learning, logic, searching, artificial neural networks, genetic algorithm, knowledge representation. AI is applied in gaming, natural language processing, expert systems, vision systems, speech recognition, handwriting recognition, intelligent robots [5].

Python is an example of a language that does everything right within the domain of things for which it is designed. What sets Python apart is that the application can be written on one platform and can be used on other platforms. Python code is readable and has a concise syntax that allows applications to be written using fewer lines of code than other programming languages. Python supports functional, imperative, object-oriented, and procedural coding styles. Python provided for educational and other purposes for which other programming languages may fail [6].

Python is particularly attractive for workloads in data science, machine learning, and scientific computing. NumPy is the basis of the Python stack for machine learning. It enables efficient operations on data structures often used in machine learning, vectors, matrices, and tensors. The main data structure of NumPy is a multidimensional array [7]. NumPy is a multidimensional array library with basic linear algebra routines, while the SciPy library adorns NumPy arrays with important primitives, numerical optimizers, and signal processing to statistics and scarce linear algebra. SciPy is used in almost half of machine learning projects. The Pandas library is a format for presenting tabular data in Python for extracting, transforming, loading context, and analyzing data [4].

TensorFlow is a software library or framework, designed by the Google team to apply machine learning and deep learning concepts in the easiest way. It combines computational algebra optimization techniques to easily compute many mathematical expressions. TensorFlow contains a function that defines, optimizes, and computes mathematical expressions using multidimensional arrays called tensors. Includes deep neural network software and machine learning techniques. Includes a highly scalable computing feature with different data sets. TensorFlow uses GPU computing, automating management. It includes a unique function of optimizing the same memory and data used. TensorFlow is well documented and includes many libraries for machine learning. It offers several important functionalities and methods for the same. TensorFlow is also called a "Google" product. It includes various machine learning and deep learning algorithms. TensorFlow can train and run deep neural networks to manually classify numbers, recognize images, embed words, and create different sequence models [8].

Scikit-learn is a Python module that integrates a wide range of state-of-the-art machine learning algorithms for supervised and unsupervised medium-sized problems. It focuses on bringing machine learning closer to non-specialists who use high-level general-purpose language. Emphasis is placed on ease of use, performance, documentation, and consistency of the API. It has minimal dependencies and is distributed under a simplified BSD license, encouraging use in academic and commercial environments [9].

Theano is a Python library and compilation optimizer for manipulating and processing mathematical expressions, which include multidimensional arrays. Features Theano are tight integration with NumPy, transparent use of GPU, efficient symbolic differentiation, optimization of speed and stability, dynamic C code generation and extensive unique testing and self-checking [10].

Keras is a deep learning API written in Python, launched at the top of the TensorFlow machine learning platform. Allows for quick experimentation. Keras is an acceptable, highly productive interface for solving machine learning problems with a focus on modern deep learning. Provides basic abstractions and building blocks for the development and delivery of high-repetition machine learning solutions. Keras can run on TPU or on large clusters of GPUs, Keras models can be performed to work in a browser or on a mobile device [11].

Natural Language Toolkit (NLTK) is a platform for building a Python program for working with human language data. It provides easy-to-use interfaces and lexical resources such as WordNet, along with a package of word processing libraries for classification, tokenization, stemming, tagging, parsing, and semantic reasoning. NLTK is suitable for linguists, engineers, students, teachers, researchers, and industry users [12].

III. ADVANTAGES AND DISADVANTAGES OF PYTHON

Python stood out and became one of the most popular programming languages. Python includes very little coding and simple syntax, unlike programming languages that can be used to develop AI applications. Testing can be easier, and the focus can be on programming itself. Python comes with build-in libraries used for AI. Important characteristics of Python:

- Support functional and structured programming methods, as well as OOP.
- It can be used as a scripting language or it can be compiled into bytecode to build large applications.
- Provides high-level dynamic data types and supports dynamic type checking.
- Support automatic garbage collection.
- It can be easily integrated with C, C++, COM, ActiveX, CORBA, and Java [2].

Like any programming language, python has its advantages and disadvantages, which are written below.

A. Advantages of Python

Python is a programming language that has English-like syntax. It makes it easier to write, read and understand code. Python is a very productive language, because due to its simplicity, the focus is on solving problems. Python is an interpreted language which means it is executed directly code by line. In the event of any error, execution is stopped and the error that occurred is reported. Python shows only one error, even if there are multiple errors. This makes it easier to troubleshoot. Python does not know the type of variable until the code is run. When executed, it automatically assigns a data type. The programmer does not have to worry about declaring variables and their data types. Python comes under an open source license approved by OSI, which makes it free to use and distribute. The source code can be downloaded, modified, and distributed as own version of Python. Python's standard library is huge, and there are almost all functions for solving various tasks. Python package manager (pip) facilitates the import of other packages from the Python package index (PyPi). Python code can run on different platforms [13].

B. Disadvantages of Python

Regular code execution often leads to slow execution. The dynamic nature of Python is responsible for Python's low speed because it must do extra work while executing code. Python programming language uses a large amount of memory. It is considered a disadvantage when creating applications when it is necessary to perform memory optimization. Python is generally used in server-side programming. Python is not used on client-side or mobile applications because it is not memory efficient and has poor processing power compared to other languages. Communication with the database is not Python's strength. The Python database access layer is primitive and underdeveloped compared to technologies such as JDBC and ODBC. Python is a dynamically typed language, so the data type of a variable can be changed at any time. A variable containing an integer can contain a string in the future, which can lead to execution errors. Therefore, it is necessary to do a thorough testing of applications [14].

IV. COMPARISON OF SELECTED AI PROGRAMMING LANGUAGES

There are various languages for writing AI, but there is no perfect programming language that would stand out as the best programming language used in artificial intelligence. The development process depends on the desired functionality of the

AI application being developed. Based on the functionality of the AI application, a coding programming language is used. The languages commonly used for artificial intelligence projects are compared to highlight advantages and disadvantages. Java, Python, Lisp, Prolog and C++ are the main AI programming languages used for artificial intelligence and that meet different needs in the development and design of different software.

Python is one of the favorite programming languages in AI development among developers because of its syntactic simplicity and versatility. Python is used for machine learning for developers because it is less complex compared to C++ and Java. Python is a portable language because it is used on platforms including Linux, Windows, Mac OS, and UNIX. It is likable because of its features such as interactive, interpreted, modular, dynamic, portable, and high level which make it more unique than Java. Python is a multi-paradigm program that supports object-oriented, procedural, and functional programming styles. Python supports neural networks and the development of NLP solutions thanks to its simple library of functions and more ideal structure. Supports testing of algorithms without the need for their application. Python is fast in development compared to Java and C++. Developers using Python have difficulty adapting to a completely different syntax when they need to use a different language for AI programming. Unlike C++ and Java, Python works with the help of an interpreter which makes compilation and execution slower in AI development. Not suitable for mobile computing [15].

Python programs run slower than Java programs, but they also take much less time to develop. Python programs are usually 3-5 times shorter than equivalent Java programs. This difference is attributed to Python's built-in high-level data types and its dynamic typing. For example, a Python programmer does not waste time declaring argument types or variables. The powerful Python polymorphic list and dictionary type, for which rich syntactic support is built directly into the language, find use in almost every Python program. Because of the run-time typing, Python's run time must work harder than Java's. For example, when evaluating the expression, a + b, it must examine objects a and b to find their type, which is not known at compile time. The appropriate addition operation is then called, which can be overloaded with a user-defined method. Java, on the other hand, can perform integer addition, but requires declarations of variables for a and b, and does not allow overloading for the + operator for instances of user-defined classes. For these reasons, Python is much better suited as a "glue" language, while Java is better characterized as a low-level implementation language [16].

C++ is the fastest computer language. Its speed is important for developers who value time the most. It enables fast execution and has less response time and is therefore applied in search engines and computer game development. C++ allows extensive use of algorithms and is efficient in the use of statistical AI techniques. C++ supports the reuse of programs in development due to inheritance and data hiding, which is efficient in saving time and costs. C++ is suitable for machine learning and neural networks. It is good for finding solutions to complex AI problems. It is rich in library functions and a collection of software tools. C++ is a multi-paradigm program that supports object-oriented principles that are useful in achieving organized data. C++ is bad at multitasking. C++ is only suitable for the application of the kernel or database of certain systems or algorithms. The bottom-up approach is extremely complex and makes it difficult for novice developers to write AI programs [15]. What applies to Java applies to C++ even more. The Python code is often 5-10 times shorter than the equivalent C++ code. Anecdotal evidence suggests that a single Python programmer can complete in two months what two C++ developers cannot complete in a year [16].

Java is a multi-paradigm programming language that follows object-oriented principles and the Once Written Read/Run Anywhere (WORA) principle. It is an AI programming language that can run on any platform that supports it without the need to recompile. Most of the syntax is derived from C and C++. Java is not only appropriate for NLP and search algorithms but also for neural networks. Unlike C++, Java is easy to use and even debug. It has an automatic memory manager that facilitates the work of programmers. Java is slower than C++, has lower execution speed and longer response time. Java is portable, but older platforms would require software and hardware changes [15].

Lisp is the language used to develop AI. It is the second oldest programming language after Fortran. Lisp has evolved into a powerful and dynamic coding language. Some consider Lisp to be the best AI programming language because of the liking for freedom it offers developers. Lisp is used in AI because of its flexibility for fast prototyping and experimentation. Lisp has a unique macro system that facilitates the research and application of different levels of intellectual intelligence. Lisp is suitable for inductive logic and machine learning projects. Lisp supports the compiler instead of the interpreter and is therefore fast and efficient in encoding. An automatic memory manager was

invented for Lisp, which collects garbage. Lisp offers specific control over systems resulting in its maximum use. Few programmers are familiar with Lisp programming. Being a vintage programming language artificial intelligence, Lisp requires configuration of new software and hardware to accommodate it use [15]. Lisp is close to Python in its dynamic semantics, but so different in its approach to syntax. Python has introspective possibilities like Lisp. Python programs can construct and execute program fragments on the fly [16].

Prolog is also one of the oldest programming languages and is therefore suitable for AI development. Like Lisp it is also the primary language for AI. It has mechanisms that facilitate flexible frameworks that developers enjoy working with. It is a declarative language based on rules because it contains facts and rules that dictate its language of coding artificial intelligence. Prolog supports basic mechanisms such as pattern matching, tree-based data structuring, and automatic backtracking essential for AI programming. Prolog has a built-in list processing that is necessary to represent tree-based data structures. It is effective for rapidly prototyping frequently published AI programs. It allows the creation of a database at the same time as running the program [15].

V. CONCLUSION

Artificial intelligence (AI) is a widespread are known worldwide. As such, it is often taught through courses at universities. AI plays a major role in advancing technology as well as facilitating various jobs. AI strives to create machines that will be able to replace people in various jobs, achieving accuracy and precision. Huge results have been achieved in the field of AI, but there is still a tendency towards something bigger and better. Various programming languages and various researches have contributed to this.

Python is used in various fields of AI. Python is one of the favorite programming languages among AI developers because of its syntactic simplicity and versatility. Python is a multi-paradigm program that supports object-oriented, procedural, and functional programming styles. There are many programming languages used for programming in AI. People constantly wondering which programming language is best for programming in AI, and there is no answer to that. Each programming language has its advantages and disadvantages. This paper presents a comparison of programming languages that are most popular among AI programming developers. The list of programming languages consists of Python, C++, Java, Lisp and Prolog. Depending on the functionality of the AI application, a programming language is used. By selecting the appropriate language, the appropriate result is achieved.

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An Implementation of a Generic Scheme of an Artificial Neural Network and the Backpropagation algorithm in C++

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Abstract – Due to the learning capabilities of artificial neural networks (ANNs), they are commonly used for solving complex problems, such as: prediction, optimization, approximation and recognition. To be able to solve such complex problems, an artificial neural network (ANN) has to be trained. The commonly used algorithm for that purpose is the backpropagation algorithm, which is a supervised learning approach. Therefore in this paper we present a generic scheme of one-layer artificial neural network and we apply the backpropagation algorithm. To carry out an analysis, we coded the structure of the artificial neural network and the backpropagation algorithm in C++.

I. INTRODUCTION

Artificial neural networks (ANNs) are biologically inspired computing models, approximating the way brain functions. Structurally an artificial neural network consists of a set of connected artificial nodes called neurons. Throughout connections, usually regarded as synaptic edges, an artificial neuron takes the inputs and computes the output as a non-linear function of the sum inputs. Note that edges simulate real life synapses, passing electrical signals from one cell to another. Usually there are several layers of neurons built into one neural network. Each layer is a vector of neurons computing the output that is taken as an input to the next layer. A weight that is a real number is assigned to each synaptic edge. Weights are dynamically updated (increased or decreased) throughout training and learning in order to be able to reach the output for a specific input.

The very early beginnings of this topic can be traced back to 1943 when McCulloch and Pitts [1] designed the first model of an artificial neuron. Few years later, in 1949, Donald Hebb published his work known as "The Organization of Behavior" [2] which introduced the law for neuron learning, based on straight-forward synaptic propagation. Later this law became known as Hebbian Learning. Two years later Marvin Minsky created the first ANN. John von Neumann's book "The Computer and the Brain" [3] published in 1958 had big impact on the topic and radically changed the whole approach. Frank Rosenblatt [4] created the Perceptron in 1958. However, the Perceptron works only fine for linearly separable input data sets and this constrain was first reported by Marvin Minsky and Seymore Papert [5] in 1969. Minsky and Papert reported that the Perceptron in not able to classify non-linearly separable input data sets. However, the technology of Perceptron was not a fail but rather a case of an upgrade for more advance application. A three layers architecture that can be applied for non-linearly separable data was presented in 1992 by Hecht-Nielsen [6].

There are several types of artificial neural networks that can be applied to specific problems. Feed forward neural networks are commonly used in computer vision and speech recognition, because they can easily cope with noisy data. There is no backpropagation and the neuron fires an output if the activation passes certain threshold. Radial basis function neural networks distinguish other neural networks due to their fast learning speed. These neural networks consist of three layers. The first layer corresponds to the input, the second layer consists of units with non-linear radial basis activation function and the third layer corresponds to the output. This type of neural network is commonly used for classification, system control and function approximation. Self-organizing neural networks [7], [8] are best for pattern classification. Input patterns are compared to known patterns and they are associated to the best match. Once the best match has been found, cluster's weights needs to be updated. Metrics is based on the square of minimum Euclidean distance. Recurrent neural networks utilize the fact that neurons are able to memorize some of the information that had in the previous step. Feeding back the output to the input, these neural networks are commonly used for text into speech conversion. Most of nowadays computer vision technologies explore convolutional neural networks due to their high accuracy in image and

signal processing. Neurons of this type of networks have learnable weights and biases. However, sometimes we have to combine different types of neural networks that will work independently towards the output and here comes the concept of modular neural networks. The main advantage of this type of neural network is the ability to decompose large computational process into smaller tasks, making them suitable for implementation into multi-module decision systems.

The backpropagation algorithm is a well-known and popular algorithm for training artificial neural networks. This algorithm was invented in the early 60's and it was implemented to run on computers in 70's. Even thought Werbos [9] in 1974 was the first that showed that this algorithm can be applied to neural networks, it took few decades until this algorithm was popularized again in a paper called "Learning representations by back-propagating errors" written by Rumelhart, Hinton and Williams [10]. The backpropagation algorithm is a supervised learning technique which is based on Widrow-Hoff learning rule. The core of this algorithm is that it starts with random weights assigned to the synaptic edges and the goal is to adjust them until the artificial neural network learns from training data. Note that this is done in thousands and sometimes millions of iterations of error updates.

In this paper we introduce a generic scheme of an artificial neural network and the application of the backpropagation algorithm. To be able to simulate the execution of this algorithm, we programmed it in C++.

II. MATERIALS AND METHODS

The general architecture of a neural network is shown on Figure 1. It consists of three layers: an input layer, hidden layer and output layer. To understand how neural networks work, we have to consider the artificial neuron, Figure 2. The neuron takes N inputs $A_1 A_2 \dots A_N$ throughout N synaptic edges weighted from W_1 to W_N plus threshold θ – Figure 2. The output of the neuron equals the activation function of the sum of products x such as : $x = \sum_{i=1}^{N} A_i W_i + \theta$, Figure 2. The activation function makes the decision if a given input signal is considered relevant or not and thus firing (activating) the neuron or not.

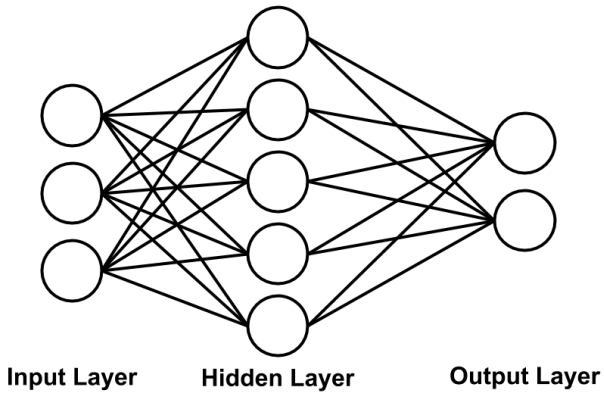

Figure 1. General architecture of an artificial neural network

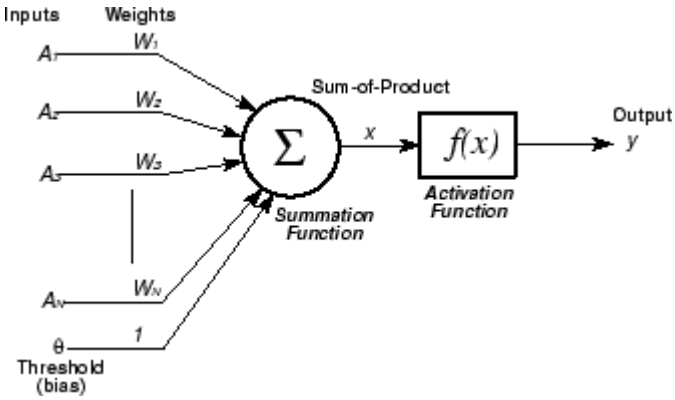

Figure 2. Computational model of an artificial neuron

Even though there are different types of activation functions, some of them, such as: the binary step, linear, sigmoid and tangent hyperbolic activation functions are commonly used. The simplest of all activation functions is the binary step activation function. This function serves as a threshold classifier. The neuron is activated ($y = 1$) if that the sum of products x is greater than certain threshold, otherwise not ($y = 0$), Figure 3.

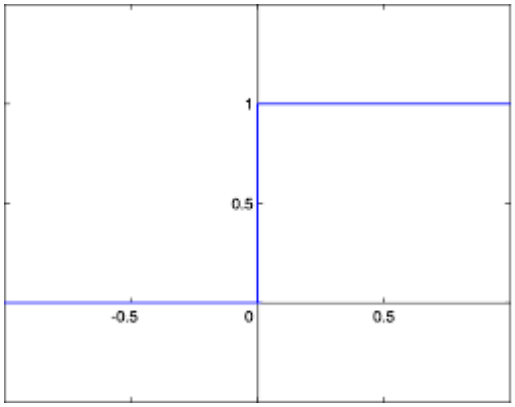

Figure 3. Binary step activation function

The equation of the linear activation function is $y = cx$ or the sum of products x is multiplied by a constant c, Figure 4. This activation function is used in the output layers.

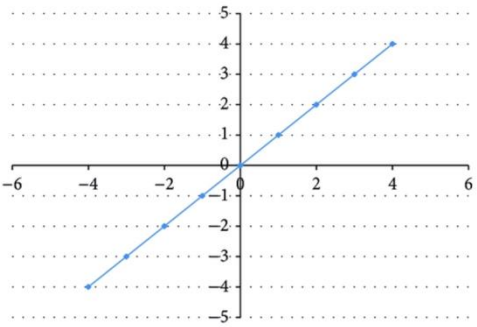

Figure 4. Linear activation function

Sigmoid activation function is a non-linear function. The equation of this function is $y = 1/(1 + e^{-x})$ and it can be plotted as 'S' shaped graph, Figure 5. The output of the neuron ranges between 0 and 1 and small changes of x around 0 will result in major change of y. This activation function is also used in the output layers.

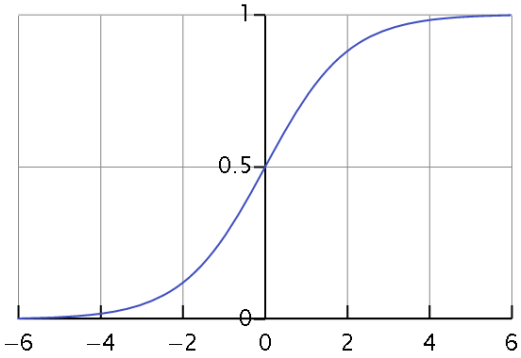

Figure 5. Sigmoid activation function

Tangent hyperbolic activation function (tanh) is basically shifted sigmoid faction, Figure 6. The output of a neuron using this type of activation ranges between -1 and 1 and it is usually used in the hidden layers of neural networks.

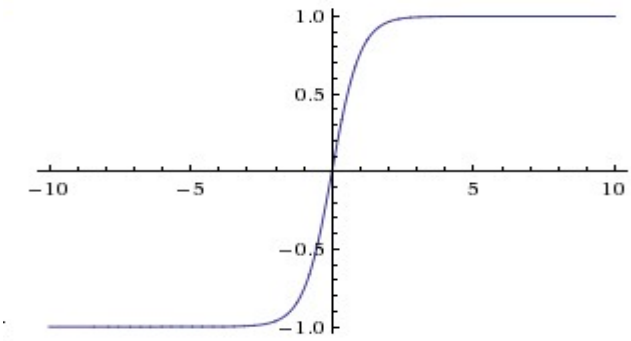

Figure 6. Tanh activation function

Figure 7 shows the structure of the neural network on which we applied the backpropagation algorithm. It takes k inputs $i_1 i_2 \dots i_k$ and consists of n neurons $n_1 n_2 \dots n_n$ that generate also n outputs $o_1 o_2 \dots o_n$. All neurons use sigmoid activation function, thus calculating the output o_r as $o_r = 1/(1 + e^{-x_r})$ such as the sum of products $x_r = \sum_{i=1}^{k} i_i w_{i,r}$. Note that the notation $w_{i,r}$ denotes the weight of the synaptic edge connecting the $i'th$ input to the $r'th$ neuron, Figure 7. Our goal is to obtain a vector of desired outputs $[do_1, do_2, \dots, do_n]$ for an input vector $[i_1 i_2 \dots i_k]$ applying the backpropagation algorithm that does so in a process of iterative update of the weights of synaptic edges $w_{i,r}$. The way the backpropagation algorithm does this is after computing the output of the $r'th$ neuron o_r an error e_r is computed such as $e_r = (do_r - o_r)(1 - o_r)o_r$ and this is done for all neurons in the architecture. Once the error for the $r'th$ neuron was computed, the weight of synaptic edge $w_{i,r}$ must be updated to $w_{i,r} + e_r i_i$ providing that the output o_r in the following iteration will come closer to the desired output do_r than it was in the previous iteration. This mechanism allows network convergence and the whole process is known as network training or learning.

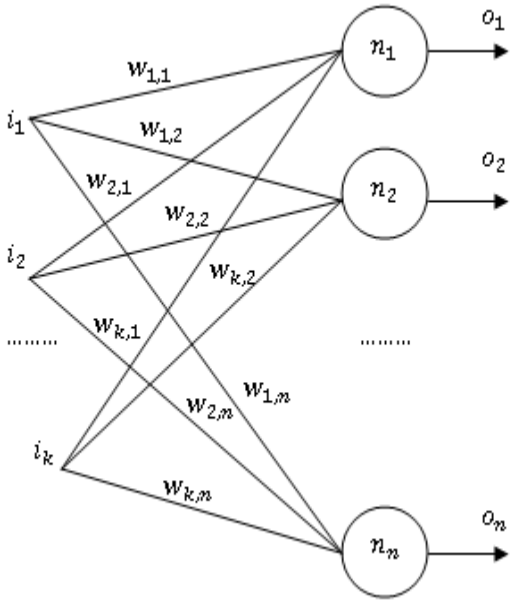

Figure 7. Structure of the test network

III. RESULTS

We used object-oriented programming in C++ to implement the network and the training algorithm. The structure of the neural network that is shown on Figure 7 was abstracted by a class *NeuralNetwork* with inputs, outputs and desired outputs being implemented as float arrays and a set of initial synaptic weights $w_{i,r}$ being implemented in form of matrix. The initial set up of the synaptic weights is done by a constructor, while the backpropagation algorithm is implemented as a special function within the class based on the explanation in the previous section. The main program accepts input and desired output vectors Figure 8 and performs training calls upon the network, having previously set up the initial weights of the synaptic edges, Figure 9. In order to understand what happens throughout the learning process, we printed the results on the screen.

```
Enter the number of dendritic inputs
4
Enter of how many neurons your neural network is built
4
Enter dendritic input 1
1

Enter dendritic input 2
0

Enter dendritic input 3
1

Enter dendritic input 4
0

Enter your target output for neuron1
0

Enter your target output for neuron2
1

Enter your target output for neuron3
0
```

Figure 8. Setting the input and desired output vector

```
0.5
Enter dendritic weight[2,2]
0.5
Enter dendritic weight[2,3]
0.5
Enter dendritic weight[2,4]
0.5
Enter dendritic weight[3,1]
0.5
Enter dendritic weight[3,2]
0.5
Enter dendritic weight[3,3]
0.5
Enter dendritic weight[3,4]
0.5
Enter dendritic weight[4,1]
0.5
Enter dendritic weight[4,2]
0.5
Enter dendritic weight[4,3]
0.5
Enter dendritic weight[4,4]
0.5
How many training interations do you want to be performed
1000
```

Figure 9. Setting the initial weights of synaptic edges

Our neural network was tested for $[1,0,1,0]$ input vector and $[0,1,0,1]$ desired output vector Figure 8, i.e. we wanted to train the network to work as an inverter of the input. Therefore we analyzed what happened throughout the training process in: 100, 500, 1000, 5000 and 10000 iterations, Table 1. At the end of each epoch we calculated the absolute error between the current outputs of the neurons and the goal values. To improve the uniformity of the process, all $w_{i,r}$ of the synaptic edges were initially set up to $0{,}5$.

For this scenario, from the obtained results we can see that most of the convergence of the neural network to the goal happens in the first 100 and 500 iterations, Table 1 and Figure 10. The absolute error between the current output and the desired output continues to decrease having increased the number of training iterations (1000, 5000 and 10000) but the rate of this change is not as sharp and significant as it was throughout the first couple of training iterations. As results clearly show, after 10000 iterations the absolute error between the output and the goal is about 0,005 or we can consider that our neural network was almost trained to function as a digital inverter, Table 1, Figure 10 and Figure 11.

TABLE I. Outputs of the neurons for different number of training iterations

Number of iterations	Neuron	Output of neuron	Desired Output	Abs. error
100	n1	0,0565899	0	0,0565899
	n2	0,946133	1	0,053867
	n3	0,0565899	0	0,0565899
	n4	0,946133	1	0,053867
500	n1	0,0235008	0	0,0235008
	n2	0,976719	1	0,023281
	n3	0,0235008	0	0,0235008
	n4	0,976719	1	0,023281

1000	n1	0,0163614	0	0,0163614
	n2	0,983715	1	0,016285
	n3	0,0163614	0	0,0163614
	n4	0,983715	1	0,016285
5000	n1	0,00717572	0	0,00717572
	n2	0,992831	1	0,007169
	n3	0,00717572	0	0,00717572
	n4	0,992831	1	0,007169
10000	n1	0,00505166	0	0,00505166
	n2	0,994951	1	0,005049
	n3	0,00505166	0	0,00505166
	n4	0,994951	1	0,005049

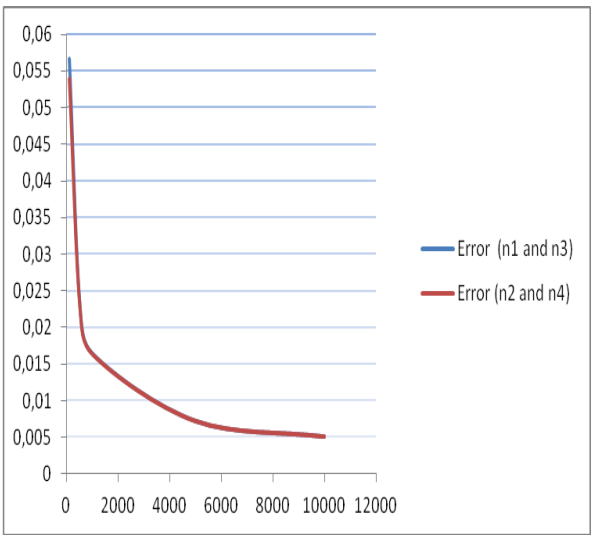

Figure 10. Convergence of the neural network throughout the training process

```
dendriticweights[3,3]=0.5

Output of Artificial Neuron1=0.0050516
Output of Artificial Neuron2=0.994951
Output of Artificial Neuron3=0.0050516
Output of Artificial Neuron4=0.994951


Error 1=-2.53903e-005
dendriticweights[0,0]=-2.64151
dendriticweights[0,1]=0.5
dendriticweights[0,2]=-2.64151
dendriticweights[0,3]=0.5
Error 2=2.53672e-005
dendriticweights[1,0]=2.64174
dendriticweights[1,1]=0.5
dendriticweights[1,2]=2.64174
dendriticweights[1,3]=0.5
Error 3=-2.53903e-005
dendriticweights[2,0]=-2.64151
dendriticweights[2,1]=0.5
dendriticweights[2,2]=-2.64151
dendriticweights[2,3]=0.5
Error 4=2.53672e-005
```

Figure 11. Output of the network after 10000 training iterations

IV. CONCLUSION

In this paper we analyzed the structure and the training of an artificial neural network. This cutting-edge technology emulates the way our brains work and recognize everyday's patterns upon ours experience. Neural networks map this concept in the domain of the artificial intelligence to construct machines that can actually act intelligently in unpredicted conditions. However, in order to achieve that, the structure needs to be trained and here comes the main challenge, i.e. more training is performed the more accurate the recognition is. In this paper we used the backpropagation algorithm and we showed that in the case of uniform initial weights setup, the network learns most of the things in the first couple of training iterations.

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Managing Education in the COVID-19 era

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Abstract – The COVID-19 pandemic has brought tremendous changes in all socio-economic and political domains. The educational system worldwide has stopped for a few months due to the high-risk environment that is present in pre-schools, schools, and universities. A difficult task was put in front of government and educational institutions: reduce face-to-face exposure between educators and learners but maintain the quality and integrity of individual curriculums, and the quality of education overall. In this paper the impact of COVID-19 on education is analyzed. Additionally, future trends and education reform is discussed. The main goal of the paper is to provide sufficient insight into the changes and challenges of COVID-19 regarding the educational system, and to discuss potential solutions when it comes to education reform that would be in accordance with social distancing and preventive measures against the COVID-19 pandemic. The paper manages to concisely tackle this "issue", and provides an adequate basis for future research in this domain.

I.INTRODUCTION

Due to the COVID-19 pandemic high schools and universities all over the world are developing strategies for the upcoming school year. Some of these strategies include social distancing measures, while others include rapid development and infrastructure implementation for online teaching. Now, due to the emergency status of the pandemic, universities are don't have long-term fully planned strategic plans for online learning, but rather its response time over quality of the online platform. Therefore, existing platforms are used for online communication and teaching. These measures and reforms in the education system vary across countries [1]. It also depends on the type of course and level of education. For example, the training of physicians is severely impacted as traditional didactic learning, and the crucial traditional model of person-to-person communication and teaching is compromised [2, 3]. It is evident that the current pandemic puts a huge strain on education governing bodies as well as on educators (teachers, professors) and learners (high school and university students). Schools and universities have to take into consideration the potential dramatic negative effects of online learning. Some of these negative effects may manifest themselves in the form of academic failure, poor culture and networking habits, decreased collaboration, and higher rates of school dropouts [4]. This is one of the main reasons why education governing should be intensified and a clearly defined strategic plan should be introduced on national scale.

During the peak of the COVID-19 pandemic, students and educators used various online platforms for learning. This included the Zoom app, Youtube live, Team link, Google hangout, Skype, Google classroom etc. The learners used one or more of these application for distributing, haring and acquiring learning materials [5]. The questions is: *Should educators continue to use various available platforms or should there be a unified education platform?* The main issue is that the majority of educational institutions are not technically equipped, thus the employees (teachers, professors) use platforms which require the "least hassle". This approach is practical in the short-term, however in order to effectively and efficiently report on the status of the educational institutions, it is necessary to develop a unified and centralized platform.

Certainly, the shift to digital technologies in education has raised concerns among educators regarding the heavy reliance on technological solution. More precisely, ethical and moral concerns arise, as the face-to-face and traditional approach to teaching is tremendously hindered by the COVID-19 pandemic and the massive transition to online learning solutions [6].

In this paper the impact of the COVID-19 pandemic on education is addressed. In addition, education reform and future trends in education are analyzed. The main goal of the paper is to propose suggestions and guidelines regarding solutions for the educational system in the Republic of Serbia. The paper includes three main sections (excluding the Introduction and Conclusion sections). The first section addresses the impact of COVID-19 on the educational system around the globe. The second section discusses the education reform and future trends in education. Finally, potential solutions and guidelines for effective COVID-19-era education management are presented.

II. IMPACT OF COVID-19 ON EDUCATION

As noted in the Introduction section the COVID-19 pandemic has tremendously affected in various intensities a wide array of courses across educational institutions of all levels (schools,

undergraduate and graduate programs etc.). In the field of medicine, institutions face challenges as physical teaching and communication is handicapped. Telemedicine and virtual meetings are in place to fill the gap of social distancing measures. However, accreditation organizations have to optimize between flexibility and adaptability, and upholding specific rigorous standards [7]. This further indicates that education reform cannot happen spontaneously, but must be in accordance with a developed strategic plan. Without such a long-term plan, first efficiency will "suffer" and afterwards effectiveness and quality of education will deteriorate. It can be argued that exactly this, the deterioration of education quality is one of the most negative impact of COVID-19 on education. However, this impact is somewhat a "silent impact", as it will not manifest itself immediately, but later on, possibly after graduation of students. This draws further issues, as half-skilled graduates flood the job market (which already negatively hit by COVID-19). Saturation on the job market and high unemployment rates would heavily annul the benefits of a degree. Therefore, it can be argued that the COVID-19 pandemic has a direct and indirect impact on education as well. The indirect impact comes from the biased and saturated job market that reduces the need for certain professions. The direct impact is more evident and more direct and it includes the educational institutions and curriculums.

During the pandemic, it was almost impossible to conduct meaningful and effective education as there were no strategically implemented online learning platforms. [8]. Educators had difficulties in the process of implementing online solutions. The main issues included the lack of facility availability, the high demand and insufficient coverage of network and Internet usage, the lack of collaboration with parents, and the process of planning and evaluating the teaching and learning process [9]. Evidently, educators and learners have to acquire adequate teaching and learning equipment. Now, besides the impact on education, the COVID-19 pandemic has negatively affected national economies as well. This affected a large number of household due to job loss and overall higher unemployment rates. Therefore, countries worldwide have to implement sustainable strategic plans that take into consideration the hardships of many households and that they will consider helping in the process of attaining adequate technical equipment for distance learning.

The consequences of the COVID-19 are evident in all fields of education and expertise. For example, a hassle-free, continuous education is disrupted and the economic damage to educational and science institutions is big. From here, the application of modern ICTs in education and science is becoming and imperative, and the main goal is to provide the same experience and educational and scientific performance as traditional teaching [10]. In the era of the COVID-19 pandemic, teachers face difficulties as they can drastically change activities regarding the existing and pre-COVID-19 established curriculum [11].

As noted earlier, one of the factors that hinder a "smooth" distance learning and online education platform implementation is the lack of technical equipment and even the lack of skills and knowledge to use that equipment. Therefore it is necessary to evaluate educators in every institution, as well as to gather information from households regarding the ability to acquire the minimum necessary equipment for distance learning. In the next section, the process education reform and future trends in the educational system are analyzed.

III. EDUCATION REFORM AND FUTURE TRENDS

The whole concept of education will endure changes and reforms. It was argued that curriculums in the future have to focus on four main elements. These are content, approach, goal and evaluation. The new post-COVID 19 educational system has to address the positive and negative aspects of online teaching. Strategic plans should be implemented in order to maintain and even improve the quality of education on all levels [12]. This further implies that there should be a strategically developed unified plan regarding educational institutions, and that only smaller changes should be introduced by individual institutions.

Furthermore, e-learning or more broadly digitalized education which would characterize the new educational system around the world should be evaluated from three aspects. The first aspect is the level of adequacy of online learning and the necessity for implementing systems, which would encourage effective learning systems. Such effective learning systems should involve content presentation, collaboration, timely feedback and learning structure. The second aspect includes the convenience factor for learners when it comes to access to teaching material. Namely, teachers, or more broadly, educators should optimize teaching and learning content in accordance with the students' behaviors, motivation and goals. In addition, analytical tools should be introduced to students as these are often not sufficiently represented in curriculums. Finally, the third aspect is the completeness of the whole online education

systems. More precisely, it is necessary to provide the best combination of conventional teaching and online ICT-based learning [13].

Besides the negative aspects and challenges that educators and students face due to the fast transition to online learning, parents are also experiencing difficulties as not every household has an adequate environment for online learning. Various factors can affect the student's "classroom at home" including disabilities in the family, not enough space, inadequate or non-existing equipment that is necessary for online learning etc. [14]. This issue was noted in the previous section, and surely, this is an important aspect of a digitalized education system, where "no learner left behind" policy should be nurtured. In this case, the "learner" can be a student or pupil on all levels of education.

One the most important things and hardest one is to maintain academic integrity and an adequate level of quality of education for learners. This requires a strategic approach with continuous monitoring and evaluation of standards of the newly implemented online education system [15]. The evaluation process should be thorough and independent from the specific institution that is being evaluated. The reason behind this is the possibility of malpractice, especially in the domain of undergraduate and graduate degrees.

Furthermore, it is important to note that there are teachers and educators who are not skilled for online teaching and don't possess the necessary technical knowledge to conduct any form of digital education. [16]. Faculties resisted to fully transition to online education solutions. However, as the COVID-19 pandemic lingers, virtual teaching and virtual classrooms should be viewed as an opportunity and solution, rather than as a burden or unnecessary transition and adaptation [17]. As for the future, educators and students have to be equipped with adequate technical tools for online teaching and learning. Further, the inexperience of teachers and the high possibility that not every household will be able to ensure an adequate learning environment, has to be addressed. A national strategic plan is needed, with detailed planning of massive online education which will tackle challenges and barriers that educators and learners face [18]. This way, a structured approach to education would be achieved. Organizing sustainable and quality curriculums in the new era of COVID-19 is challenge that has yet to be passed.

IV. POTENTIAL SOLUTIONS

Based on the reviewed and analyzed literature in the domain of COVID-19 impact on education, and after evaluating possible future trends in education, the following potential solutions and guidelines for effectively "tackling" the COVID-19 era challenges in the domain of education are proposed:

- institutions have to develop long-term detailed plans regarding their curriculums and courses;
- these courses and course schedules have to be in-sync with social distancing measures in manner that will not have a severe detrimental effect on the quality of education;
- national projects should be initiated where financially struggling educators and learners would have a chance to get the necessary technical equipment for conducting online teaching and learning;
- a multiple scenario strategic plan has to be developed after operational plans are put in place;
- a unified platform should be used for reporting on the status of courses, curriculums, staff and students in educational institutions;
- rigorous standardization and accreditation should be conducted in order to maintain or even improve education quality.

Overall, the main principles for the COVID-19 era education reform is to maintain education quality without breaking social distancing and other safety and prevention measures.

V. CONCLUSION

In this introductory review paper, the impact of COVID-19 on the education system in general is analyzed. In addition, education reform practices and future trends in the domain of education are reviewed. The goal of the paper was to discuss potential solutions and guidelines for an effective education reform in accordance with the COVID-19 pandemic measures. The proposed guidelines are mainly aimed at the education system in the Republic of Serbia. However, the review of literature provides a sufficiently strong basis for these guidelines to be relevant in some degree in other countries (depending on the situation with the COVID-19 pandemic). Based on the review of literature it can be concluded that in order to effectively conduct an education reform, collective strength and actions are needed. More precisely, the collective planning and implementation of operational solutions should be conducted not only by individual institutions, but by institutions on all levels of education and governance.

The main limitation of this paper is the lack of an empirical study that could include educators, learners and government officials. Such an empirical study would provide additional significant insight into the complexity of the COVID-19 pandemic from the aspect of education. For future research it is recommended to conduct a meta-analysis of various studies in this domain and compare results with the empirical study. This current paper provides a solid basis for this future research.

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Usage of 3D Scanning in Education

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Abstract - 3D scanning technologies are used to convert a physical model into digital 3D computer-aided design file. This digital output is well used for designing and fabricating customized parts through additive manufacturing technologies. 3D scanning has great application in industries like automotive, aeronautics, dental, jewelry making, video gaming, special effects and animation movies. The 3D scanners serve as powerful tools for professionals in various fields. Over the last five years, 3D scanning and printing technologies and their applications have increased approximately more than ten times. Design prototype of the new or modified product or an architectural model of buildings are made, bioprinting, food, implants and even real house printing is done. It is already used in educational purposes too, so it is important to investigate how it can contribute to developing new skills of students.

I. INTRODUCTION

As we move toward the future of manufacturing and design, consumers are demanding a more 4.0 Industry trend. This new trend takes old industry models and leaves them in the dust and at the forefront of it all, technology is setting the pace.

The impact that technology has had on today's schools has been quite significant. This widespread adaptation of technology has completely changed how teachers teach and students learn. By embracing and integrating technology in the classroom, students are being set up for a successful life outside of school.

3D scanners are automatic 3D acquisition devices which create the digital 3D model from real 3D objects effectively in lesser time cost-effectively. It has high accuracy, affordable cost of product scanning, easy to use to produce a color data. In the current scenario, 3D scanning technology is growing in many fields including those in education, medical purposes, design which helps to create a design for the manufacturing of prototype. For reverse engineering and inspection, a 3D scanner is a useful tool as it requires lesser time for capturing digitized surface data [2].

Nowadays 3D printing and 3D scanning technologies, originated around three decades ago, gain more and more popularity. 3D technologies are actively used not only by scientific specialists, but also by many companies, producing and designing goods of a wide range. A sharply increasing interest in 3D technologies is explained by the possibility to essentially reduce, with their help, the expenses of complicated technical goods production due to reducing the costs of making sketches, models, prototypes. The experts call 3D printing "a salvation of economy" and "a breakthrough in medicine"; emphasize ecological compatibility and easiness of use of modern 3D devices [5].

There are often references in design education to the idea that design graduates of the future will be working in jobs that do not yet exist. There are therefore opportunities emerging that are not currently recognized as within the designers' purview. One such area of growth is emerging out around the potentials created by technological developments relating to 3D scanning. This technology is proving to be a catalyst for not only new product outcomes but also innovations in thinking and practice. This is particularly in relation to new workflows that are permeating traditional discipline boundaries. The wide range of advances in digital scanning over the last twenty years have resulted in a myriad of complex capabilities, and the potential of these technologies to support innovation in practice, outcome and thinking are only beginning to be explored. 3D scanning is part of a rapidly evolving suite of digital enablers that are challenging conventional design practice and suggests that educators need to more effectively research and understand the innovations that 3D scanning technologies can inspire [3].

Recent advances in CAD assisted manufacturing and reverse engineering (RE) tools have resulted in significant changes in engineering and design process. Recently, there is an increasing demand from the industry for different applications such as 3D scanning of physical models, part inspection, rapid prototyping and tooling. In engineering areas, such as aerospace, automotive, shipbuilding and medicine, there are cases where free-form surfaces or sculptured surfaces such as gloves, shoes and human faces can be difficult to model using 3D CAD software. In these cases, RE is an efficient approach

to significantly reduce the product development cycle. RE describes the process designers use to digitize a physical model and then to create a CAD model using this data [4].

The specific applications of 3D scanning technology are limited only by the user's imagination. 3D scanning technology can be used for recording any situation in which an object's actual 3D shape needs to be visualized, verified, perhaps the geometry is unknown, or it needs to be rebuilt. The different subject areas 3D scanning is applicable into are RE, 3D visualization and modelling, cloud-to-cad comparison, prototyping, custom manufacturing, analysis, digital archiving, inspection and quality control and architectural data requirements [4].

II. 3D SCANNING TECHNOLOGY

3D scanning technology emerged in late 20thcentury. The initial 3D scanners in the 1980s used contact probes meaning they physically touched the target articles a number of times until the device had enough digital data points to create a 3D model. As this method was time consuming, newer methods which were more efficient and fast were developed. The main purpose of 3D scanning is to create a digital three dimensional model out of the data collected by the scanner from its surroundings. Creation of the 3D digital model is made by using the idea of point cloud. Information regarding the object's shape is collected at such points. The whole shape, geometry, color or pattern of the object is extrapolated using the data collected at these points during the process called reconstruction. After that, a file is generated which can be 3D printed and give the three dimensional replica of the original object.[1]

The methods used for 3D scanning are primarily classified as:

LASER triangulation 3D scanning technology - projects a laser beam on the scanned surface and measures the deformation of the laser rays. This method uses single laser point or a laser line to scan around the object. The laser beam is first made to fall on the object and as it reflects off from the 3d scanned object, the change in its trajectory is recorded by a sensor. The change in laser trajectory measured with the application of trigonometric triangulation to it helps the scanning system to calculate the specific angle of deviation. The distance from the object to the scanner gives the angular measure directly. With the knowledge of the distance of the scanner from the object, the scanning hardware can map the surface of the object and thereby record a 3D scan. Advantages are its resolution and accuracy while the disadvantage is it is sensitive to the properties of the surface that it scans which could be a problem in scanning a very shinny or transparent surfaces.

Structured light 3D scanning technology - This method uses light grid pattern projections and synchronizing it with a camera for obtaining surface properties of the object using triangulation principle. Pattern of light is produced by using light modulators based on different technologies, in this method displacement of individual stripe is converted to 3D coordinate of the object. Advantages of this technology are its resolution, speed and the fact that it can be used to scan people.

Photogrammetry - or 3D scanning from photographs, this technology captures the photographs of subjects from different angles after which with the use of computational geometry algorithms and computer vision, the captured photographs or 2d images of objects are reconstructed into their 3D form. The biggest challenge of this technology is to analyze accurately multiple photos and all the points in them. The main advantages of this scanning technology is its precision, acquisition speed and its capability of reconstructing subjects of various scales that are photographed from the ground or air.

Contact-based 3D scanning technology – or also known as digitizing, uses a probe attached to the device used for contact based scanning. The deformation of probe when in contact with the object to be scanned gives the data regarding the surface of the object. Advantages with this scanning are its precision and ability to scan reflective or transparent surfaces. The disadvantages are its speed and inability to work on organic and free-form shapes.

LASER pulse-based 3D scanning technology - this technology is based on the time of flight of a laser beam. The subject is illuminated with a laser first and then a sensor is there to collect the reflected laser beam from the surface of the object to be scanned. The time taken by the laser to travel from the emission point to the reception point at the sensor can give the geometrical information of the object. These scanners hence measure the time interval between emitted laser to hit an object, get reflected and come back. Since the speed of light is known, the time interval can give the exact distance between the object and the 3D scanner. The great advantage of this type of scanning is that it can scan large objects and large environments but it is a slow process.

Just as additive manufacturing covers a wide range of digital technologies with very different attributes and applications, so does 3D scanning.

From micro-scanning for accurate forensic analysis, using articulated arm mechanisms, to long range scanning of large sites for geological and topographic surveys using free standing, continuous scanning solutions. For industrial designers, the use of contact, non-contact, active and passive scanners as part of industrial design practice has long been established for reverse engineering applications to inform product additions and modifications. However, the integration of 3D scanning into new ways of thinking about the relationships of users and the objects that populate their lives, changes the importance of the technology. The move from mass production to mass customization requires improving mechanisms, such as 3D scanners, for collecting data in relation to bespoke products. More importantly, rethinking the way that 3D scanners are utilized as part of the industrial design workflow will provide a catalyst or the evolution of the human object interface that instigates a changed relationship between people and products. 3D scanners up until now, have been at the periphery of industrial design practice, but this shift in thinking will bring them into the heart of design practice and therefore design education [3].

III. 3D SCANNING IN EDUCATION

3D scanning is a useful, versatile educational tool, with the potential to transform the classroom environment. It is adding a new dimension to learning, immersing students of all ages more deeply in the topics they are taught. The potential for 3D scanning to be a transformative educational device encompasses a variety of subjects, from science and mathematics to art. As this technology is becoming increasingly affordable, it is now becoming a realistic benefit to the modern classroom. The classroom is transitioning to an increasingly online environment, with social media, apps, blogs, and computers taking a more central position in reinforcing curriculum. Students are encouraged to present their ideas using digital tools and work in collaborative groups to use tech cooperatively.

By reviewing the literature sources, five different ways in which 3D scanning is enhancing students' learning experience are recognized:

- Facilitates interactive and fun learning process. A traditional classroom setting where the teacher teaches while students listen is less and less engaging for modern students. The use of 3D scanning in education is one of the elements that break this practice. It encourages a two-way flow of information and close interaction between the teacher and the students. Instead of asking students to sit idly and study a concept, it motivates them to inject abstract concepts with energy. 3D scanning can also encourage students to collaborate more enthusiastically, helping them work together on investigations, understanding data, creating solutions and communicating their findings. In doing so, they are provided with a valuable sense of accomplishment.
- Promotes student empowerment and interactivity. 3D scanning can empower students because it teaches them industry principles like a human-centered design. It also exposes students to design thinking. At an early age, they can learn to know and focus on the process of creating prototypes for a given design problem and have a unique hands-on experience in discovering various disciplinary core ideas. Learning abstract concepts can be challenging, and uninvolving for students. 3D scanning offers opportunities to make these abstract concepts far more interactive. It enables students to experiment in life sciences areas such as topography and anatomy using accurate 3D modelling.
- Makes tough and abstract concepts easier to learn. 3D scanning in education provides a better avenue in teaching hard to explain concepts in class. Using books and presentations can only scratch the surface but using 3D scanned objects students can dive deeper in learning abstract theories such as thermodynamics, geometry, and anatomy. Today's educational environment is geared toward teaching kids about science and engineering practices in a collaborative format. Group work involving a 3D scanner provides an opportunity for planning and carrying out investigations, analyzing and interpreting data, designing solutions, building theories from generated evidence, and communicating information.
- Improves the learning experience. Having the ability to get a 360-degree view of the lessons and actually getting a touch of it is the key to improve the learning experience of a child at school. For instance, history classes can create 3D printed models of both cultural and historical artifacts. Architecture and engineering students, on the other hand, can use it to explore in a deeper level the models of their works. Meanwhile, medical students can turn to 3D scanned models as a reference for enhancing their knowledge and skills in their field. The same goes with engineering students who can use it for inspection

purposes and for the assessment of the structural integrity of mechanical designs.

- Accelerate three-dimensional learning. The 3D printing industry offers promising benefits and limitless potentials. It is already widely-used in different industries. Incorporating 3D scanning, 3D modeling, and 3D printing lessons as early as possible prepares them for this breakthrough. In a three-dimensional learning process, students first find, research or make their own three-dimensional objects. Next, they scan them, which is itself an iterative learning process. Iterative learning involves repetition and cycles of activity. 3D scanning is perfect for this as it allow the students to experiment and to look at and analyze what they are doing as they are doing it.

IV. CONCLUSION

As 3D scanning becomes more accessible to designers, and the range of technologies becomes better understood by the discipline, the opportunities for collaboration on projects responding to the global megatrend of digital immersion increase. 3D scanning is one of the digital enablers that will work with associated digital enablers, such as additive manufacturing, ubiquitous computing and big data, to fundamentally change what design is and does. Higher education needs to consider more effectively the connections made by collective digital technologies and digital immersion through its scholarship and research, to inform the development of graduates capable of navigating the new world, post the digital revolution [3].

Although use of 3D scanners is increasing in many industries, the use of 3D laser scanned data for building 3D models is not as widespread in education as the use of 3D modelling and animation software. The ability to integrate 3D scan data with 3D software and virtual technologies can provide users in design and manufacture education with highly accurate data to construct complex organic shapes, which may not have been possible when only using advanced 3D surface modelling software in the past.

From start to finish, the 3D printing and scanning process is a way for students to participate in hands-on projects in the classroom. It is a step-by-step process that involves four key steps: scanning, modelling, printing and iteration. At each stage of this process, students have to make key decisions about their design and how it can best solve the problem at hand. It can be concluded without a doubt that 3D scanning is only at the beginning of transforming practical teaching in a modern classroom.

These new generations of students require more than books and the teacher-centered delivery of instruction. Schools should align their curriculum on the latest technologies and discoveries and keep in mind that the true essence of education lies not only on learning theories and formulas but mostly on its real-life applications. This is what 3D scanning in education aims to bring: an up-to-date model of learning that can enhance the knowledge and skills of modern-day students.

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3D Animation in the Film Industry

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Abstract – This paper processes the use of 3D animation in film through analysis and practice. It presents the possibility of modeling and animating a film, inspired by the role playing game "Dungeons and Dragons". Blender, which has potential use in education, was used as animation software.

I. INTRODUCTION

The idea of presenting movement through a medium appeared first in the Paleolithic, but became popular only in the 17th century AD, with various games of shadows and with the use of the "magic lantern". Using the sun, candles and lanterns as light sources, images from transparent slides would be projected onto walls or ceilings. Through the centuries and many phases, the lantern developed into an overhead projector, and later into a projector as it is known today. In 1833, the first stroboscope appeared. Thanks to the stroboscope, cinematography was born and finally between 1895 and 1920 animation as we know it today was developed. Around the turn of the millennia, computer animation was born and took over as the new dominant technique. It is most often associated with three-dimensional films, although many works are generated by this form of production. For example, the first film made entirely by computer and without the use of cameras: "Rescuers in Australia" (1990), does not look much different from the traditional style of hand-drawn and later photographed images.

The Japanese style of animation known as "Japanimation" or the much more popular term "anime", although it originated around the 1900s, took off and began to gather a huge audience in the USA with series and films such as "Astro Boy", "Speed Racer" and "Akira". Beginning in classical animation, the Japanese technique migrates over time towards a mix of traditional and digital style through shading, CGI and the like. As the American culturally-targeted audience of animated films shifted from adults to children, some Japanese publishers took the opportunity to sell more serious films, drawing on philosophy, existential issues and complex life dilemmas to steal the teen and adult audience who lost their cultural "right" to watch cartoons. This idea proved to be extremely profitable and resulted in anime and goods related to it, to be one of the main exports of Japan today.

II. FILM ANIMATION

The manifestation of animation in film differs drastically depending on the use. There are films with a large use of computer-generated imagery (CGI), films with miniature use where the sole purpose of animation is to capture some details or atmosphere and of course there are fully animated films.

The use of CGI in movies is an extremely common thing today, although it all started almost roughly. In the first instances of use, the effects, however interesting they were to see, were too conspicuous, extremely protruding and proved to kill the immersion of the story instead of furher deepening it. Fortunately, CGI artists as well as software have progressed and thanks to that, it is now sometimes difficult to discern reality and special effects. "The real attraction of the animated film, as opposed to more prevalent live-action variety, is the fact that there is literary no limit to the bounds of the writer's imagination, whether the film is to be produced in 2D or 3D." [1]

The use of CGI animation in films is comparable to the use of music, camera angles and lighting, although it is not directly related to the story, it serves to better explain it and bring the audience a better experience.

Animated films are divided into two groups: two-dimensional and three-dimensional. Two-dimensional animated films, in fact, involve a number of films made with three-dimensional techniques because they ultimately give two-dimensional results. Although there is currently a misconception that animated films can only target a young audience, the directors try to process more complex topics through simple dialogues, humor and entertaining characters with the intention to draw an audience of a wider age spectrum.

III. REVIEW OF THE MOST RELEVANT SOFTWARE

As the modern market for digital mass production and public accessibility arrived, people

began to animate and create films from their homes, both the simplest two-dimensional and complex three-dimensional animations that almost match large animation houses and studios. With the advent of these independent artists, companies saw a path to making money, but also to finding new names and talents in the field of animation, and that path was affordable software for new creators. The struggle between this software is never ending, since the technology is constantly evolving and enabling new directions of program progress and new ways of making the creation process simpler. There are many programs in the race at the moment, but three stand out: Maya, 3DS Max Design and Blender. [2]

Maya is Autodesk's subscription software for 3D animation, modeling, simulation and rendering [4]. The annual subscription to the Maya 2020 software is $1620, but it also comes with the direct help of specialist support and access to a large collection of online resources. Maya has an affordable design that allows for fast effective modeling and animation, but also a complex interface that in most cases requires the help of experienced designers to master. Even though hard to master, once that that happens, it provides one of the best platforms for 3D design. Taking into consideration the simplicity of the program but also the complexity of the animations it can create, Maya is considered to be at the top of the 3D modeling game. It is also widely used in large studios thanks to its scripting language "Mel" which has an incredible level of flexibility, and companies like to install their special tools in order to make their job much easier. It also has an excellent set of its own tools for positioning skeleton structures and models (rigging) and fantastic but affordable animation methods that facilitate the workflow of animators. Some of the companies that use Maya are: Blue Sky Studios, Framestore, Moving Picture Company and many others. Maya is available on Windows and Mac.

3DS Max Design is also an Autodesk subscription-based software, and it’s priced $1,620 annually in 2020, same as Maya, but is used for more extensive three-dimensional designs, modeling, animation, and rendering. The interface is simpler than Maya's and thus the software itself is a more accessible work environment, therefore used by beginners, but also by a number of professionals such as: architects, designers, engineers and visual experts. Unlike Maya, it gives visible results after only a few steps. 3DS Max truly outshines others during the creation of complex models, by providing a very fast workflow with all polygon processing tools in just one part of the user interface. It also has a fantastic ability to visualize architectural works that Maya does not. 3DS is also available on Windows and Mac.

Blender is a free software created by the eponymous "Blender Company". It offers sculpting options but also classic 3D design and thus is a great place to start studying digital versions of these techniques, designers who do not have enough experience or ability to start with Maya, can find that starting point in Blender. It is mostly based on the field of animation and visual effects, mainly for the purpose of creating entertaining content. [3]

IV. ANIMATION STORY ORIGIN

The original idea for the animation script actually comes from a popular role playing game called "Dungeons and Dragons". It works by having a number players, and a Dungeon Master (DM), who is in charge of creating the whole world through which their players will go to solve quests and experience adventures. In one of these games, the character "Hunter Stone" was created. He is a former Confederate soldier in the 1800’s and is living with his family on a farm in the prairie. After an attack of a native tribe on his home, he becomes a general of the American army with a grudge and tries at all costs to prevent the players from bringing peace to the Wild West, just to be able to continue raining vengeance on the natives for the suffering they brought him decades earlier, thus being the main antagonist of the campaign. The plot of the animation begins with Hunter and his son planning on painting the barn door, while his wife is going towards them to bring them a drink. Hunter explains how to do the job properly when they are interrupted by a sudden attack. A chaotic fight ensues in which Hunter loses his wife and child. The injured man crawls out of the barn and sees his wife's hairpin on the ground, in an attempt to grab it he accidentally pricks himself, and suddenly Hunter is filled by some new strength. He attempts to stand up, but is immediately hit by a spear and thrown back to the ground. When he looks up, he sees something he did not expect, himself standing exactly where he stood before he was knocked down. Still not understanding his newly developed power, the original Hunter looks at his arms in awe, unsure of what just happened. For context: Hunter received a “Talent”; an ability that can be anything ranging from a most ordinary hourglass, to the creation of matter from thin air. Hunter's talent allows him to create copies of something, and even himself, after adding inertia to it. When he is hit in the scene, as inertia is created, a copy falls to the ground, while the original continues to stand. A fight ensues in which he defeats the remaining opponents. In the end, tired, broken and without hope, he falls to his

knees next to his former home and thinks about what to do now.

V. CREATION OF THE ANIMATION

A. *Farm creation*

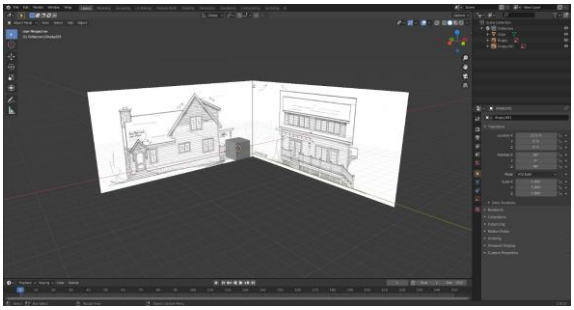

Figure 1. Creating of farm - phase 1

First, a template is placed in the background so as not to work blindly. Starting from one cube, it is slowly built towards the desired shape using the selection tool and the wireframe option, the edges of the object are placed in the desired positions. In the case of windows, chimneys, stairs, etc., extrude is used in combination with inset and loop cut tools. When using a loop cut, parallel lines are created that are moved by selection to the desired location, the same is done with the inset tool. Wireframe mode allows one to see the template through the model and makes it much simpler to format it according to the design. It is possible to shape the box by simple selection. Using a loop cut, a center line can be set and then extruded upright to create a roof shape. Details are created using the commands on the numeric keypad 1, 3 and 7 that place the user on the x, y and z axes. The chimney is extruded from the bottom of the farm. The preparation for windows, stairs and doors is done via the inset and loop cut options, while in the end, the terrace, doors and windows are created.

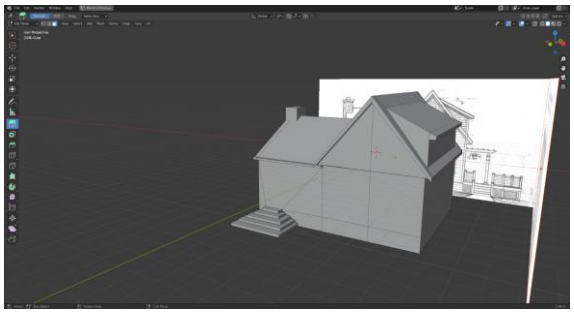

Figure 2. Creating of farm - phase 2

The excess lines created by loop cuts and insets are removed with the dissolve edges option.

B. *Barn creation*

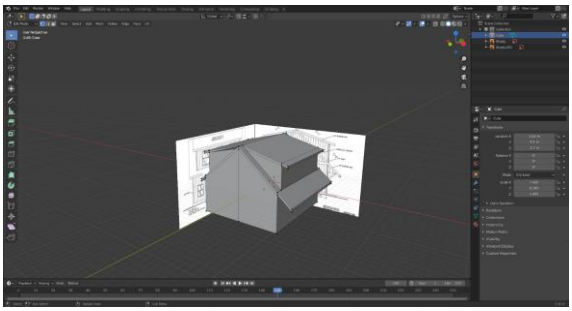

Figure 3. Creating of barn - phase 1

The same technique is applied on the barn as was on the farm and therefore a similar result is obtained. Details are added as well as windows and doors. With the dissolve edges option, the excess lines, created by constant loop cuts and insets, are removed. The process of creating a barn is extremely similar to the process of creating a farm.

Figure 4. Creating of barn - phase 2

C. *Creating of ground*

For the ground first an empty flat surface (plane) is created and scaled to the desired size. Using the subdivide option set at some large number such as 50, the plane is divided into a 50x50 matrix. The fractal value is now increased to obtain random irregularities on the terrain. The material is adjusted to the color of the earth, with some settings to avoid glare and irregular light shafts. Thus simple earth like ground is made. After this, a very simple grass is created and inserted onto the ground through the hair function.

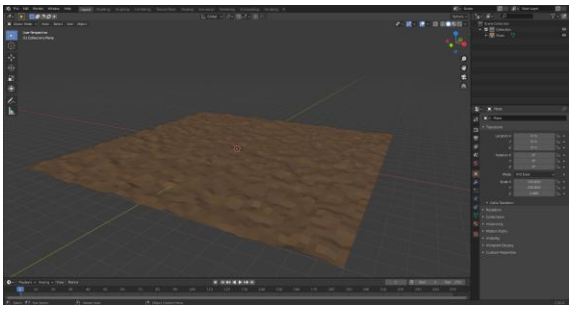

Figure 5. Creating of ground

D. Human and skeleton creation

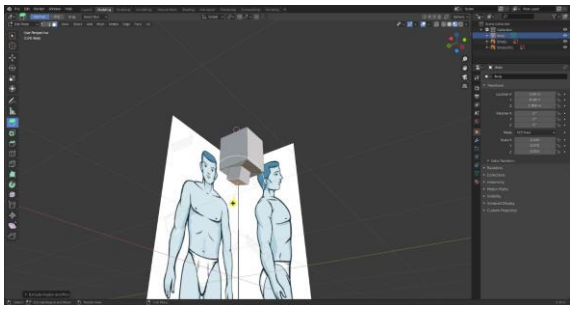

Figure 6. Creating of human - phase 1

In the beginning there is a simple model and a head frame is made. Using the inset method, a cut is created that corresponds to the neck. Then the neck is pulled out with an extrude. Then through the use extrude the rest of the body is made, by selecting the right side, and using "Delete Faces" option half of the body is removed. The remaining left side is now selected and the mirror option is applied to minimize the amount of work by working symmetrically on both halves. After the slab is made, as a Renaissance artist, chipping away with the chisel piece by piece, the creator follows the pattern, shifting and morphing, until everything fits properly. In the end, something close to a human being emerges.

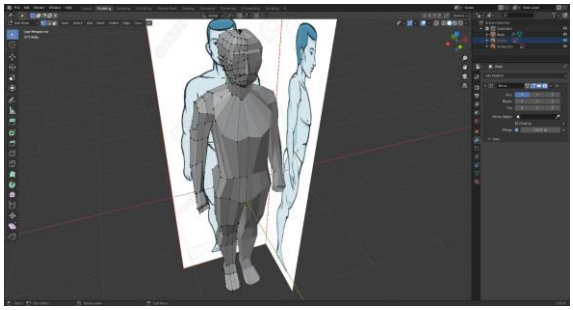

Figure 7. Creating of human - phase 2

The skeleton is added through the "Add" option and then through selection of the "Armature". It starts at the bottom of the spine and forms a pillar to the start of the neck. At the base of the neck, it branches out to the right creating a shoulder and an arm, and upwards – creating a neck and a head. After everything is done, the bones are named. Using the "auto name left / right" option lets the program know which half of the body is left and which is right. Now that the program knows which half of the body is which, it can automatically generate the other half through the symmetry option.

E. Scene setting

The farm, the ground as well as the actors can now be added and upgraded with additional details, textures, objects and so on since there is a set scene and it is possible to observe how it behaves in the given conditions. Now the animation process can begin. First a camera is inserted and after that the "animation" mode is activated. In animation mode (left), one may click on the numeric keypad 0 to bring themself to the camera named with that ordinal number. The camera is animated just like objects through keyframes. To add a new keyframe, one sets the timer (below) to the desired frame and clicks the letter I. If the object is in different places between two different keyframes, Blender will generate an animation that represents the movement between the two locations.

Figure 8. Scene setting

VI. CONCLUSION

Blender is the fantastic software for creative expression but also for professionally oriented work. Since it is free, this kind of software should not be missed by any animation startup. As a key factor in many major animation houses, video game companies and even being used as an element in the confusing music videos of experimental hip hop bands, Blender has come a long way. Since its beginnings in 2002, it has truly expanded and found a home in the most unexpected places.

Although not easy to master, it is not difficult for someone who has little experience with animation to understand it and pass that knowledge on. This software can be ideal for classrooms as a medium for learning about a new, interesting art form. Such an interaction would reveal many new names in the world of animation, but also in the world of film in general, given that amateur directors would get a chance to try and test their mettle in a safe environment.

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[5]https://www.bgsu.edu/content/dam/BGSU/libraries/documents/collab-lab/Maya-Tutorial.pdf

Software Reengineering with Object-Oriented n-Tier Architecture: Case of Desktop-to-Web Transformation

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Abstract – This paper presents the problem of software reengineering based on object – oriented principles and the use of web services. The theoretical part describes the concept of object-oriented programming which provides such that application architecture that it can be later expanded, maintained, or modified without changing the core of the application. Prototype of application, built on the principles of object - oriented programming, was reengineered in terms of switching from one platform to another.

I. INTRODUCTION

Software systems need to be reengineered for several different reasons: business process changes, changes in requirements and policies, modernization of technological infrastructure, change of legislation, as well as because of difficulties during maintenance in large software systems.

Aim of this paper is to present a case study of reengineering that use object-oriented principles to transform desktop application into web version. The example shows possibility to have the application core functions implemented with class libraries and the front-end platform shift (from desktop to web) was therefore easy to implement.

The rest of the paper is organized with sections as follows: Theoretical background in software reengineering, object-oriented programming and SOLID principles, Literature review, Research methodology, Research results – case study and conclusion.

II. THEORETICAL BACKGROUND

A. Software Reengineering

Reengineering is process in software development that includes improvements of existing solutions for better maintenance support, performance improvements, architectural change, technology platforms adaptations etc. During the software reengineering process, system is being reconstructed into a new form.

Reengineering includes sub-processes (Figure 1): reverse engineering, code reconstruction, data reconstruction, forward engineering, inventory analysis, document reconstruction. [1]

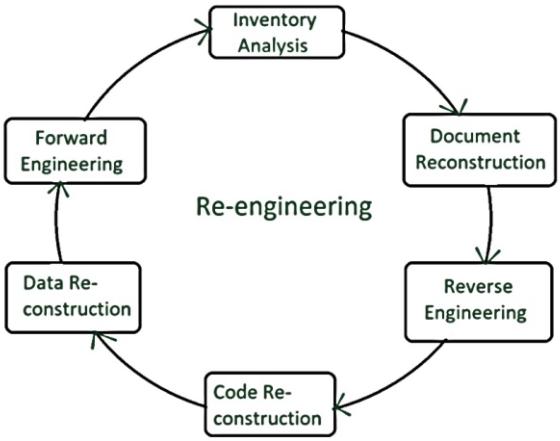

Figure 1. Software reengineering steps [1]

One of software systems types that, after a long period of use, undergo reengineering, are legacy systems. They could be defined as usually large software systems with great importance [1, 2] Legacy system is an old software program in use, still satisfying user needs, despite the fact that there are newer technologies or more efficient methods for performing the task. Their usage is closely related to procedures and terminology that were used for many years and reengineering of such systems is a complex task, not only because of the large number of software functions, but also because of the domain knowledge needed to be understood. Therefore, new developers sometimes have difficulties to understand the system. The large organizations continue using such systems because there are crucial for the business. [3]

The goal must be set in software reengineering and understanding of existing program is crucial. It is beneficial to implement the concept of software reuse within the reengineering, where having reusable modules (such as class libraries) could

speed-up the process. With high quality components, software reuse can simplify the code and make it reliable. [4]

Reengineering can include use of documentation for reconstructing and reorganizing the existing system, as well as reverse engineering to acquire models and sources suitable for reconstruction. The overall functionality of the system does not need to be changed, usually only the system architecture is changed. Reengineering means renewal, it is the process of transforming the old system into a new system, but it also could include addition of new functionalities. Special concern, during reengineering is to create such a software that will have components ready for future reuse and better maintenance. Regarding the reengineering model: each reengineering starts, if possible, with the source code of the existing application and the target goals of what is desired achieve. At this stage, the existing system can be translated into a new one by switching from one programming language to another, from one operating system to another, or from one platform to another. [5]

B. Object-oriented programing

OOP is programming model based on object concepts which are used in real life. Objects contain data in form of attributes and code in form of methods. Computer program constructed in this way have classes. Objects are instances of classes. [6] There are four basic principles supported object – oriented programming languages:

- Abstraction - using an abstract class / interface shows the purpose of the class, not its implementation. An abstract class has one or more abstract class members. An abstract class member is one that is not implemented, it has only a declaration, not a body.
- Encapsulation is a concept that defines class protection. The information in the class is protected from direct access and the only way to change it is through defining methods. Encapsulation is achieved by dividing class members into public, private and protected. [7]
- Inheritance – one defined class (super-class) can transfer its data and functionality to a new one (sub-class). It inherits all public/protected members of the class and introduces its new specific fields and methods. In this way, a hierarchical hereditary line is created. [7, 8, 9, 10]
- Polymorphism is a property that the same method works differently, depending on the context, i.e. type of objects. It is made possible with the ability of a subclass to redefine the inherited method. [7, 9, 10, 11]

C. SOLID principles

SOLID is acronym for five principles of design of object-oriented code. It doesn't teach developers how to create programs, but it helps them to create better written code. [19]

- *Single Responsibility Principle* - one class or module should be responsible for one part of the functionality provided by the software, and that responsibility should be fully supported in the class. [20]
- *Open/closed principles* - Software entities (classes, modules, functions, etc.) should be open for extension but closed for modification. This means that modules should be written in that way that they can be expanded without the need to modify them - to be able to change what the module does, without changing the source code. [21]
- *The Liskov Substitution Principle* - extends the Open/Close principle. The focus is on behavior of super classes and their derived types. Objects in the program should be interchangeable with examples of their subtypes without changing the correctness of that program. [12]
- *Interface segregation principle* - The goal of the principle is to reduce the side effects and frequency of change requests by splitting the software into several independent parts. This is only feasible if an interface is defined that corresponds to a specific client or task. [13]
- *Dependency Inversion Principle* - abstraction does not depend on details, but details depend on abstraction. In other words, the same level of abstraction that is at a given level should be used. Interfaces may depend on other interfaces and no concrete classes should be added in the signature method of an interface. [14]

III. LITERATURE REVIEW

When it comes to software reengineering, there are many examples of applying its principles in practice. Almost every company that is successful in the field of programming has at least one legacy system that needs reengineering.

"When software is developed over a long period of time, it is often very difficult and expensive to follow all standards all the time. Therefore, reengineering is performed, which improves the functionality and efficiency as well as the sustainability of the code. Existing applications can be adapted to improve their own functionality, user interface, while taking full advantage of the current

technology. This way results in applications becoming more reliable, efficient and easier to use, and all initial client investments remain fully preserved." [15]

A. Transforming desktop applications to web applications

Internet is becoming a platform on which people work, communicate, share and collaborate, with using mobile applications, web applications and even desktop applications. The largest Internet browsers such as Google and Yahoo support the gradual replacement of desktop applications with a new brand of web-based applications. Although this is a justified approach and there are some successful applications that have changed the platform (email, bookmark…) using today's web technologies to re-create sophisticated desktop applications is very difficult. Newly created web-based office applications come with significant limitations. They may be fun and convenient, but they are far from efficient, flexible, and productive as desktop applications with well-established databases. On the other hand, web applications offer many advantages, enable data sharing, wide access, low risk of data loss and most importantly cooperation. [16] There are many other examples of applying the principle of software reengineering in practice. Almost every company that is successful in the field of programming owns at least one legacy system that needs reengineering.

Vasyl Soloshchuk, SEO developer of INSART - Fintech Engineering described on its linkedIn profile successfully completed software reengineering projects. Online marketing platform has a history of more than ten years become very complicated to update and new requests indicated that it should be executed complete reengineering. With the help of the latest technologies, a new system architecture has been created that improves performance. It also avoids all errors found in legacy system and new functionalities are added to it. The result was a system which has become scalable and very easy to update. [17]

NASA has a whole complex of legacy systems that are becoming very expensive for maintenance and reengineering is one of the processes that can modernize these systems. In order to maintain the systems later, at the lowest cost, modern principles of software engineering are used. A branch dealing with software technologies in the NASA / Johnson Space Center has been involved in development and testing for reengineering methods and tools for several years within several large projects. One of them is ROSE (Reusable Object Software Environment) project that represents reengineering FORTRAN in object - oriented C ++. [18] Reengineering is a combination of reverse engineering, followed by advanced engineering into a new modernized software system (Figure 2). Three levels of reengineering are presented: translation, redesign and complete reengineering. [18] On the ROSE project, reverse reengineering was used for recovery of the FORTRAN design. Several CASE tools were used, such as data and structure analysis tools, complex metric tools, restructuring tools... The forward engineering part of this process used Object Modeling Techniques, Object Oriented Analysis Development Methods and design. [18]

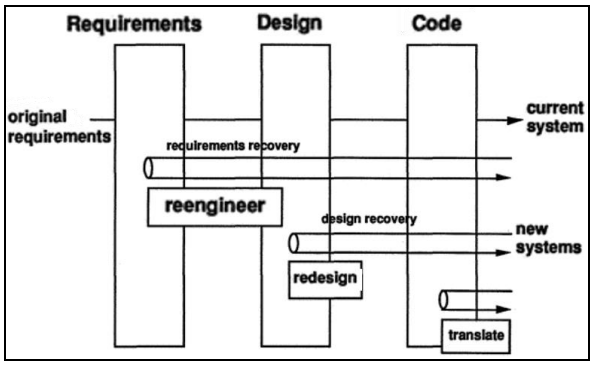

Figure 2. Software reengineering through process on ROSE project [18]

IV. RESEARCH METHODOLOGY

The research presented in this paper was conducted in year 2019. The subject of research is to theoretically and empirically explore the possibility of applying the basic principles of object-oriented programming (encapsulation, inheritance, and polymorphism) and SOLID principles when creating a new software version, i.e. software reengineering. Research hypothesis is formulated in the sense of proving the possibility of application of OOP and SOLID principles in aim to enable transformation of desktop to web application with particular concerns on structural quality of programming code.

Two types of research were conducted in this paper - theoretical and empirical. Theoretical research was supposed to answer the question of the principles of object - oriented programming used in implementation of the software to make it suitable for later eventual change of platform while preserving the functional core of the application. Empirical research is based on prototyping a multilayer desktop application and transforming into web application. Within this development, a new version of the software is in focus, with transition from one platform to another (desktop application to

web application) while preserving the functional core of the application. The essence of using OOP principles is to use the same classes from middle tiers, to build a web version of the application.

A. Description of the business context

The application business domain chosen to illustrate the concepts from the title of this paper is recording data about university teaching staff. Data about new teaching staff are entered into a database, and the type of teaching staff is checked. Depending on the type some data are enabled or prohibited. In this case, there are two types teaching staff: Teacher (professor) and Associate. If an associate is concerned, application enables only general data entry, while in professor case additional data are required to be entered.

B. Aim and description of the used technologies

The aim of the practical part of this paper is to show the object - oriented principles in creating software for later reengineering in order to move from one platform to another with the change of technologies for creating a user interface (desktop and web).

Tools / Development environments used for implementation examples are: MS SQL Management Studio and MS SQL Server, Visual Studio 2019, as well as Sybase Power Designer. The languages are SQL for database generation, C# for application creation and UML for model creation.

V. RESEARCH RESULTS – CASE STUDY

The application consists of four parts: database, web service, user interface and the program code which is the core of the application. All of these parts are physically separated, but through references they work together. As the desktop application is created as an object-oriented n-tier application and each part is independent, reengineering was quite simple. It was only front-end, i.e. new user interface that was created, but it was attached to existing components. These two examples (desktop and web applications) use the same crucial parts. The component diagram Figure 3 presents the component diagram, which shows the whole solution.

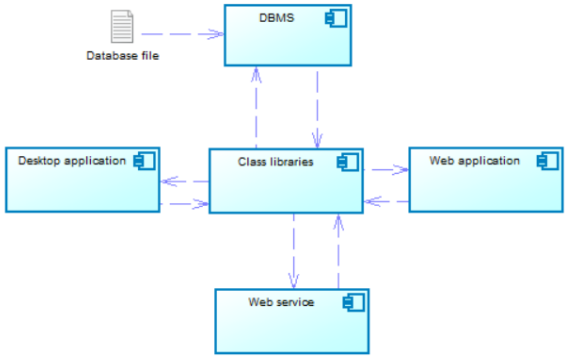

Figure 3. Component diagram

In Deployment diagram, since there are two versions of the application, desktop and web applications that are based on the same core, there is no significant difference in the layout diagram. The only difference is that with a desktop application (Figure 4), the software runs directly on the client computer, and the web application (Figure 4) is running on web server and presented with web browser.

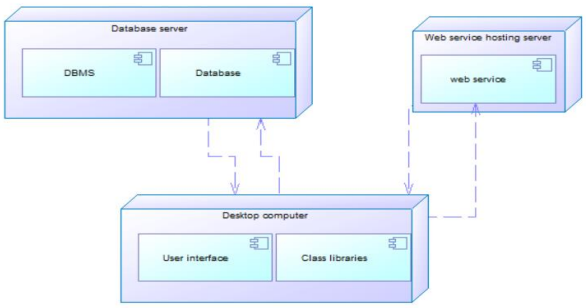

Figure 4. Deployment model for desktop application

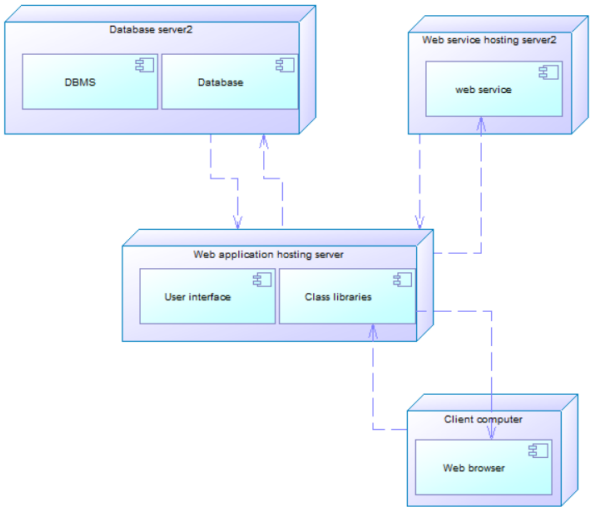

Figure 5. Deployment model for web application

For the purpose of this work, two prototypes of the application were made, one is a desktop version (Figure 6) and another web version (Figure 7) of the same application. Both applications implement the same functions. They allow the entry of teaching staff. Anyone can enter first and last name, work position, and depending on that, other fields are opened. If the position is "Teacher", it is possible to choose the title and scientific field. If he is an associate, there is no possibility of further data entry. The entered data can be stored in the database or the action can be canceled.

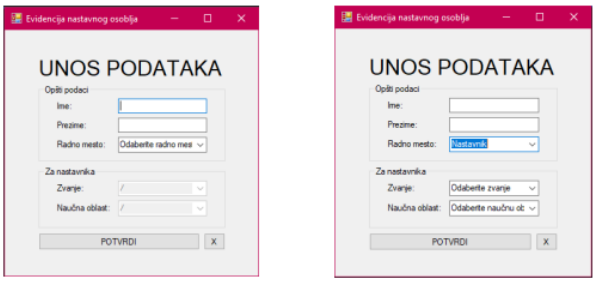

Figure 6. Desktop application user interface

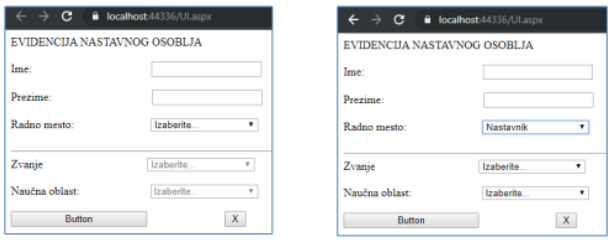

Figure 7. Web aplication user interface

VI. CONCLUSION

The most common reengineering is the reengineering of outdated software that has a good function but due to their technologies are no longer subject to change and are expensive to maintain. Reengineering helps to retain their core functions and support business processes.

Aim of this research is to explore the role of object-oriented programming principles in efficiency of reengineering. During the theoretical research and related work analysis, it has been proved that object-oriented programming and use of SOLID principles, as well as n-tier architecture helps in more efficient software reengineering. Therefore, hypothesis was proved. Another proof for hypothesis has been obtained with the implemented practical example – case study.

During the practical development of the application prototype, the principles described theoretically were included and it was concluded that such an application is possible, which, once again, proves the hypothesis. The application is organized through layers, to make the transition from platform to platform easier. It is built so that it has a user interface independent and all methods are inherited from other classes. Classes are divided by function, according to what they do and through the references included in the system. The database is also independent and can be easily changed at any time. Such an organization has proven successful in transitioning with desktop to web version of a software.

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Analysis of Students Attitudes About E - Learning

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Abstract: Nowadays, information is spreading rapidly. Across the Internet and easy to access, students have the opportunity to learn in different ways. E-learning is represented everywhere. Professors have the opportunity to provide students with study scripts, electronic textbooks, and other literature needed to deliver classes online. The necessity is to know the attitude of the students about e-learning. It is, also, investigated whether online learning is more effective if they still consult with the professor and which platform they use for teaching.

I. INTRODUCTION

E-learning involves the application of different forms of information and communication technologies in the education component in order to improve the quality of learning [2].

„The term so-called "distance learning" is nowadays linked to the concept of learning through the Internet, ie. e-learning. New information is being created every day, and more general development continuously requires new knowledge and skills. A Fast and timely education is needed that will be widely available and open at the same time. Thanks to the internet, learning is no longer enclosed in four walls of the classroom and it is accessible to anyone anywhere at any given time [1]."

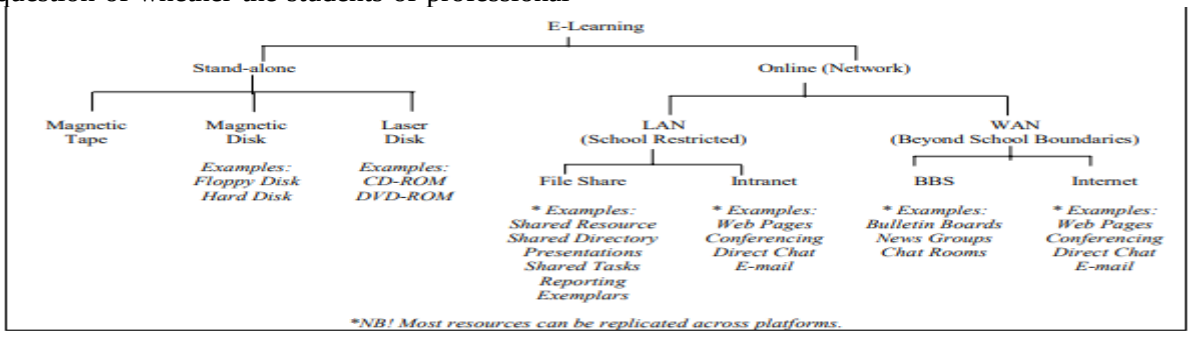
The main motive of this research is directed to the question of whether the students of professional studies share a positive attitude according to e-learning and whether it is easier for students if they still have a consultation with the professor and which platform students use. All of these benefits of e-learning can result in higher completion rates and better quality.

This paper's structure consists of several sections. The Research methodology section explains the research problem, research goal, research questions, hypothesis, place and method of research and sample. The next section is "about e – learning". The results of research are presented in next section. The Final sections are discussion and conclusions.

II. THEORETICAL BACKGROUND

The term "e-learning" is one of the most widely used syntax processes today in modern education around the world. Various definitions of e-learning are used. E-learning is a methodology by which "teaching content or learning activities are delivered using electronic technologies". [3]

E-learning covers a broad area within ICT Education and comes in many media formats as seen in Picture 1.



Picture 1. Media Formats of E-Learning [8]

E-learning is facilitated and enhanced by the use of information and communication technology. Such devices at this technological moment include the computer with additional devices, digital television, laptops and pocket computers, and mobile phones. [3]

Communication enables the use of the Internet, email, discussion groups, and collaborative learning systems. E-learning also involves learning from a distance, through network, and can be considered as a component of flexible learning. When learning takes place exclusively online, it is called online learning. When learning is distributed by mobile devices such as mobile phones, laptops, and pocket computers, it is then called m - learning. [3] [7].

"Classroom learning ensures student and teacher contact. In practice, each type of learning often combines with classroom learning and this is then called flexible blended learning [7]."

"The term e-learning was created in 2000. E-learning has many advantages in relation to classical learning. The benefits are most reflected in the reduction of school costs and trips as well as opportunities to learn when the individual has time and at the pace that suits him or her. This learning method achieves the ability to respect and support different learning styles with each individual individually. Content can be accessed at any time and from any place that has an internet connection [4].

There are two types of e-learning - synchronous, asynchronous and blended e-learning. Synchronous e-learning involves the presence of a teacher who manages the learning process, a virtual classroom, and real-time content delivery, teacher and student meet for a limited time in virtual classrooms and are able to share information simultaneously and communicate directly with others students, examples of this are: virtual classrooms, audio/video teleconferences, the Internet forums… Asynchronous learning is more flexible in which it does not require the simultaneous participation of all students and teachers. Asynchronous learning allows students to learn at any given time and from anywhere. This form of learning involves teaching in which students receive a purposeful knowledge that enables them to perform the necessary tasks. An example of asynchronous e Learning is attending online classes through the internet where participants adopt certain thematic units, including recorded lectures, presentations via the internet, etc [5] [9].

"E - learning includes: technologies, teaching materials and content and teaching strategies. [6]" Knowledge can be defined as an understanding of a term and the potential ability to apply and use it for some purpose. It involves complex cognitive processes such as perception, learning, communication, and inference. Attitudes are through learning and upbringing acquired habits and tendencies to react to a particular way to someone or something [3].

All the benefits od e – learning can result in an increased completion rate [2]. Advantages are:

- Time and space flexibility,
- Computer interaction between students and professors,
- Questions are asked more freely,
- Communication and work in groups on joint projects between students,
- Using interactive content and different media ,
- Learning content can be adapted to individual students [6] [10]…

Disadvantages are:

- Motivate the student to enroll in an online course or program
- Many e-learning programs fail. The dropout rate is up to 60%
- Hire teachers or tutors who will pay special attention to student motivation and follow up their progression
- May experience loneliness and isolation due to lack of live contact
- It takes too long to create e-learning content for education
- The design and creation of interactive and multimedia content should be given particular attention
- Dependencies of courses on technology [6] [10]…

III. RELATED WORK

In the research, which was conducted at the Polytechnic of Hrvatsko Zagorje Krapina, in 2015, on a sample of 132 respondents, the majority chose the combined principle of learning where it is much more represented than the traditional principle, while in this study only a slightly higher number of students said that the combined principle is more represented than the traditional [2].

IV. RESEARCH METHODOLOGY

Research is conducted upon the methodology presented as follows:

1. Research goal - The goal is to determine students' attitudes about the quality of

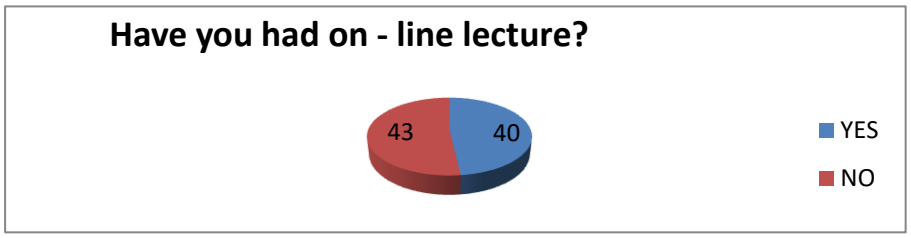
online teaching, comparing it with traditional teaching methods, and whether online learning is more effective if the student consults with the professor, and also to identify which educational software students use. It is necessary to know how students will gain the best knowledge.

2. Research questions:
   RQ1: Is online lecture and traditional lecture equally represented?
   RQ2: Is online learning more effective if consulted regularly with a professor through the Internet?
3. Hypothesis:
   -Respondents believe online lectures and traditional lectures are equally represented.
   -Online learning is more effective with consultations with a professor.
4. Place and method of research – The research was conducted at the Technical Faculty at Zrenjanin by dividing the survey trough social networks.
5. Sample – The survey was conducted in the period from 20.04.2020 to 26.04.2020 where the respondents were 83 students from the Technical Faculty in Zrenjanin.

V. EMPIRICAL RESEARCH RESULTS

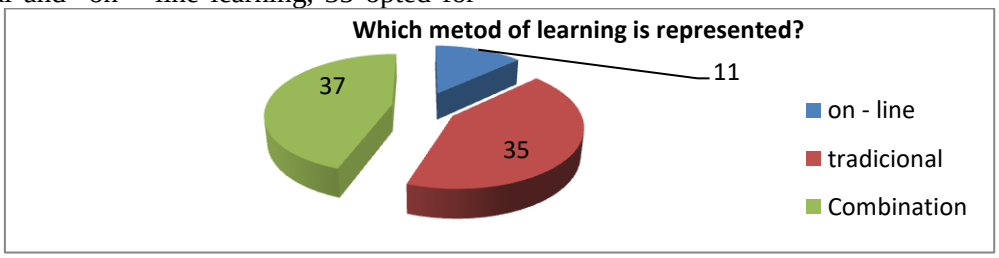
This section presents the results of a survey conducted to understand students' views on e – learning, as well as to compare online and traditional learning and use of online platforms. Of the total number of respondents, 39 students are the first year, followed by 13 students with the second year, 12 with the third year, 7 students with the fourth, and finally with 12 students with the fifth year (master studies). The vast majority of respondents (79 students) are 19 to 25 years old, while only 4 of them are 26 to 30 years old. Most of the respondents are IT Engineers (26 students), followed by Oil and Gas (12 students), IT in education (9 students), Software Engineering (8students), Clothing Engineering (7students), Mechanical Engineering (6 students), Engineering Management (5 students), Environmental Protection (5 students), Information Technology Management (3 students) and IT in Business Systems (2 students).

When asked "Did you have on - line lecture?", 43 students replied "NO", others 40 students replied "YES".



Picture 2. Chart showing students who had on - line lecture

When asked "Which learning method is represented?", 37 students voted for a combination of traditional and on – line learning, 35 opted for traditional learning, while only 11 students voted for on – line learning.

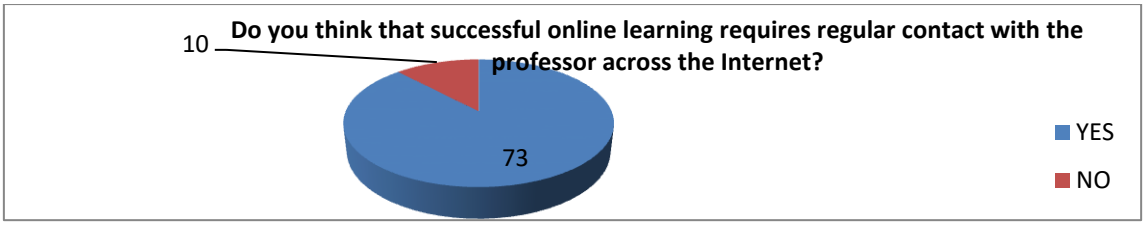


Picture 3. Chart showing which method is most represented

When asked "If you chose online learning, the reasons are:?", where multiple responses can be marked, 16 students marked communication and group work on joint projects between students. In addition, 7 students marked time and space flexibility and the ability to tailor content to

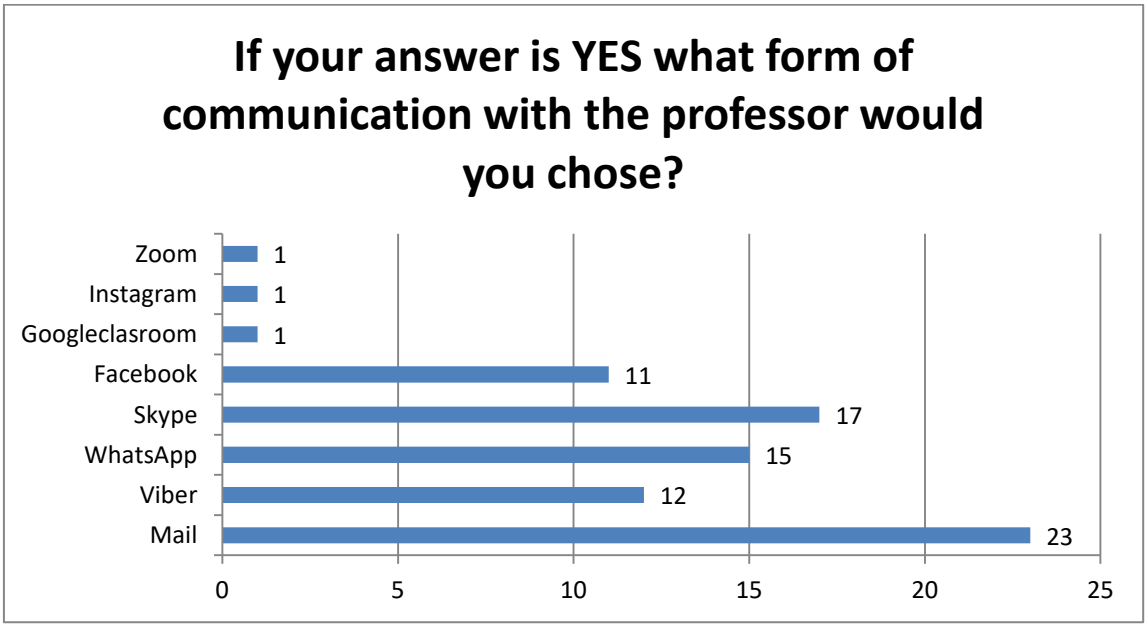
individual students. 6 students marked the use of interactive content and various media, while only two indicated that questions were asked more freely. When asked "If you chose traditional learning, the reasons are:" where multiple answers can be marked, the majority of students have stated that online has not yet developed so much as to exceed traditional learning. 17 students indicated that nothing could replace the professors' live word, while five indicated that in their view it took too long to develop content for online learning. One student indicated that traditional learning provides much better interaction with professors. When asked "If you chose combination learning, the reasons are:" where multiple answers can be marked, a slightly larger proportion of the students surveyed opted for the blended learning method. Twenty - nine students felt that the combination of traditional and online learning produced the best results, and nineteen students indicated that it was convenient to search the Internet for anything that was not clear in the classes.

When asked "Do you think successful online learning requires regular contact with the professor across the Internet?" 73 students replied that consultation with professors was essential, while 10 replied that consultation with professors did not play an essential role in successful online learning.



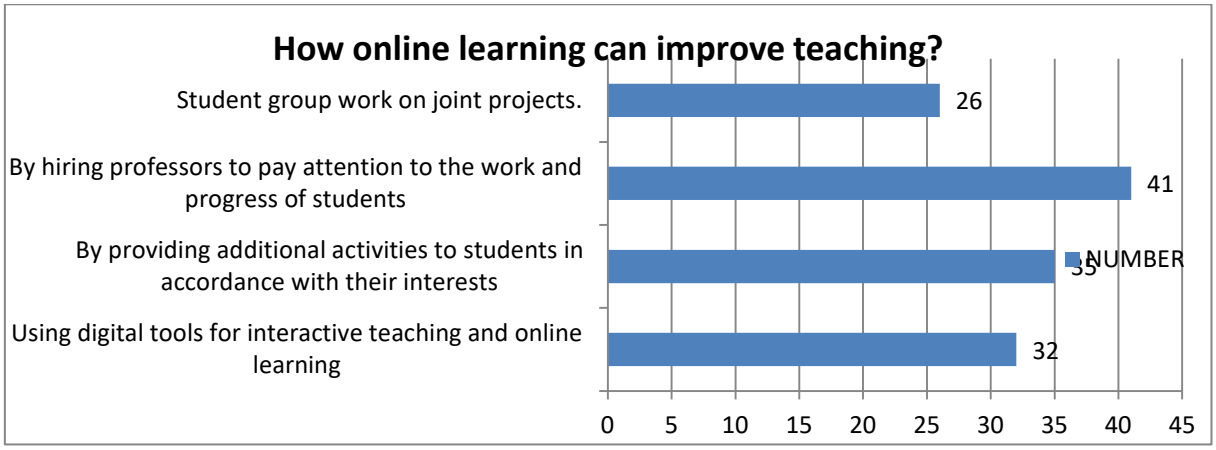
Picture 4. Chart showing student opinion on whether consultation with the subject teacher is important for more successful online learning

Asked "If your answer is Yes what form of communication with the professor would you choose?" where it is possible to mark multiple replies, as many as twenty-three flagged the email, Skype flagged seventeen, then fifteen tagged WhatsApp, Viber tagged twelve, Facebook eleven tagged and finally Instagram, Google classroom, Zoom tagged one each the student.



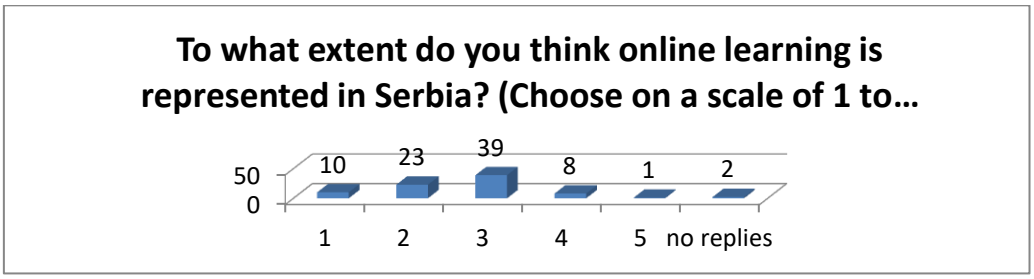
Picture 5. Chart showing which forms of communication with the professors that students would choose

When asked “How on – line learning can improve teaching?”, forty-one respondents replied that they could improve by hiring professors to pay attention to student work and progress, thirty-five replied that they could improve by providing additional activities to students in accordance with students' interests, thirty of them and two replied that she could enhance teaching by using digital resources for interactive teaching and online learning and twenty-six students replied that she could advance by doing student group work on joint projects.



Picture 6. Chart showing students' opinions on how online learning could be improved

When asked "Which educational platforms do you use or have used?", where multiple responses could be marked, more than half of the respondents, as many as forty-three indicated the Google classroom, seven indicated Moodle, while one student indicated Skill share, Udemy, Kahoot, Zoom, Vedamo. As many as thirty-five students indicated that they were not using any. When asked "How much do you think online learning is represented in Serbia? (Choose on a scale of 1 to 5, where 1 is not represented and 5 is strongly represented). " The majority of the surveyed students, 39 of them, share the opinion that online is mediocrely represented in the Republic of Serbia (on a scale of grade 3), 23 students think that it is very little represented (on a scale of grade 2), 10 that it is not represented at all. on the scale of grades 1), 8 respondents think that they are more represented (on the scale of grades 4), while only one student thinks that online learning is strongly represented in Serbia (on the scale of grades 5). Two students left the field blank for this question.



Picture 7. Chart showing students' opinions on the prevalence of online learning in the Republic of Serbia

VI. DISCUSSION AND CONCLUSION

Most respondents were in the first year of study. Students are mostly from 19 to 25 years of age, mostly from the fields of information technology, while there were also from all other fields at the technical faculty. Slightly more than half of the students met at an online lecture. The combined principle of learning, something a little more than the traditional is mostly represented. Out of the total number of respondents, 48 of them were from the fields related to the field of information technology, which are: IT engineer, IT in education, Management of Information Technology, Software Engineering, IT in business systems.Respondents from these fields voted equally for the traditional principle and for the combined, while from the direction of Oil and Gas they mostly voted for the combined, in Clothing Engineering they voted the most for the traditional, in Mechanical Engineering they voted equally for the traditional and combined principle, in Engineering Management mostly voted for the combined principle, while in Environmental Protection they voted the most with online learning. They mostly opted for the combined principle of learning because the combination of traditional and online principles leads to the best results, and also because the student can search the Internet for what was not clear to him in class. Most students stated that when learning online, they need to consult with the professor, mostly by e-mail. E-learning can improve teaching the most so that professors can be engaged to pay attention to the work and progress of students and give additional activities in accordance with their interests. The educational platform most used is the Google classroom, Moodle is used only by a few students. The opinion of the authors is that the Google classroom was the most represented due

to the availability and simplicity of the interface. Google Classroom has met all the requirements for quality online teaching, has a simple interface, and a well-organized reporting system for both teachers and students. In each year of study, there are respondents who do not use any platform, which is about 42%, of which more than half of them chose the traditional principle, who mostly use mail, Viber, WhatsApp, Skype, Facebook to consult with the professor, while a couple consider that there is no need to consult a professor. The largest number of students believe that online learning is moderately represented in the Republic of Serbia. With this research, it can be concluded that combination learning is most represented in technical faculty in Zrenjanin because a combination of both methods produces the best results. Also, online learning is more effective if student consults with a professor trough email and the most commonly used platform is Google classroom.

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Students' Attitudes Regarding Online Learning During Covid-19 Pandemic

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Abstract: Investigation of students' attitudes about online learning during the Covid19 pandemic was the main focus of this paper. The research was conducted at Faculty of Technical Sciences in Čačak and it involved 136 students from three study programs: Information Technologies, Engineering Management and Electrical and Computer Engineering. Students gave relatively low marks for general attitudes towards online teaching, especially its efficiency compared to the traditional one. Additionally, students gave relatively low marks for statements which refer to cheating in exams in e-learning context. When it comes to teamwork in the e-environment, students gave relatively high marks for statements which refer to the satisfaction of working in a team, turning an assignment in on time, coping skills etc. The majority of students points out at least one benefit of online teaching, where by most of them considers that this sort of teaching saves time, and their cognitive load was not too increased due to this type of learning. On the other hand, more than half of students stated that they had at least one issue during their attendance in class, and that Internet disconnection was the most common one.

I. INTRODUCTION

During the state of emergency caused by the COVID-19 pandemic, pupils and students in Serbia took online classes from home. Apart from daily video lessons aired on national television, teachers used a multitude of other technologies and platforms which made the classes quite diverse. At the Faculty of Technical Sciences in Čačak which has multidisciplinary departments and fields studied, with the state of emergency having been declared, students have had the opportunity to switch to taking online classes, with the support of The Moodle Learning Management System (LMS) for uploading course materials, assignments, projects, tests and video recordings of classes. The synchronous teaching was done via Zoom, Office 365, Google Meet and Webex. Considering the uncertainty of the current pandemic there arose a need for determining students' attitudes on online teaching with the aim of improving this type of teaching. In order to have a clear view of the students' attitudes, a survey has been conducted which include students from different departments and different years of studies.

During the pandemic, many an author carried out research on teaching in extraordinary circumstances. Muhammad and Kainat [1] dealt with students' perspectives in Pakistan during the Covid-19 pandemic. The conclusion was that online teaching cannot provide appropriate results since a significant number of students does not have appropriate equipment, as well as Internet access. Wadood et al. [2] surveyed students in Bangladesh regarding knowledge, attitudes, practice and perceptions about COVID-19. They found that general knowledge, attitude, practice and perception of university students regarding COVID-19 were not satisfactory. Over one third of students had a negative attitude on avoiding public transport and public gatherings. Furthermore, over a third of students avoided staying at home so as to avoid places wiith a large number of people. Bao [3] conducted a study about COVID-19 and online teaching in higher education at Peking University. Five quite significant principles for online education were established: „(a) high relevance between online instructional design and student learning, (b) effective delivery of online instructional information, (c) adequate support provided by the faculty and teaching assistants to students; (d) high-quality participation to improve the breadth and depth of students' learning, and (e) contingency plan to deal with unexpected incidents of online education platforms." Shahzad et al. [4] conducted a study to determine the impact of virtual teaching on students behaviour. Results showed that students have a positive atittude towards the new way of teaching. Research on online teaching during the pandemic proposed by Ali [5] points to the most significant aspects of that sort of teaching (resources, teacher readiness, confidence, as well as students' motivation and the possibility of attending e-classes). Muflih et al. [6] highlighted one of the research' results on students' attitudes towards online teaching during the pandemic, which is the positive attitude students have of online courses as an aid for working on assignments.

Main barriers to online education identified by students were "the geographic locations and lack of past experience with using online tools".

II. METHODOLOGY

The subject of this research is students' attitudes towards e-classes during the COVID-19 pandemic. Consequently, the main goal of the research is to examine the level of presence of certain categories which refer to the evaluation of attitudes toward e-learning. Nevertheless, the goal is to do a pilot study of the developed questionnaire.

The research hypothesis refers to the assumption that students give positive evaluation marks to e-teaching activities which were implemented during the pandemic, i.e. during the state of emergency.

The data was collected through a questionnaire which was developed for the purposes of research. The first part of the questionnaire consists of four categories of attitudes and 21 statements which are evaluated on a five-level Likert scale (1-does not apply to me at all; 2-it partially applies to me; 3-I am not sure; 4-it mostly applies to me; 5-it completely applies to me). The Cronbach's alpha reliability coefficient is 0.88. This scale includes the following subscales: the quality of e-teaching, cheating on tests in the e-environment, engaging in teamwork and cognitive load. The Cronbach's alpha reliability coefficient for the subscales are:

- Quality of e-teaching: 0.84;
- Cheating on tests in e-environment: 0.68
- Engaging in teamwork: 0.79
- Cognitive load: 0.63

In the second part of the questionnaire, students were asked to single out the advantages of e-teaching compared to the traditional one, as well as the difficulties they encountered. The third part of the questionnaire implied ranking of material formats used according to the frequency of use.

Although the Cronbach's alpha reliability coefficient for the whole scale is acceptable (over 0.8), lower values were obtained for certain subscales. The reason for this could be a small number of statements for certain scales [8].

Dependent variables in this research were grouped according to the abovementioned attitude categories.

For data processing, procedures of descriptive statistics were implemented with the use of the SPSS software package. To determine the variance in prominence level which refer to the presence of certain theories of study, descriptive statistical techniques were used, such as arithmetic means and standard deviation.

The sample consisted of a total of 136 students from The Faculty of Technical Sciences in Čačak, University in Kragujevac. The research involved students from three study programs: Informational Technology (73 students), Electrical and software engineering (32 students) and Engineering management (31 student).

III. RESULTS AND DISCUSSION

In order to gain a more detailed insight into the representativeness of certain attitude categories, below are means shown for each individual statement.

Table 1 shows average values for statements which refer to the quality of teaching.

In Table 1, it is visible that students give the highest evaluation mark for the statement which refers to the utility of recorded materials for subsequent studying (M = 4.39). Additionally, the students assess that the access to e-learning was clear (M = 4.30). On the other hand, the lowest evaluation marks were given for the statement of how much online teaching contributed to the material comprehension (M = 2.71) and the statement which refers to how much online teaching could replace the traditional one (M = 2.87). Such a finding implies that general attitudes towards e-teaching were relatively low evaluation marks (under the average mean of 3).

TABLE I AVERAGE MEANS FOR THE E-TEACHING QUALITY EVALUATION SCALE

The quality of e-teaching	M	S.D
The application of modern technology in teaching and learning has advantages compared to traditional teaching	3.32	1.258
It was difficult to understand the teacher's e-lesson	3.02	1.256
E-teaching affected your achievements	3.19	1.112
E-teaching contributed to better understanding of the subject compared to traditional teaching.	2.71	1.143
The approach to e-learning was clear.	4.30	0.855
The overall engagement of professors who taught online was satisfactory.	3.67	1.011
E-learning can replace the traditional approach.	2.87	1.216
Recording the lessons and uploading the video recordings on the e-learning system was useful for subsequent studying.	4.39	1.012
Students' self-evaluation has a positive effect on learning.	3.22	0.994
I am satisfied with the online colloquium.	3.60	1.142

Other authors find that e-teaching did not meet the expected effects due to lack of equipment and internet access [1], as well as that attitudes towards this sort of teaching are not satisfactory [2]. On the other hand, there

are statements which point to the positive effect of virtual environment towards this approach to studying [4].

In Table 2, average means are shown for statements which refer to cheating on tests in e-environment. In Table 2, students' lowest evaluated statement was the one which refers to the individual evaluation of the use of illicit means in these learning conditions (M = 2.11). Yet, most students assess that other students cheat (M = 3.33). Of course, something that must be taken into consideration is subjective evaluation, and that, when it came to this particular ethical issue, students were not completely honest. And other research show that students give low evaluation marks for all types of cheating during examination [7].

Table 3 shows average means for statements which refer to engaging in teamwork. When it comes to teamwork, Table 3 shows that students give high evaluation marks for turning an assignment in on time (M = 3.69), while they are unlikely to think that teamwork in an e-environment is any more difficult compared to traditional teaching (M = 3.14). Still, it should be noted that the evaluation marks for all the statements given in this group are below 4. This finding shows that students are likely to need further support in the realization of activities in this manner.

Table 4 shows average means for statements which refer to the cognitive load and fatigue during e-learning.

TABLE II AVERAGE MEANS FOR THE CHEATING IN EXAMS SCALE

Cheating during e-testing	M	S.D
Students cheated during e-testing.	3.33	1.211
Students are responsible and conscientious not to use illicit means without the professor's supervision.	2.89	1.165
You used the chance to manipulate illicit means so as to achieve better results.	2.11	1.209

TABLE III AVERAGE MEANS FOR THE ENGAGING IN TEAMWORK SCALE

Engaging in teamwork	M	S.D
Students follow the deadlines for assignments in teams.	3.69	0.984
Students cope well with the realization of distance teamwork.	3.54	1.242
Students were satisfied with the involvment of the rest of the team during the preparation of seminar papers.	3.49	1.162
Teamwork is more difficult in distant learning and the inability for students to meet as with traditional teaching.	3.14	1.462

TABLE IV AVERAGE MEANS FOR THE COGNITIVE LOAD AND FATIGUE SCALE

Cognitive load and fatigue	M	S.D
A higher cognitive load in students was present in distant than in regular teaching.	3.59	1.330
You had the will to study at home.	3.00	1.339
You felt more tired after e-teaching compared to standard teaching	3.08	1.361
Household chores interfered with completing obligations regarding classes.	2.87	1.216

Based on the average means shown in Table 4, relatively low evaluation marks are noticed (below and above the 3 mark), which refer to the cognitive load during e-learning. In this group of statements, most of the students stated that the cognitive load during e-learning was increased compared to regular conditions (M = 3.59). Students consider that the least of their distractions were chores (M = 2.87), which means that students were able to balance between faculty and private responsibilities.

This research also tested which benefits of e-learning students pointed out compared to traditional teaching. Table 5 shows the results of this part of research. Students were able to choose multiple answers. Results show that 10.29% of students think that there are not any advantages of e-learning compared to the traditional one. Still, the largest percentage of students thinks that this type of teaching saves time (74.3%).

About a third of those students who acknowledge those benefits think that e-learning makes learning easier and improves the connection between students. As a special advantage, students stated the fact that they were able to stay at home during studies.

Table 6 shows results which refer to the difficulties students have had during e-teaching.

TABLE V BENEFITS OF LEARNING IN E-ENVIRONMENT

	Yes (%)	No (%)
Saving time	74.3	25.7
Studying is easier	32.4	67.6
Increased interest	19.9	80.1
Improved quality of learning material	20.6	79.4
Improved communication between students and teacher	32.4	67.6
Other benefits	1.5	98.5

TABLE VI ISSUES WITH ATTENDING E-CLASSES

	Yes (%)	No (%)
Internet disconnection	74.3	25.7
Computer issues	32.4	67.6
Increase of interest	19.9	80.1
No internet access	1.5	98.5
Other issues	10.3	89.7

Results show that 46% of students did not have an issue with taking classes online. Table 6 shows that the largest percentage of students (out of those who singled out at least one difficulty) had issues with Internet disconnection (74.3%). Other difficulties students have pointed out were power outage, lesson schedule, technical difficulties with video conference platforms, delay of emails with online meeting dates, and that one of their inmates had e-classes at the same time. Other authors find the main obstacle to be lack of skills for the use of technology for studying [6]. Unlike other students in this study, students in Pakistan had difficulties with following classes in pandemic conditions due to the lack of technical equipment [1].

Table 7 shows the consistency of using materials in different formats in percentages. Looking at Table 7, one could conclude that teachers usually taught via video conferences, and that they relatively often provided materials in pdf form. E-testing was also used. This finding in accordance with findings of other research which point to the presence of online platforms and tools for video conferences [6]. As it was already mentioned, at the Faculty of Technical Sciences, where the research had been carried out, a system for e-learning Moodle as well as other platforms for video conferences were used during the pandemic, which gives an additional explanation for the more frequent use of certain types of material and activities.

IV. CONCLUSION

The results of the research show that the hypothesis set on the positive attitudes towards online teaching during the pandemic is partially confirmed. Namely, students have given relatively low evaluation marks for the general attitudes towards e-teaching, especially for its efficiency compared to the traditional one. Nevertheless, they consider that recording the video material and its later use can be useful. Students give relatively low evaluation marks for statements which refer to cheating on exams in the e-learning context.

TABLE VII FREQUENCY OF MATERIAL USE IN DIFFERENT FORMATS RANK (%)

	1	2	3	4	5
Power Point	10.3	17.6	39	16.2	16.9
Pdf materials	5.1	10.3	36	18.4	30.1
Tests	2.9	25.7	26.5	27.9	16.9
Regular textbooks	8.1	36.8	27.9	19.9	7.4
Video conferences	7	8.1	25.7	33.8	31.6

However, due to subjective evaluation and the possible insincerity of the students, this result should be taken with a grain of salt. When it comes to teamwork in the e-environment, students give relatively high evaluations for statements which refer to the satisfaction of working in a team, turning an assignment in on time etc.

Furthermore, students' evaluation point to the fact that their cognitive load was not too increased for having to study in this manner. Most students singled out at least one benefit of e-teaching, whereby most of them think that this teaching method saves time. On the other hand, more than half of students said that they had had at least one issue during class, and that the most frequent one was Internet disconnection.

Video conferences, materials in pdf format and e-testing proved to be the most frequently used ones during the pandemic. Still, it should be taken into consideration that this new approach to studying was probably a novelty for most teachers, as well as students, where adjustments are yet to be made.

Further research implies the scrutiny of teachers' attitudes towards teaching under extraordinary circumstances and comparing the evaluations. Additionally, it would be useful to determine the objective differences in students' achievement during traditional teaching and teaching in e-environment.

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School Management Improvement - Pedagogue Information System

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Abstract - This paper describes a prototype of school pedagogue information system with basic purpose to show that the elementary school management can be improved. This prototype is developed through system analyses, models generation and software implementation. Relational database was created in MySQL database management system for the purpose of storing necessary data for school pedagogue work. Web application was developed in PHP programming language with intensive usage of HTML/CSS/JavaScript technologies. Further system development and possible upgrades are also commented.

I. INTRODUCTION

Information system (IS) is every system which elements and the whole system with its environment communicates by exchanging data and information. It is an organized collection of methods, processes and operations for data gathering, storing, manipulating and information transmission through organizations including the software, hardware, org-ware and life-ware. [1] [2]

Information systems can be used as a decision support system and for realizing the basic enterprise functions. Every elementary and high school as a social well-organized system must have an information system supported by information and communication technology (ICT).

IS development is a process of transforming concepts from the real world to various models that can be implemented in a form of solution through activities like: user requirements specification, future model design, process models, data models, object oriented models, technical specifications, program specification etc. [3] [4].

II. RELATED WORK

Information systems enable countries and school authorities for better efficiency in education planning, strategical planning, and schools monitoring.

For example, in paper [5] is presented Education Management Information System (EMIS) developed in Philippines. This program helps policy makers to manage an education system. Through eight modules it provides information to education administrators in the planning and delivery of educational services. This was enabled with data collection, processing, dissemination, and utilization. Activities supported with EMIS are suitable for planning, implementation, monitoring and evaluation of school operations. EMIS implementation in all levels and types of schools' lead to sustainable quality education and performance.

According to [6] school information systems is a set of three sub-group of management information systems that are used in educational organizations. In schools there are distinct information systems support different types of decisions:

- administrative information systems (budget, schedule, timetables, student records).
- learning management systems (groupware, e-learning, learning management system).
- assessment information systems (test data, assessment data, grades).

Usually, the school management must work with several IS with different purposes that are compatible in limited ways.

"An information system based on one or more computers, consisting of a data bank and one or more computer applications which altogether enable the computer-supported storage, manipulation, retrieval, and distribution of data to support school management. " [7]

Today, educational institutions are looking for an optimum distribution of resources for achieving maximum benefits to students, teachers, and the management. In the contemporary world with high educational demands, management information system (MIS) is a system that these institutions need to have with basic aim to put their progress in the right direction. A MIS has a central data repository capable for gathering, organizing, and storing data and processing and analyzing, as well as generating various reports from it. Education management information system is designed to monitor the

performance of education programs and to manage the distribution and allocation of educational resources. [8]

Integrated web-based school information management software is presented in [9]. It has an educator's web-based program for schools which is an integrated database that connects school and students, family, and staff.

III. System Analyses and Design

According to [4], information system development is divided into several phases:

- Planning (project identification, economic feasibility, workplan, tasks, staff).
- Analyses (requirements, model process, data model, use cases).
- Design (architecture, interface, program, databases, files).
- Implementation (programming, testing, installation, documenting, maintaining).

From related work it can be conclude that the job of school pedagogue is not covered in information systems. Planning this IS was based on school pedagogue work description and information needs for achieving maximum benefits to students, teachers, and the management. This system must have a database that stores data about students, teachers, and classes [7]. Data from this database must be inserted, updated, or deleted with web application that is easy for maintaining and installation. Most of programming languages in this area belongs to free and open software community, so the cost of development is minimal. Various reports were needed and possibility to create reports that can be printed or saved in electronic form like PDF format.

School pedagogue work description - before the beginning of each school year, the Ministry of Education sends new curricula to schools or confirms the old ones, after which they are taken over and recorded by the school pedagogue. Pedagogue then classifies teaching obligations by ability into three categories (below average, average and above average) and sends them to teachers. The pedagogue records the basic data on enrolled students and opens a pedagogical "file" of students. Pedagogue receive information about the students from the school secretary. The student file is appended with data about the social position of students, which they received from parents, and then obtaine data with psychophysical tested data and mental abilities. Pedagogue processes all this data and send it to class teachers and teachers for inspection. During the school year, pedagogue records the school work of students based on the data from the diary entered by teachers and sends information to the Ministry of Education on the general success of students in the school, by grades, subjects and categories. Then, at certain intervals, it analyzes the stored data together with the data on the students' abilities and make conclusions about the interests and behavior of the students, which it then gives to the teachers for insight, as well as information about the general success. Also, concludes about the problems of students of any kind and informs the class teacher and parents about it and provides adequate help and support. The task of the pedagogue is to solve the observed problems. Starting from the teaching obligations given by the curriculum and the need for new information from the pedagogical and psychological profession (professional seminars, symposia and lectures organized by the ministry, university, institute, etc.), it collects appropriate documentation and literature and records it. Pedagogue then analyzes it, draws conclusions from individual sources and makes a preliminary decision on their possible impact on the teaching process, and then makes modifications to the curriculum within the limits allowed. He sends these changes and proposals to the teachers in charge of specific subjects, classes and classes to which the changes apply.

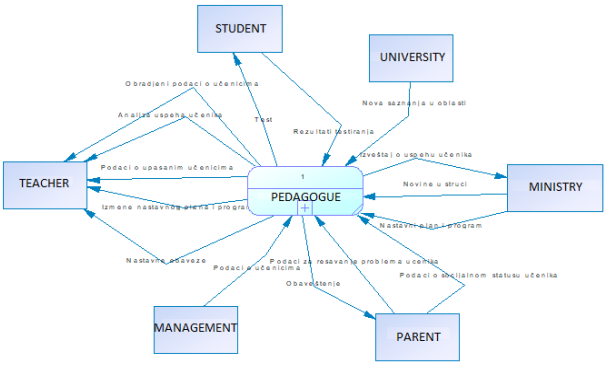

Figure 1. Business process model – main diagram

In the process of IS development, in analyses phase, were created models suggested in [4]: business process model (BPM), conceptual data model (CDM), physical data model (PDM), object oriented model (OOM) with use case and class diagram.

Figure 1 shows process model as a business process model first diagram that is called the context diagram. This diagram shows external data flows and external systems and subsystems called entities

that are in interaction with school pedagogue. This diagram of a model defines a system boundary.

Figure 2 shows decomposed process from figure 1. On this level were identified basic functions: school year preparation, work during the school year, and improving plans and programs.

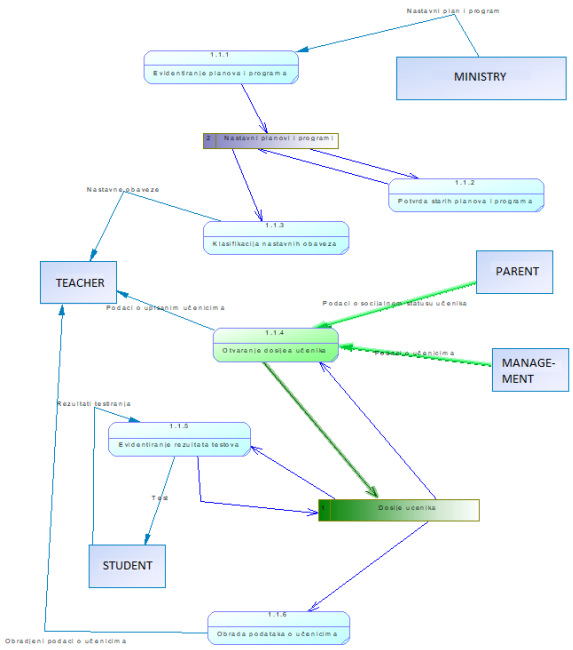

Figure 2. Business process model diagram

List of organized tasks performed by the school pedagogue are presented as data processes in this model which should be supported in new software:

TABLE I. PROCESS TREE

	Basic function	***Elementary and primitive business process***
1	School year preparation	1. Recording plans and programs 2. Confirmation of old plans and programs 3. Classification of teaching obligations 4. Opening students' files 5. Recording test results
2	Work during the school year	1. Student data processing 2. Analysis of students work and progress **3.** Forming a report to the ministry
3	Improving plans and programs	1. Collecting new knowledge documentation and literature 2. Curriculum changes

Next activity in IS development is designing data models. Two models are important: conceptual data model and physical data model. Conceptual model is abstract and independent from the implementation. Entities are defined based on data stores from previous model and data dictionary structure. Entities has attributes, identification attributes that are unique, established connections between entities, cardinalities and constraints arising from business.

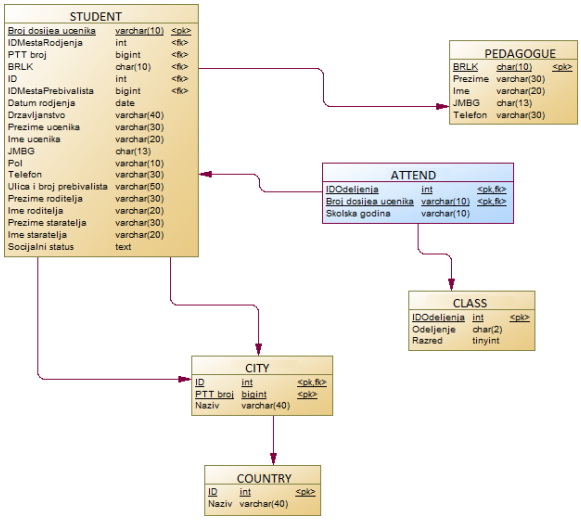

Figure 3. Physical data model diagram

Physical data model with its characteristics that correspond to relational database management software presents an appearance of database after implementation.

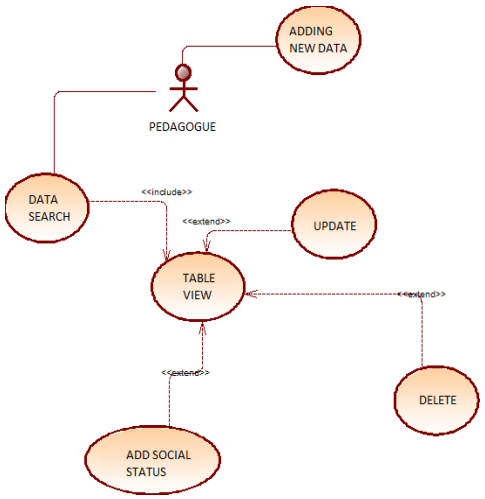

Figure 4. Use case diagram – Pedagogue software functions model for entering new data

Object oriented model of future software is based on the business process model process tree presented in table I, job description, requirements, and data models. It is done through the set of use case diagrams, where one of them is shown on figure 4.

This set of diagrams defines menus content, main menu items, as well as individual web pages functions with options available to the end user, i.e. pedagogue. Class diagram is done from data models and operations defined in business process model.

IV. IMPLEMENTATION

Implementation is based on all previously created models that are result of the design phase of IS development. Software was realized in PHP programming language with intensive usage of hypertext markup language (HTML), cascade style sheet (CSS), and JavaScript technologies. Web application was created as a solution that is nowadays programmers often use in the ICT world, together with mobile applications. Data models were implemented as a relational database created in MySQL database management system with PhpMyAdmin web application.

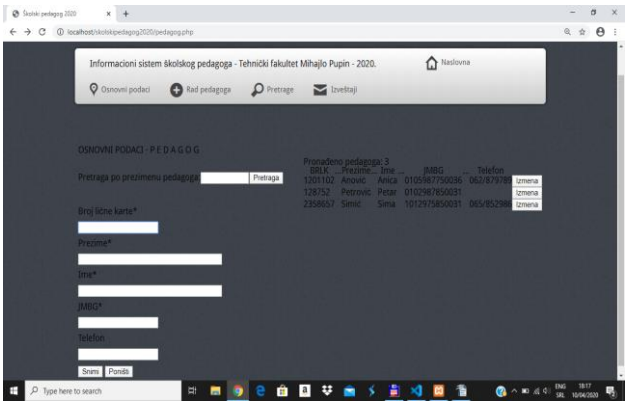

Figure 5. Web application page for entering data

Main menu is a drop-down style menu that has following items: basic data, pedagogue work, data search, and reports. Basic data menu items are pedagogue, teacher, city, country, class, and institution.

Pedagogue work menu has items defined from model process tree presented in the table I.

Database data entry for adding new pedagogue for example was realized with web pages that have forms for entering data like that is shown on figure 5. Source code for just a small part of this form in HTML language is:

```
<form action="pedagog.php" method="Post">
<table>
<tr style="float:left; clear:left; margin-
top:10px;"><td>First name*</td>
<td style="float:left; clear:right; margin-
top:10px;"><input type="text" name="firstname"
maxlenth=30 size=40 required
tabindex=1></td></tr>
<tr><td>
<input type="submit" name="save" value="Save"
tabindex=6>
<button type="reset" name="reset"
tabindex=7>Reset</button>
</td></tr> </table>
```

Users enter data in controls like input box, date time picker, list entry, etc. The entered values are stored in variables that are sent to other or same pages using the POST method and object. On second web page, data from variables are retrieved into the second set of defined variables. Next step is opening the connection (with four parameters: server name, user name, user password, and database name) to the database with the mysqli_connect PHP function, creating the the insert SQL statement which is then executed with the PHP built-in function mysqli_query. Messages are necessary for informing the user what happened at the end of execution of this software function. For this purpose was used echo command.

```
<?php
$server = "localhost";
$user = "root";
$password ="";
$database = "pedagogue2020";
$brlk=$_POST['brlk'];
$lastname=$_POST['name'];
$firstname=$_POST['firstname'];
$jmbg=$_POST['jmbg'];
$tel=$_POST['tel'];
$dbconnection=mysqli_connect($server,$user,
$password,$database);
if(!$dbconnection)
{echo('No connection with the database server!');}
else
{$query="Insert into pedagoguetable values
('$brlk','$firstname','$lastname,'$jmbg','$tel')";
$resultset=mysqli_query($dbconnection,$query);
if ($resultset)
{echo "pedagogue".$firstname.' '.$lastname."
successfully added into the database!"; }
else
{echo " pedagogue .$firstname.' '.$lastname. " not
successfully added to the database. Error, check the
data entered on previous page!"; }
}?>
```

Updating and deleting entered data from the database is done like the previous input with difference in the SQL query only.

The SQL query for updating pedagogue data in the database:

```
$query="Update pedagoguetable set brlk='$brlk', fir
stname='$firstname, name='$name, JMBG='$jmbg',
Telephone='$tel' where brlk='$id';";
```

The SQL query for deleting data about the student from the database:

```
$query="Delete from `studenttable` where `brdos`=
$brojdos;";
```

Data search as a very important task in IS. It was done by entering the criteria for search in a small web form. Then the PHP page was reloaded and checked whether the search button is pressed with the previously mentioned post HTML method, and if it is pressed then the search word is retrieved from the post method variable, the connection to the database was established, SQL select statement was formed and finally executed on the same way as it was done for insert.

Select SQL query example:

```
$query="Select * from studenttable, city, country w
here studenttable.RBa=City.RB and City.ID=Countr
y.ID and `brdos` like '%$search1%' and `firstname`
LIKE '%$search2%' order by ` firstname
`, `Lastname`;";
```

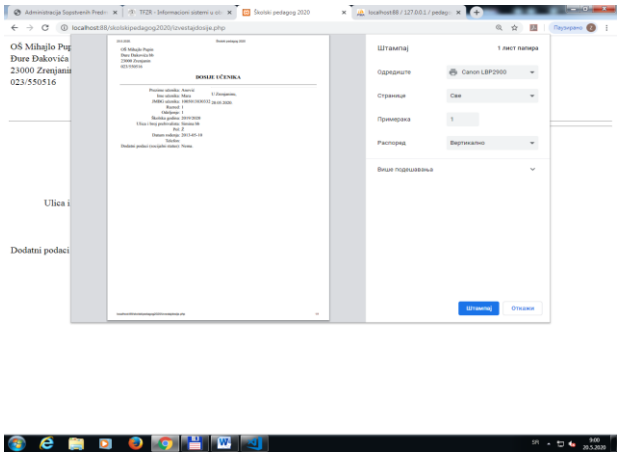

Figure 6. Report generated in IS web application

Reports are done as a printer-friendly pages without web design elements with white background color. Data on this pages are displayed in tables without borders with <table>, <th>, <tr>, <td> HTML tags. Working data that was read from database on the same way as it was done for data search.

V. CONCLUSION

Pedagogue information system could be used to improve the school management work because it is suitable for planning, monitoring and evaluation of school operations.

It was developed as a teaching example at University of Novi Sad, at Technical faculty "Mihajlo Pupin" in Zrenjanin, during the realization of the "Information systems in education" course on the final, fourth year of study at bachelor's degree.

Further system development could include programming the mobile version of application for Android and IoS operating systems.

Upgrading function could be multiuser function with authentication and login form at the beginning, so two or more pedagogues or other users could use this information system.

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Locus of control in the function of improving work with students – Pilot research

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Abstract – This paper represents the results of a research focused on analyzing locus of control in function of improvement working with students. The subject of research is defining presence of a particular type locus of control at students. The subject of research is also statistical relationship of locus of control and satisfaction with teaching staff, grades/success, provided knowledge and relations with colleagues. Research has been conducted during November of 2019. and sample had N=60 examinees. Methods used in data processing were variance analysis and regression analysis. In the research was also used locus of control scale (Julian Rotter) which was defined as independent variable. As dependent variable was defined dimension which represents student satisfaction, which contains four item (satisfaction with teaching staff, grades/success, provided knowledge and relation with colleagues). This is a pilot research, which could expand depending on a new items of dimension chosed as a dependent variable. Research result showed that locus of control has a strong negative statistically impact on the satisfaction with professors and assistents in teaching and grades/success, and that it has a positive impact on relations with colleagues, while it has no impact on the satisfaction with obtained knowledge.

I. INTRODUCTION

Students positive reactions on changes in education, learning process and extra effort, depends a lot on teaching staff (professors and teaching assistant) and their will to motivate students. Key mission of professors/teaching assistants is not only to teach particular science field, but also to motivate students to use their maximum potential, so they can accomplish vision and mission of their careers. Good professor/teaching assistant has to be a good pedagogue. It's very important for them to know how to approach to their students. Observing their personality helps in this. It is necessary to realise what kind of personality do they have, and to know all about influences of different motivators on different types of personalities. Psycho-moral and socio-demographic characteristics of working staff affects on their behavior towards particular job and other people. Observing psychological side of people can help in prediction of their behavior. Motivating students relative to their locus of control represents motivation on psychological aspect. Analyzing the students' locus of control represents their psychological analysis. It was taken as a starting point for personality analysis, and for improvement of their results and better socialization.

The position of control is psychology term that refers to a person's opinion about the causes of accomplished results in life. The concept of locus of control in psychology was introduced in 1966. This concept derivatives from a theory of learning introduced by Julian Rotter in the mid-twentieth century. Also, this concept was originally developed within the theoretical framework of Julian Rotter's theory of social learning. Rotter describes locus of control as a hypothetical construct that refers to the level in which individual believes that the appearance of reinforcement is contingently related to his own behavior [1]. Expectancy factors are called external and internal control. Internal locus of control refers to the perception in which positive or negative events are consequence of their own acts and they are under the personal control. External locus of control refers to the perception in which positive or negative events are not connected with own behavior in specific situations, so then they are out of personal influence. Generally speaking, the locus of control can be seen as a behavior in function of expectations and substantiation in a specific situation. While studying individuals in therapy, Rotter observed that:[1]

1. Different people in the same learining conditions, learn different things;
2. Some people respond quite predictably, others less, while some unpredictably;
3. Some people have strong and direct connection between their behaviors and the rewards they receive.

In his research, Rotter notes that rewarding or punishing a particular individual behavior strengthens the expectation that the same behavior

will trigger similar reactions (positive or negative) in the future. The level of expectations about the repetition of similar consequences was higher in persons who believed that they were dependent on their own behavior and actions, or on themselves. Rotter also thinks that the beliefs are events that have happened as a result of internal or external actions, that were made by one of the characteristics of personality. Several studies show that the locus of control, defined as individuals' tendency to believe that they may or may not control their environment and the course of events, plays a role in the way that individuals perceive their environment [1].

This research shows that it is very important for professors/teaching assistants to take the role of leaders who will help their students to act in accordance with their personality and sense of belonging.

II. THEORETICAL FRAMEWORK

The results of the research, which relate to the internal-external locus of control (behaviors that are characteristic of internal personality types), showed that top managers and leaders would be persons of internal locus of control, which means that students of management should have this characteristic [2].

The research that was supposed to show the impact of gender, locus of control, love of money and economic status on students ethical perceptions gave the following results: gender and internal locus of control positively affects on students' ethical perceptions, and love of money has a negative impact on ethical student's perception, while economic status has no effect on ethical student's perception [3]. According to research results, in most cases students hate failure, most believe that there is no perfect solution in real life, and when they are insecure and need to make an important decision, they usually consult with someone more experienced in that field [4].

The basis of the research conducted by Sari and Fakhruddiana was to determine the relationship between the internal locus of control and social support, with the delay of thesis preparation by students [5]. The regression analysis showed a very significant relation between the internal locus of control and social support with the delay in completing the thesis, as well as a negative relation between the internal locus of control and the delay of completing the thesis. This means that the lower internal locus of control is, there is a higher level of delay in preparing a thesis for students. The same results happened with the relation between social support and the delay in submission of the thesis, the lower level of social support results with the higher delay in completing the thesis by students. The research it was conducted to determine the influence of locus of control on the relationship between social exclusion and characteristic choices (unique choices). The results of this study show that participants who believed that the environment controls their fate (external locus of control) preferred more unique choices in the context of social exclusion than inclusion, while participants who believed that they could control the environment (internal locus of control) preferred less characteristic choices and less social exclusion [6].

The research conducted at the University of Botswana was intended to show an association between the external locus of control and depression among postgraduate students, as well as the influence of age and gender on this relation. The results showed that of the 272 students, 47.3% had low level of depression, 23.4% had mild level of depression, 18% had moderate level, while 11.3% had high level depression. Both internal and external locus of control, along with age, showed a 31% difference in depression scores, while gender did not affect significantly to depression levels. Results direct attention to locus of control as one of the cognitive variables associated with depression [7]. The research obtained result revealed that there was no significant gender and age difference found in the big five and locus of control. Further, there is no significant relation between locus of control in the big five personality characteristics [8]. The academic locus of control plays an important role in explaining student behavior in education. According to research, the mean level of locus of control was determined at students of pedagogical formation. Also, it was concluded that the internal and external locus of control did not vary depending to gender and year of study, but did vary depending on the age of the subjects. It was found that the level of student satisfaction in the pedagogical formation is significantly related to the external locus of control, while is not to the internal and academic locus of control [9].

The research conducted in Pakistan among graduates showed that men have an internal locus of control, while women are highly oriented towards an external locus of control [10]. The research conducted by Gifford, Mianzo, and Briceno-Perriott on a sample of 3000 first-year students, found that students who enrolled in faculty with lower scores according to the internal locus of control, scored

significantly higher grades than those who had more external on the same scale [11]. French also examined the locus of control from the aspects of personality variables of the work locus of control (WLOC) for examinees. Work Locus of Control (WLOC) is the level in which individuals feel that they have an impact on work-related rewards or penalties. Those with an internal locus think that they have control, while those with an external locus believe that rewards are more governed by external factors such as the happiness or actions of others. The results compared the perception of stress and the prevalence of job unions for those with an external locus, compared with those with more internal WLOC. Those with an external locus were found to be more likely to experience both, interpersonal conflict at work and organizational constraints. They showed lower affective prosperity, also experienced lower feelings of satisfaction, and had lower physical prosperity. Respondents with an external locus scored lower in terms of job satisfaction. The results support the existing literature and identify that perceptions of job stress and job tasks are in a function of personality and environment [12].

III. METHODOLOGICAL PART

A. Subject and problem of reasearch

The subject of the research is directed towards observing students' satisfaction with the teaching staff, grades/success, the knowledge provided and the relationship with their colleagues. The focus was on observing motivators that influence student behavior from the aspect of locus of control. The subject of the research is based on determining the psychological aspect in approach to students. The subject of the research is based on determining the psychological aspect in approach to students. Based on personality type - the type of locus of control that is taken as a benchmark in this research that influences students' further view and behavior toward studying and which builds their stance on particular segments of studing. The research problem deals with the formation of an optimal approach to students in relation to their locus of control. We were guided by the fact that, if we estimate what affects on students in terms of creating their relationship to education, it can be easier to manage and improve their work and productivity level.

B. Reasearsh question

The research subject can be presented through the following research questions (Figure 1):

IP1: Is there a statistical relation between locus of control and satisfaction in relationship with teaching staff?
IP2: Is there a statistical relation between locus of control and satisfaction with grades / success?
IP3: Is there a statistical relation between locus of control and satisfaction with the provided knowledge?
IP4: Is there a statistical relation between locus of control and satisfaction with relationships with colleagues?
IP5: Is there a statistical relation between the locus of control and the student satisfaction dimension?

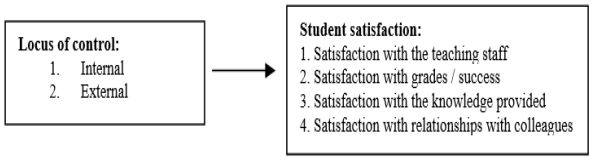

Figure 1. Presentation of research question of influence of locus of control on student satisfaction

C. Research tasks and goals

Examinees' characteristics are unavoidable factor that shapes and influences on their attitude towards study. When we consider characteristics of the subjects, the goal is to examine do their psychological characteristics influence on satisfaction of certain segments during the study. We assume that the characteristics mentioned above, form and shape the views of the examinees. We observe attitude through thinking, emotions and actions that a person has toward a particular phenomenon (things, people, situation). The research goal was to determine what has influence on development of students' satisfaction from the locus of control aspect.

IV. RESEARCH

Sample - The sample of examinees includes students of undergraduate and graduate studies N = 60, who studied Locus of Control within the courses of Organizational Behavior and Human Resources Management.

A. Operationalization of variables in research

Dependent variable - we observe student satisfaction dimension, as a dependent variable, which includes four items: satisfaction with the teaching staff (professors/teaching assistants), grades/success, knowledge provided and relationships with colleagues.

Independent Variable - we observe the locus of control of the examinees as an independent variable. The locus of control is operationally defined by applying the measuring scale of the Rotter's Locus of Control through 29 items. The factors of the locus of control are: 1.Internal locus of control: Individuals with a large internal locus of control believe that events are primarily caused by their own behaviors and actions and 2. External locus of

control: individuals with big external locus of control believe that fate or chances primarily determines events [13].

B. Measuring instruments

The student satisfaction scale contains only four items: satisfaction with the teaching staff, grades/success, provided knowledge and relationships with colleagues. Satisfaction is measured by a Likert scale from 1 to 10, where 1 represents total dissatisfaction, and 10 represents complete satisfaction.

The locus of the control scale is measured by the Rotter scale of the Locus of Control. The Rotter's Locus of Control scale of internal versus external locus of control, consists of 29 items, with a choice of alternatives a and b. Items scores are binary variables - 0 and 1, and the total score is expressed as the sum of points on 23 statements (6 items are not scored; they only serve to disguise the purpose of the test). A higher number of points indicates a higher level of externality, and the range of results is 0-23 [14]; [15]. Where high score = external locus of control, and low score = internal locus of control. We estimate that internal consistency is between 0.65 and 0.79. The test-retest reliability rating of Rotter's Locus of Control Scale is between 0.49 and 0.83. Correlation from the Marlowe-Crowne aspect of social desirability is between -0.41 and -0.12.

C. Methods and organiyation of data processing

In the empirical part of the paper, the survey method will be used. The research was conducted during November 2019, and data was processed in IBM SPSS Statistics Version 21. After inserting results into database, data were analyzed using standard statistical descriptive methods and inference statistics procedures. Regression analysis was used as a statistical data processing method. Qualitative, descriptive and analytical methods were applied in the research. The research methodology during that period also included theoretical analysis related to the following areas: psychological factors, locus of control, relationship with students.

Descriptive Statistics

	N	Mean	Std. Deviation
Dimension of study satisfaction	60	25,58	3,259
I am satisfied with the professor's attitude towards the students	60	7,20	1,725
I am satisfied with the relationship with my colleagues	60	6,75	2,222
I am satisfied with the grades i get	60	6,52	2,013
I am satisfied with the knowledge provided	60	5,12	1,776
Valid N (listwise)	60		

V. RESULTS AND DISCUSSION

The research was directed to determ the correlation between the locus of control of the respondents with their satisfaction with the teaching staff, grades / success, knowledge provided and relations with colleagues. Subject of the research was presented through 5 research questions, which will be answered below.

During the data processing, descriptive statistics dimensions of the student satisfaction were first produced and presented (Table 1). This table contains every specific item and dimension. Based on the results, the mean value of the speech is 25.58. Answers were scored with a Likert scale of 1-10, but for the purposes of the study, we use the score of items dimension. Maximum score is 40 and it represents complete satisfaction of the mentioned segments. It can be concluded that students are slightly more than average satisfied with the segments of study. First item representing students' satisfaction with the teaching staff is their attitude towards students, and it was rated 7.20. Grades were ranged from 1 to 10, so it can be concluded that students are satisfied with the professors' attitude towards them. This item has the highest satisfaction rating compared to the other three items. When we observe second dimension item that represents relationship satisfaction with colleagues, we get average score of 6.75, which is above average satisfaction. The third item that represents satisfaction with the grade success is 6.52, which is also above average satisfaction. Satisfaction with the provided knowledge was given an average score of 5.12. According to statistics, conclusion is that the students are satisfied with the study segments. According to the students, each segment should be improved, especially course materials and the methods of teaching. Materials which contain current business trends, should have the influence on the curriculum. They should not be outdated. It is also very important for knowledge to be practical and applicable in practice.

Table 1. Showing the descriptive statistics of the student satisfaction dimension

The first research question in the paper was “Is there a statistical relation between locus of control and satisfaction with the teaching staff?”. In the table number 2 we can see the influence of the locus of control on the satisfaction of the teaching staff through regression analysis. Based on the results, we can conclude that the locus of control has a direct and very significant statistical influence on the satisfaction of the professor / teaching assistant relationship with the students.

Table 2. Showing the influence of locus of control on teacher satisfaction with staff through regression analysis

Coefficientsa

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	12,585	,505		24,924	,000
	The score of locus of control	-,476	,043	-,823	-11,023	**,000**

a. Dependent Variable: I am satisfied with the professor's attitude towards the students

The second research question that was asked in the paper was "Is there a statistical relationship between control locus and satisfaction with grades / success?" In the Table 3 (Table 3) we can see the influence of control locus on satisfaction with grades / success through regression analysis. Based on the results, we can conclude that the locus of control has a direct, statistically significant and very strong influence. When looking at the direction, it can be seen that people with an internal locus of control are more satisfied, as in the case of the past question.

Table 3. Showing the influence of locus of control on satisfaction with grades / success through regression analysis

Coefficientsa

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	12,678	,612		20,713	,000
	The score of locus of control	-,544	,052	-,807	-10,404	**,000**

a. Dependent Variable: i am satisfied with the grades i get

The third research question that was posed in the paper was "Is there a statistical relationship between the locus of control and the satisfaction with the provided knowledge?" In the following text, Table 4. (Table 4.) shows the influence of the locus of control on the satisfaction with the provided knowledge through regression analysis. We can conclude that the locus of control has no direct influence and is not statistically significant. From this we can also conclude that the type of locus does not affect in the students opinion that the knowledge provided to them is adequate.

Table 4 Showing the influence of locus of control on knowledge satisfaction provided through regression analysis

Coefficientsa

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	5,833	,909		6,413	,000
	The score of locus of control	-,063	,078	-,106	-,814	**,419**

a. Dependent Variable: I am satisfied with the knowledge provided

The fourth research question in this paper was "Is there a statistical relation between locus of control and satisfaction with colleague relationships? "In the further test, Table 5. (Table 5.) shows the influence of locus of control on satisfaction with colleagues through regression analysis. Based on the results, it can be concluded that the locus of control has a statistically direct , significant and very strong influence. When we observe direction,we can see that people with an internal locus of control are less satisfied with their relationship with colleagues, and that students with an external locus of control are more satisfied. It is known that people with an internal locus of control are more self-oriented, while those with an external locus are more oriented to others. This result was expected.

Table 5 Showing the influence of locus of control on satisfaction with colleagues through regression analysis

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	,138	,709		,194	,847
	The score of locus of control	,584	,061	,784	9,634	**,000**

a. Dependent Variable: i am satisfied with the relationship with my colleagues

The fifth research question in this paper was "Is there a statistical relationship between the locus of control and the dimension of student satisfaction?". In the following text, Table 6. (Table 6.) shows the influence of the locus of control on the dimension of student satisfaction through regression analysis. Based on the results, we can conclude that the locus of control has a statistically significant direct influence. When looking at the direction, it can be seen that people with an internal locus of control are more satisfied, and students with an external locus of control are less satisfied. As people with an internal locus of control feel that everything depends on them, the resulted sense of satisfaction was also expected as something for what they are responsible. Consequently, it is in the nature of man to feel pleasure, and therefore he also tries to feel it and to experience things satisfactorily. In contrast, people with an external locus of control feel that they cannot influence on the things around them so much, including their satisfaction, as confirmed by these results.

Table 6 Showing the influence of locus of control on satisfaction with the student satisfaction dimension through regression analysis

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	31,233	1,492		20,927	,000
	The score of locus of control	-,499	,128	-,457	-3,912	**,000**

a. Dependent Variable: dimension of study satisfaction

VI. CONCLUSION

This paper presents a pilot research focused at the analysis of locus of control in the function of improving work with students. Factors that influence on students' attitudes toward study were

examined. The locus of control was taken as a factor which influences on students' attitudes towards segments of study, and also he creates them. The most important result is the influence of the locus of control on the student satisfaction dimension. Based on the results, it can be concluded that the locus of control has a direct influence and is highly statistically significant. Looking at the direction, it can be seen that people with an internal locus of control are more satisfied, and students with an external locus of control are less satisfied.

When observing the relations of the locus of control separately, with the items, different statistical results are obtained. The first result, showed that the locus of control has a direct and very significant negative statistical effect on the satisfaction of the professor / teaching assistant relationship with students. The lower locus of control causes greater satisfaction. Also we can conclude from the second result-item that the locus of control has a direct and statistically significant very strong influence, and that the direction is also negative, as in the case of the past result. The third result-item which observes the influence of the locus of control on knowledge satisfaction, gives a different result, where there is no statistically significant effect. The fourth result-item shows that the locus of control has a very strong statistical effect on the satisfaction with colleague relationship, which is different from the other two results. It means that people with an internal locus of control are less satisfied with their relationship with colleagues, and that students with an external locus of control are more satisfied. This research is a pilot study, which later could be expanded. Firstly, with comparison to the extension of a dimension as a dependent variable, it would add elements such as: tuition fees, courses, technical conditions, practices/projects, etc. Also in the next research some other independent variables will be added, to measure what else does affect to the attitude of the students. It is recommended to expand the sample size, so the results can be more relevant.

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Application of Sensors in Real Time Systems for Optimizing Industrial Processes in Chemical Facilities

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***Abstract*: An overview of automated industrial plant and its architecture has been discussed briefly in this paper. The content herein is very educative at introductory stage to concept of Industrial Automation and Informative about latest trends in Industrial Automation. Mineral processing and Chemical producers are building new plants need technologies that help them get the most from their assets, while also helping them minimize safety and quality risks. The ability to accurately measure valuable elements and minerals is critical for optimizing processes. Our emerging sensor technologies provide real-time results, opening up opportunities to make significant cost savings and increase mineral recovery rates.**

I. INTRODUCTION

Today we can witness many examples of mechanization in the most diverse areas of human activity. In the agricultural sector, the application of the means of mechanization (tractors with trailers, combines, etc.) is the most direct replacement of human energy with other types of energy. In the mechanical industry, there are tools for mechanization of the various craft works (pneumatic and electrical devices for carrying out various locksmithing works), which have facilitated the work of the worker and increased the productivity and quality of the work. In everyday, domestic work, the most widely used means for mechanization, picking up from the tools for processing wood and metals (various electric chains, asses, etc.), and all the way to the asset for working in the kitchen (electric mixers, machines for melting, etc.). In the modern conditions of living in the reproduction processes, the mechanization of the transfer of various goods occupies a significant place, both in the production facilities itself, as well as in the loading, unloading or loading of goods in transport vehicles and landfills (transport lanes, elevators, villa sharks).

Jointly for all the above-mentioned means of mechanization, they need direct participation of the people in their management, in the execution of the foreseen technological process.

Improvements to the machinery for mechanization, as well as the ever increasing demands for increased productivity and quality, have further increased the process of managing the machines. This imposed the need for the liberation of the man and the function of the manager of the means of mechanization, and the term automation, which characterizes the stage of the liberation of the man and the management of the operation of mechanisms and machines, came to mind. The essential difference between automation and mechanization is precisely in the machinery of management. Mechanization is an inevitable prerequisite for automation, as the utilization of natural energy is a prerequisite for mechanization.

The automation of our wide application in all areas of human activity. This apartment is a symbol of modern life. In the most diverse industrial branches (the mechanical, wood, food, graphic, processing, etc.), the automatic machines and lines are widespread, and the automation is also represented in the traffic (traffic regulation, automatic management of transport means), links (automatic telephone exchanges), administration, etc. activities.

II. AUTOMATION AND AUTOMATIZATION OF PROCESSES

Automation is closely related to the concept of automation. When we talk about the automation today, we think about modern machines, modern universal ships, computers and robots. In addition, we do not think that the principles and laws on

which the automation is based are inherent in nature. History can be followed by the development of the various tools and devices they need for the people in their entire activity. The first man-made techniques were simple tools, work tools and weapons. Later, he invented everything that he had ever done, but in time again, he managed to imagine them creating such activities that he would perform them without his action. It is the beginning of the development of the area that we now call automation.

The automaton is a scientific-technical field, the subject of which is the study of the theory and the techniques of automatic control, and it also includes:

- investigation of the conditions and laws according to the different formations;
- investigate the conditions and laws according to which the automatic systems in which automatic control is provided;
- research, design and construction of technical means;
- analysis, synthesis (design) and construction of automated control systems. Also, you need to split yourself into automation. Automation is a branch of science and techniques that encompass information theory, the theory of automatic management of methods for processing and use of information (algorithms), the theory of connections and the principles of the management processes.

III. SENSORS, SIGNALS, AND SYSTEMS

A sensor is often defined as a "device that receives and responds to a signal or stimulus." This definition is broad. In fact, it is so broad that it covers almost everything from a human eye to a trigger in a pistol. The operator adjusts the level of fluid in the tank by manipulating its valve. Variations in the inlet flow rate, temperature changes (these would alter the fluid's viscosity and consequently the flow rate through the valve), and similar disturbances must be compensated for by the operator. Without control, the tank is likely to flood, or run dry. To act appropriately, the operator must obtain timely information about the level of fluid in the tank. In this example, the information is generated by the sensor, which consists of two main parts: the sight tube on the tank and the operator's eye, which produces an electric response in the optic nerve. The sight tube by itself is not a sensor, and in this particular control system, the eye is not a sensor either. Only the combination of these two components makes a narrow-purpose sensor (detector), which is selectively sensitive to the fluid level. If a sight tube is designed properly, it will very quickly reflect variations in the level, and it is said that the sensor has a fast speed response. If the internal diameter of the tube is too small for a given fluid viscosity, the level in the tube may lag behind the level in the tank. Then, we have to consider a phase characteristic of such a sensor.

In some cases, the lag may be quite acceptable, while in other cases, a better sight tube design would be required. Hence, the sensor's performance must be assessed only as part of a data acquisition system.

The purpose of a sensor is to respond to some kind of an input physical property (stimulus) and to convert it into an electrical signal that is compatible with electronic circuits. We may say that a sensor is a translator of a generally nonelectrical value into an electrical value. When we say "electrical," we mean a signal, which can be channeled, amplified, and modified by electronic devices. The sensor's output signal may be in the form of voltage, current, or charge. These may be further described in terms of amplitude, polarity, frequency, phase, or digital code. This set of characteristics is called the output signal format. Therefore, a sensor has input properties (of any kind) and electrical output properties.

The term sensor should be distinguished from transducer. The latter is a converter of any one type of energy into another, whereas the former converts any type of energy into electrical energy. Transducers may be used as actuators in various systems. An actuator may be described as an opposite to a sensor; it converts electrical signal into generally nonelectrical energy. For example, an electric motor is an actuator; it converts electric energy into mechanical action. Another example is a pneumatic actuator that is enabled by an electric signal.

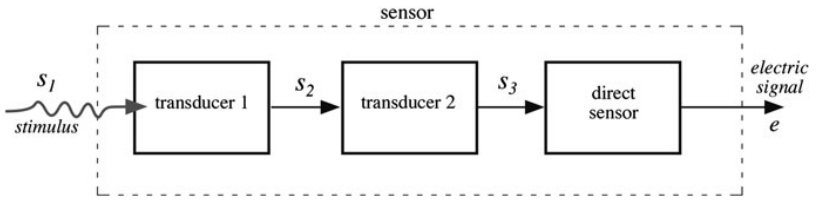

Figure 1. A sensor may incorporate several transducers. s_1, s_2, and so on are various types of energy.

IV. TRANSFER FUNCTION

An ideal or theoretical input–output (stimulus–response) relationship exists for every sensor. If a sensor is ideally designed and fabricated with ideal materials by ideal workers working in an ideal environment using ideal tools, the output of such a sensor would always represent the true value of the stimulus. This ideal input–output relationship may be expressed in the form of a table of values, a graph, a mathematical formula, or as a solution of a mathematical equation. If the input–output function is time invariant, it is commonly called transfer function.

The transfer function represents the relation between stimulus s and response electrical signal S produced by the sensor. This relation can be written as S 1⁄4 f(s).

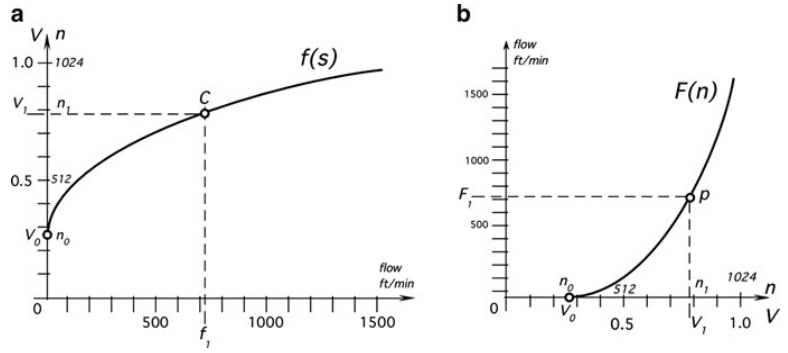

Figure 2. Transfer function (a) and inverse transfer function (b) of a thermo-anemometer

Normally, stimulus s is unknown while the output signal S is measured. An inverse $f^{-1}(S)$ of the transfer function is required to compute the stimulus from the sensor's response S.

V. MATHEMATICAL MODEL

Preferably, a physical or chemical law that forms a basis for the sensor's operation should be known. If such a law can be expressed in form of a mathematical formula or model, often it can use to calculate the sensor's inversed transfer function by inverting the formula and computing the unknown value of s from the measured S. For example, if a linear resistive potentiometer is used for sensing displacement d, an Ohm's law can be applied to compute the transfer function. In this case, the response S is the measured voltage v and the inverse transfer function F(S) can be given as

$$d = \frac{v}{E} D,$$

where E is the reference voltage and D is the maximum displacement (full scale); both are constants. From this function we can compute displacement d from the measured voltage v. In practice, readily solvable formulas for many transfer functions, especially for complex sensors, do not exist and one has to resort to various approximations of the direct and inverse transfer functions.

VI. CHEMICAL SENSORS

In industry, chemical sensors are used for process and quality control during plastics manufacturing and in the production of foundry metals where the amount of diffused gasses affects metal characteristics such as brittleness. They are used for environmental monitoring of workers to

control their exposure to dangers and limit health risks. Chemical sensors find many new applications as electronic noses. An electronic nose generally uses different types of sensor technologies in order to mimic the olfaction capabilities of mammals. In medicine, chemical sensors are used to determine patient health by monitoring oxygen and trace gas content in the lungs and in blood samples. These sensors are often used for breathalyzers to test for blood alcohol levels and as indicators of the digestion problems of patients. In the military, chemical sensors are used to detect fuel dumps and to warn soldiers of the presence of airborne chemical warfare agents. Chemical sensors are used to detect trace contaminants in liquids, and, for example, they are used to search for and monitor ground water contamination near military, civilian, and industrial sites, where significant amounts of chemicals are stored, used, or dumped. Combinations of liquid and gas sensors are used in experimental military applications to monitor compounds produced from refineries and nuclear plants to verify compliance with weapons treaties.

VII. APPLICATION OF SENSORS IN INDUSTRIAL PROCESSES WITH THE EVOP (EVOLUTIONARY OPERATION) METHOD

Modern industrialization and the breakthrough of modern industrial processes comes as a result of implementation and utilization of information technology, advances in programming and software engineering, and all available tools that support the optimization and automation of all processes. Applied computer programs for calculation of technological indicators in mineral technology, economic and technical efficiency – show modest results in the process of optimization of all processes.

The need for optimization comes from the aspect of business and economic trends, management, industrial and other processes. The need for continuous improvement is a key aspect in management; whether there is a need for increase in production of raw materials, or increasing profits when investing in particular endeavor. Since there is only one answer to the problem, we need to choose the "best" solution (or more possible solutions to the problem). So, first the purpose of the problem has to be determined: is it ***economic*** or ***technical.***

Economic purposes can include: maximizing profit, minimizing costs etc. Technical purposes can include the following: higher annual production, minimal losses during the operation of a certain machine, greater productivity etc. It's understandable that in industrial optimization prevails the economic form of the goal. If the goal isn't previously determined, an improvement cannot be executed, because there is no basis for comparison of multiple solutions. The problem must be defined so that all its information can be in a quantitative form, and that is the ***function of the goal***, which is used to select decisions in the system's **changeables**.

Information on most cycles in the real environment, as well as in mineral technology, such as technological, i.e. the size of parameters in models from processing units in the cycle - require information on input or output parameters in the closed cycle. The size of the remaining parameters are calculated or derived from other measured characteristics. The full calculation of the data actually is far more complex and requires full study of the techniques that can be applied, including their advantages or disadvantages, which would be a subject of further study or elaboration.

Systems engineering can be defined as a conception, planning, designing and engineering of influential elements of each system which still exists in the moment of processing. System analyzes represent a scientific method for bringing decisions which are based on quantitative and other objective evaluations of all alternatives that exist in systems and which are upgraded during their processing. Operational research is defined as an application of mathematical models in the problem of optimization of the goal of every system that is previously defined. These three disciplines are very similar in their aims, but only operational research by nature and form are more mathematical, hence an important and often obligatory part of the other two disciplines.

For this purpose, an attempt is made in this paper is to add to the existing real time processes a sensor to appropriate segment of the industrial process to minimize the cost and not necessary over usage of chemical substances or reagents.

EVOP (evolutionary operation) is a method for optimizing industrial or technological processes during production. The EVOP method represents a simplification of the procedure of a two-factorial and three-factorial experiment. This method uses operational data from the production process in order to improve the conditions for the operation of the process, so as to achieve continuous improvement of the function's function of the target

in relation to the previously achieved. During the work two or three independent variables are considered (influential factors). With the assistance of ESOP, the effects of independent variables (influencing factors) and their interactions can be analyzed, with the task of providing data to the operator in order to systematically advance the production process in progress, i.e. to directly act and manage the production. With this method, the achievement of the goal is accelerated several times, and it is not necessary to stop the normal production or stop the process. The method is based on statistical concepts and it is possible to monitor the risk of error. The ESOP will rely on the concept: to accelerate the evolution of the natural process (technological) if changes are made, and then they are selected so as to lead to an optimal solution. These changes in the industrial process are, in fact, the different production conditions (values of the influential factors), but so limited that such changes cannot be achieved, for the market, unacceptable products or effects within unacceptable limits. The impact of those changes on the response surface, i.e. of the analyzed dependent variable is measured and compared with the limits of border error confidence, calculated on the basis of the data. Based on this, it can be assessed whether the induced changes (of factors) have produced visible effects. If it is shown that the new conditions have an advantage, the chance that appears in the set of the then-realized data (conditions), then passes to a new state, i.e. new values of influential factors (standards). Developing the EVOP procedure at a certain point (conditions) as the center of a new state, this moves the position of the conditions from one center to another, and this shift represents a shift to the optimal solution (optimal operating conditions).

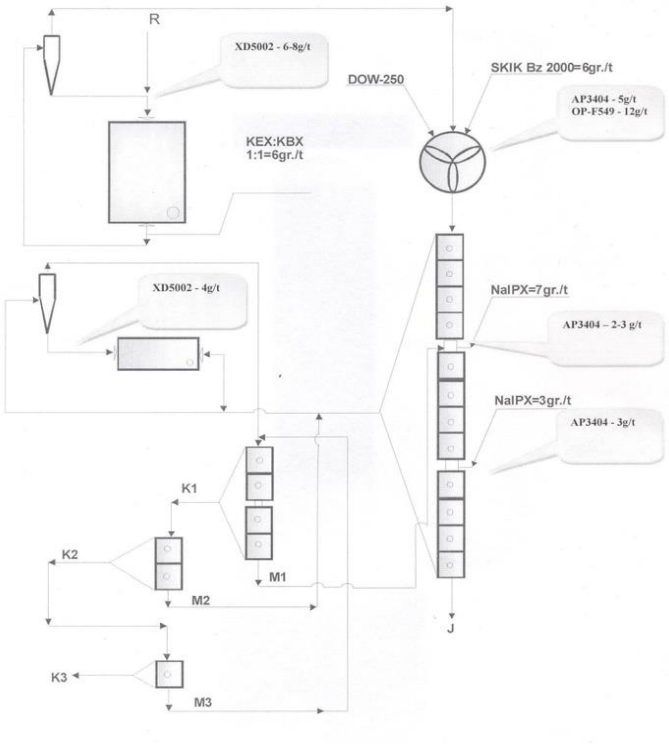

Figure 3. Reagent mode flotation in mine "X"

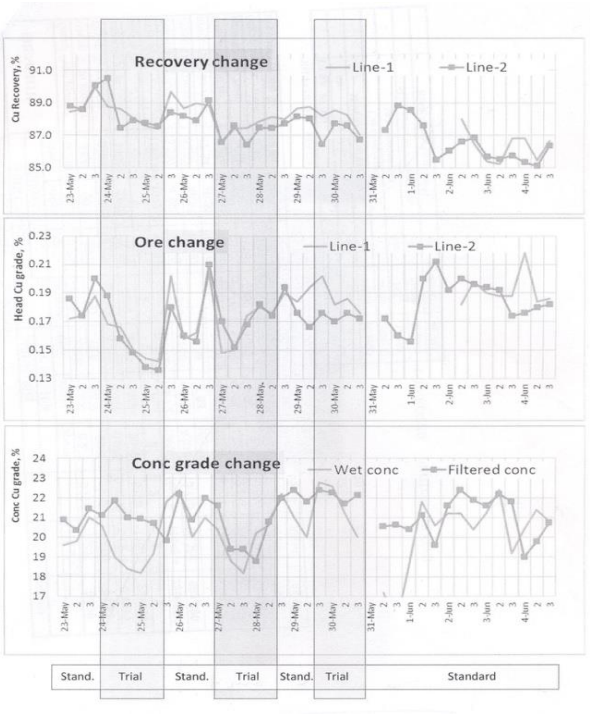

Figure 4. Obtained results in real terms

A. Laboratory tests for copper and gold (Cu / Au) in "X" mine with experimental plan

During the period of two years in the flotation of the mine "X", investigations were carried out with the change of the reagent regime, the fermentation of the ore and other parameters, which influence the utilization and quality of copper and gold in the concentrate. By adding chemical sensors to key segments of the industrial / chemical process itself we can change or even get better results on required mineral.

Table 1. Standard conditions for flotation in "X" mine

Experiment	Collectors, type	Collectors, gr/t	pH	Frothers, type	Frothers, gr/t
T – 1	BZ+KEX+KBX+NaIPX	22	11.8	DowF	20
T - 2	BZ+KEX+KBX+NaIPX	22	11.8	OP 549	20

Table 2. Investigated conditions for flotation - plan experiments (DOE)

Experiment	Collectors, type	Collectors, gr/t	pH	Frothers, type	Frothers, gr/t
T – 1	BZ+KEX+KBX+NaIPX	22	11.8	DowF	20
T - 2	BZ+KEX+KBX+NaIPX	22	11.8	OP 549	20
R-1	Aero MX-950	16	10.5		
R-2	AP-3418A	16	9.5		
R-3	Aero MX-5127	16	10.5		
R-4	AP-3418A	16	10.5		
R-5	5002	22	9.5		
R-6	5002	16	10.5		
R-7	AP-3418A	22	10.5		
R-8	Aero MX-950	22	9.5		
R-9	3404	16	9.5		
R-10	AP-3418A	22	9.5		
R-11	Aero MX-950	22	10.5	OP 549	20
R-12	Aero MX-5127	22	9.5		
R-13	3404	22	10.5		
R-14	5002	16	9.5		
R-15	5002	22	10.5		
R-16	Aero MX-5127	16	10.5		
R-17	Aero MX-950	16	9.5		
R-18	3404	16	9.5		
R-19	3404	22	10.5		
R-20	Aero MX-5127	22	9.5		
R-21(R-17)'	Aero MX-950	16	9.5		
R-22(R-11)'	Aero MX-950	22	10.5		
R-23(R-7)'	AP-3418A	22	10.5		

Table 3. Tests with a plan experiments on copper

Experiment	Quality, Cu%			Utilizing, Cu%	
	r	k	j	K	J
T – 1	0.29	2.3	0.053	83.4	16.6
T - 2	0.31	2.8	0.050	85.6	14.4
R-1	0.28	2.4	0.038	87.9	13.1
R-2	0.29	2.5	0.031	90.5	9.5
R-3	0.27	2.4	0.049	83.7	16.3
R-4	0.32	3.0	0.034	90.5	9.5
R-5	0.26	2.4	0.034	88.5	11.5
R-6	0.31	2.7	0.044	87.3	12.7
R-7	0.29	3.2	0.036	88.8	11.2
R-8	0.30	3.0	0.035	89.4	10.6
R-9	0.30	3.2	0.045	86.5	13.5
R-10	0.27	1.7	0.035	89.1	10.9
R-11	0.27	2.3	0.028	90.7	9.3
R-12	0.25	2.8	0.031	88.5	11.5
R-13	0.27	3.6	0.031	89.4	10.6
R-14	0.27	3.0	0.028	90.5	9.5
R-15	0.26	2.2	0.025	91.6	8.4
R-16	0.25	2.1	0.031	89.2	10.8
R-17	0.27	3.0	0.030	89.8	10.2
R-18	0.27	2.6	0.029	90.1	9.9
R-19	0.26	3.0	0.027	90.4	9.6
R-20	0.24	1.9	0.028	89.5	10.5
R-21(R-17)'	0.25	3.1	0.027	90.2	9.8
R-22(R-11)'	0.25	2.2	0.029	89.8	10.2
R-23(R-7)'	0.25	2.9	0.024	91.1	8.9

R-1 ÷ R-23 researches show that newly offered collectors at reduced pH values show satisfactory results for copper and gold separation (Table 1 and Table 2) and are relatively higher than the industrial results obtained for 2010 (Table 3). However, the required tests under different conditions performed under adequate conditions, somewhat confirm the industrial results in 2011/2012.

B. Optimizing the reagent regime in the phase of copper flotation in the mine "X"

On the basis of experiments carried out in laboratory and industrial conditions in copper flotation at mine "X", it came to the conclusion that future investigations should go in the direction of optimization with optimization methods that will optimize the reagent regime. Therefore, based on the industrial - laboratory null values of the collectors in the photovoltaic stages, analysis was carried out using the optimization technique.

Initial values of collectors in phases of flotation:
X1 - collector consumption NaIPX = 12 gr / t
X2 - collector consumption KBX: KEX = 1: 1 = 8 gr / t
X3 - collector consumption SKIK 2025 = 4 gr / t
Variable values of collectors at different stages of flotation:
ΔX1 - Collector consumption NaIPX ± 3 gr / t
ΔX2 - Collector consumption KBX: KEX = 1: 1 ± 2 gr / t
ΔX3 - Collector consumption SKIK 2025 ± 1 gr / t

Table 4. Tests with a plan experiments – "X" Mine

Experiment	X_o	X_1	X_2	X_3	I_1	I_2	$I_{Cu}\%_{av}$
1	+	15	10	5	90,13	89,05	89.59
2	+	15	6	5	90,52	87,90	89.21
3	+	9	10	5	89,18	88,80	88.99
4	+	9	6	5	86,66	87,22	86.94
5	+	15	10	3	89,10	87,22	88.16
6	+	15	6	3	88,60	90,48	89.54
7	+	9	10	3	88,90	89,62	89.26
8	+	9	6	3	88,00	87,08	87.54

Other operating parameters (pH = 11.72, 55-60% - 0.074 mm, flotation time (12 min) and conditioning (6 min)) standards as in industrial conditions. Two parallel investigations were carried out.
The coefficients of the linear model for the values for using the copper in concentrate $I_{Cu}\%_{av}$ are:
b0 = 1 / n [89.59 + 89.21 + 88.99 + 86.94 + 88.16 + 89.54 + 89.26 + 87.54] = 88.65
b1 = 1 / n [89.59-89.21 + 88.99-86.94 + 88.16-89.54 + 89.26-87.54] = 0.346
b2 = 1 / n [89.59 + 89.21-88.99-86.94 + 88.16 + 89.54-89.26-87.54] = 0.47
b3 = 1 / n [89.59 + 89.21 + 88.99 + 86.94-88.16-89.54-89.26-87.54] = 0.03
b12 = 1 / n [89.59-89.21-88.99 + 86.94 + 88.16-89.54-89.26 + 87.54] = - 0.596
b13 = 1 / n [89.59-89.21 + 88.99-86.94-88.16 + 89.54-89.26 + 87.54] = 0.26

b23 = 1 / n [89.59 + 89.21-88.99-86.94-88.16-89.54 + 89.26 + 87.54] = 0.24
b123 = 1 / n [89.59-89.21-88.99 + 86.94-88.16 + 89.54 + 89.26-87.54] = 0.18

C. Research on the linear model with modified reagent mode

Analyzing the linear model of the polynomial of the first order for the utilization of copper from the chalcopyrite ore, investigations were carried out by increasing the independent variable (x1-collector NaIPX) and increasing the independent variable (x2-collector KEX: KBX = 1: 1). The obtained results of the tests are given in Table 5.

Table 5. Tests with a plan experiments

Experiment	X_1	X_2	I_1	I_2	$I_{Cu\%av}$
1	15	10	90.0	89.2	89.6
2	**16**	**11**	**90.4**	**90.0**	**90.2**
3	17	12	90.1	89.3	89.7
4	18	13	89.7	89.3	89.5

Other operating parameters (pH = 11.72, 5560% - 0.074 mm, flotation time (12 min) and conditioning (6 min), X3 = 4 ÷ 6 gr / t) standards as in industrial conditions. Two parallel investigations were performed.

The use of copper in a concentrate ICu% is optimal, or it requires minimal insignificant increase in the consumption of the NaIPX collector = 15-16 gr / t, and an increase in KBX: KEX = 1: 1 = 1011 gr / t, based on the test representative sample, higher content of copper at the entrance, higher consumption of collectors and vice versa.

After determining the linear model and the adequacy, in order to arrive at the optimal values of the variable factors x_1 and x_2, another series of several experiments is performed. In addition, the signs in front of the coefficients of the variable factors b1, b2 show whether the value of the corresponding factors in those trials should increase (sign "+") or decrease (sign "-") proportionally to the size of their coefficients. In this way, the experiments are performed as long as the function Y gets a better value compared to the previous experiment.

VIII. CONCLUSION

In modern industrial practice (mineral technology, inorganic and organic technology, and other processes), more and more often goes to the application of a combination of program packages, software engineering, application of sensors or software development and optimization programming of existing processes in order to enable the first step towards proper optimization, and the possible automation of technological processes. Also, with the implementation and adding of sensors to the process, the process can be improved in its optimization.

Information about most cycles in the real environment or industrial processes requires information about the size or content for the input or output parameters in the closed loop. In most cycles, measurements are performed at the entrance to the process or cycle, that is, at the output of the manufactured products or occasionally on interstitial products. The sizes of the remaining parameters are calculated or derived from other measured characteristics, such as content distribution or sample size collected or taken at appropriate points in the cycle, emission of gases, optimal solvent content, or other. We can improve or make it easy to store od analyze data so the process can be more autonomous with the applying of the sensor on certain spot in the cycle or on specific machine to gather the date from the live cycle. The research of the performance of the cycle by applying mathematical simulation and optimization involves:

- Calculation of the full material balance of the cycle from incomplete data in the plant;
- Calculation of the model parameters from the complete data network in the plant;
- Optimization through the simulation of the personal computer cycle followed by optimizing tools and controlled by chemical sensors;
- Utilizing a personal computer for ready-made, developed or adapted computer programs for calculations, as well as using various software tools.

This technique can be used in automated optimization in almost all processes, where there are control variables and measurable targets, response-variables. Examples can be found in: refining (solvent extraction or ion exchange), pulp processes, various chemical products (paper machines, analytical chemistry, pharmacy), oil refineries and energy production plants, and more.

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Statistical Data for Modern Communication in Mathematics Subjects at Faculty

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Abstract - This paper specified the applications used for online teaching in the academic year 2019/2020 in both universities Goce Delcev, Stip and Mother Teresa, Skopje. Then two different questionnaires are listed for students from both universities in order to see their opinion on online teaching for all subject but especially for mathematics subjects. The results of the questionnaires are presented and conclusions from them are drawn. Finally, the opinions of the students from the two universities are compared in order to see if the opinions are the same, similar or different.

I. INTRODUCTION

The 2019/2020 school year was unusual for all primary, high schools and universities around the world, because one period of teaching had to be online. Of course, the same situation was in our country. In this paper our aim is the online teaching, especially online teaching for all mathematics subjects in Universities: Mother Teresa - Skopje and Goce Delchev - Stip.

Information and communication technology in the teaching process in Universities was introduced in the beginning of XXI century. Many universities in the Republic of North Macedonia have used the opportunities offered by e-learning and explored students' habits creating virtual learning environments [12]. The mathematics professors in the two mentioned universities have tried and taught the students to use the e-learning tool, so that the students already knew how to communicate with each other and with the teaching staff at any time and from any place. In paper [9] authors compare the achievements of students in Math 1 who use Moodle as a teaching tool with those who does not. They conclude how e-learning impacts on the success of the students based on the results obtained.

During the teaching process, several professors of mathematics at both universities included program packages for better visual presentation of mathematical problems. The programing packet MATHEMATICA offers an excellent possibility for visualization in math education, because it has a lot of built-in- functions. This packet enables authors of paper [10] to make highly abstract mathematical content more understandable to pupils and students. By using this packet, they find limit value of a sequence and function, derivate of a function… which leads to a simpler understanding of these notions. In paper [6] the authors considered question: Does the technical equipment of the classrooms bring better results in mastering the teaching program by the students? Also, authors determine the quality of knowledge which the students get, when learning the topic "Construction of triangle and quadrangle", with use of free software GeoGebra and informatics / mathematics approach, by comparing the achieved results on the diagnostic and the final test, of the experimental and the control group.

Both mentioned Universities were the subject of research in [1] and [3]. In [1] authors analyze and compare the final grades of the students from two Universities, Goce Delcev University - Stip, more specifically a group of students who studied in Kavadarci and students from the University "Mother Teresa" in Skopje, for Math subject. [3] was the beginning of the research in which authors have two groups of students, at two Universities: Mother Teresa Skopje and Goce Delchev - Stip. The students were process mathematical contents (algebra, geometry, analysis) in two different ways: the first group with GeoGebra and on a computer, and the other one without visualization and GeoGebra. Then a testing was done, the results were compared, and a conclusion was drawn.

At the Goce Delchev University, students were often tested electronic for the knowledge they gained in some mathematical subjects. As example, in paper [2] authors analyzed and compared the results of the electronic testing (e-testing) for the subject Mathematics 2 within Goce Delcev University – Stip using statistical data processing. Electronic testing covers the topic "Integral". [4] is a proposal how to improve the evaluation process in mathematics by using standardized electronic tests

created by multimedia software Wondershare QuizCreator software.

ICT in teaching process is very important also in primary schools. A research [5] was conducted in order to ensure valid and reliable assessment of the extent of ICT knowledge and skills of teachers in primary schools, to identify the factors in terms of teachers affecting the development of ICT competences, and to identify strategies to improve the development of effectiveness in the future. Paper [7] is focused on processes of modernization of teaching mathematics in primary schools by using ICT. The empirical results from the realized research shows that the Macedonian educational system should introduced and practiced ICT for math teaching. The survey has been conducted [8], in order to investigate the factors that affect the motivation of teachers to use ICT in their teaching and to maintain the same. In paper [11] are present the possibilities for revision and development of the curriculum of "Math Teaching Methods" related to Child-centered methodology and ICT integration.

Until the academic year 2019/2020, ICT was only an additional to the classic course of the teaching process. With the pandemic appearance, the online applications became a basic model for implementing the teaching process.

In Goce Delcev University online teaching was performed by Microsoft Teams. Microsoft Teams is a client that enables online interactive lectures. If you have a licensed Microsoft Office, you probably already have it on your device and all you have to do is to look for it in the menu of installed programs. The channel (separate virtual space) for different user purpose can be created, for example: you can create two channels for Lectures and Exercises. An online lecture can be scheduled by invitation through Outlook Calendar and New Teams Meeting. This option is proof that everyone has been correctly invited to listen the lecture. During the lecture you can watch the students if their cameras are turned on, interact with them using chat and discussion. All mathematics subject for students also were conducted online.

In University Mother Teresa online teaching was performed by Google Classroom, the free web service developed by Google.

II. RESEARCH METHODOLOGY

The research methodology consists of two questionnaires. The first questionnaire (Questionnaire 1) consists of 12 questions. This questionnaire is given in Table 1

TABLE I. QUESTIONNAIRE 1

Question	Possible Answer		
	Yes	No	I have no final attitude
1.Was it difficult for you to learn to use the application provided by your university for online teaching?			
2.Do you think the application you are using is good for the teaching?			
3.Do you think another application should be used?			
4.Do you think that the results of the students in the exams after the online classes depend a lot on the application that is used?			
5.Have you mastered the material enough with online teaching?			
6.Do you think there is a big difference between online and classical teaching?			
7.Do you think that teaching should be online and under normal living conditions?			

8.Do you think that online teaching is equally good for every subject?			
9.Is online teaching good for all math subjects?			
10. Do you agree that the exam session for math subject is good to get online?			
11. Do you mind that the results achieved as a result of online classes would be the same for math subject as those after classic classes?			
12. Would it be good to have consultations in the classic way with math subject teachers before the session?			

The second questionnaire (Questionnaire 2) consists of 4 questions seeking a complete answer.

Questionnaire 2

1. Which online teaching application do you know, have you tried to use, and would you like to use in teaching?

2. List the advantages and disadvantages of online classes.

3. Would the lack of communication with colleagues' face to face in online classes affect you badly?

4. Explain why online teaching is good/bad for all math subjects.

The questionnaires were answered by groups of 30 students from different school years, from both Universities in the period from 20.06.2020 to 28.06.2020 when the online teaching for the academic year 2019/2020 was completed.

III. MAIN RESULTS

First, we will show the results for Questionaire1 and Questionnaire 2 from Goce Delcev University - Stip. Question are answered in the same order how they are given above and the blue colored pillar displays the answers yes, the brown answers no and the gray answers: I have no final attitude.

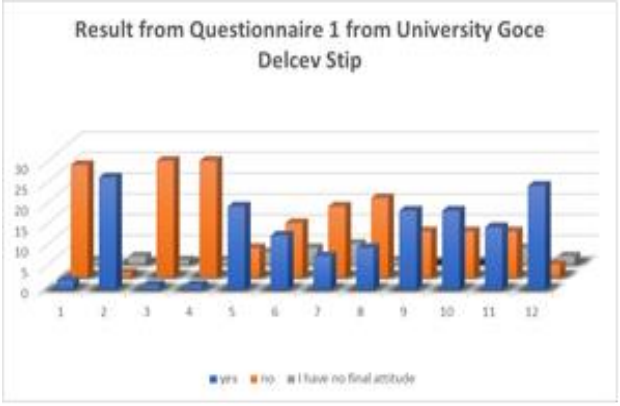

Figure 1. Results from UGD

Resultcs from Questionnaire1 can be clearly seen from the Fig.1. So, we can see that students didn't find it difficult to learn to use the application provided by their university for online teaching, they didn't thing to use another application for learning and also didn't think that the results of the students in the exams after the online classes depend a lot on the application that is used. Students also thing that it would be good to have consultations in the classic way with math subjects teachers before the session.

Results from Questionaire2 showed that students do not care about the platform used for online teaching. They know several other online learning apps like Zoom, Google Meet, Google Classroom … They believe that the application they use is not "to blame" for the disadvantages of online teaching. That is why they have no special interest in introducing a new application. According to them disadvantage of online teaching is the direct contact of a student-professor. They consider the advantages to be: 24-hour availability of the professors, the fast and simple communication and the availability of the learning material as opposed to the fact that during the class they mistype from the board. The absence of socializing during breaks between classes as a lack of online teaching was a serious problem for students as they often felt lonely, scared and worried. And almost everyone agreed that the absence contact with other colleagues negatively affects them primarily on their mental state. For math subject all students are thinking that online teaching does not bring same problems because in their teaching process before all teachers involve ICT. Math program as: GeoGebra, Wolfram Mathematica, Matlab, help them to solve many problems now and

before. They have previously attached work material to e-learning, they knew how to use e-learning, they had enough practice material and enough online contacts with teachers. Nevertheless, for the mathematics subjects, the students think that in normal living conditions it is best to hold classical classes because mathematics is not a simple science and mathematics is not easy to overcome. As a disadvantage they mention the absence of contacts with colleagues during the breaks when they explained the obscure tasks solved in the class among each other. Some of the weaker students point out the lack of face-to-face consultations with professors as a disadvantage. The disadvantage of online teaching that all students agree on is the need of modern technology (smartphone, laptop, computer, etc.) as well as the Internet. Many students who faced this problem were among the respondents.

Now we will show the results from University Mother Teresa - Skopje. The results for Questionaire1 from University Mother Teresa Skopje are given in Fig.2.

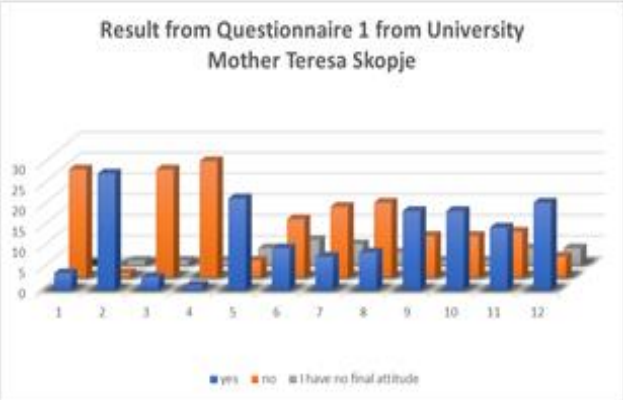

Figure 2. Results from MT

Results from Questionnaire 2 for the first question was the same as at University in Stip, that students do not care about the platform used for online teaching. They don't know other online learning apps. In relation to the second question as an advantage's student see the comfort of home for online learning and flexibility of communication with professors as well as the optimal studies costs. However, one of the biggest disadvantages of online learning is the need for information technology and the Internet. Regarding the question "Would the lack of face-to-face communication with colleagues in online classes affect you badly?", students unanimously answered "yes". Regarding the answer to the last question, there are a student who see online learning as good, but in global everyone shares the opinion that online learning of mathematics subjects is not an excellent method. They think that this way of learning is a good solution for the current situation, but they wish the previous way of teaching to be returned as soon as possible. Students think that physical presence teaching is appropriate in terms of mathematics subjects, due to the specifics of the subject and their habits created during the previous levels of education.

IV. CONCLUSION

The opinions of the students from both Universities on many of the questions coincide. This means that students share the same opinion and many of them want the teaching process to be online at least during the pandemic and then classical teaching to be returned. All the students think that there is no better way of learning than the classical teaching.

In general for all subjects at the end of the semester of 2019/2020 school year, almost 70% of the students from Goce Delcev University - Stip were satisfied with the online classes and said that they would continue the next semester with online if we still have the restrictions due to the pandemic. Many the students from University Mother Teresa - Skopje stated that in general for all subjects they do not feel as much prepared for online learning. Many of them support online learning only during a pandemic.

After the situation caused by the pandemic; education politics will have to change their ways of behaving in order to help students to enter in the digital world much more prepared. Confirmation for the well-done work for Goce Delcev University - Stip was given by "Microsoft". On their official website they published that Goce Delcev University is the most successful University in the Republic of North Macedonia in transition from physical to distance learning.

The new reality creates many challenges and seriously influences universities to change their profile in universities that are research competitive, information recognizable and accessible, so they need to constantly invest in advanced scientific and information technologies that will be available to all students.

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Recap on Social Media Impact on Education

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Abstract – Social media application on education is rather well investigated topic. However, due to the complexity of social media influence and other factors, its impact on education can' be pinpointed. Namely, there are positive and negative effects of social media and its use in curriculums. Whether there will a positive aspect or negative aspect of social media in education, depends on the environment and the individual teacher, learner, and groups of learners. In this paper a review on social media impact on education is conducted. In addition, guidelines and propositions regarding the use of social media in classrooms is discussed. The main goal is to review the existing body of literature and to address the ever-growing necessity for social media use in education due to the current pandemic situation. This introductory review paper aims at concisely presenting the key factors of social media presence in the education system. Overall, the paper provides a solid basis for future empirical studies and even for meta-analyses.

I.INTRODUCTION

Social media has become an inseparable part of students' lives across all levels of education. The impact of social media on students' behavior, and performance in school, and universities has been heavily analyzed. There is evidence that social media has a negative impact on students' attention. However, it was also noted that social networks have the potential to enhance collaboration between students [1]. The question is: *How severe is the negative impact, and do the positive aspects "outweigh" the negative?* To answer this question is not a simple task as social media influence varies across specific social media application, education levels, and even on an individual level. The use of social media platforms and its effect on student behavior and their overall education is not isolated. More precisely, other relational constructs and influencing factors can affect students. These relational constructs can be social support, social capital, and social networks [2]. Now, in another study it was noted that there is no clear evidence between social media consumption and students' academic performance [3]. In the same study it was argued that time management plays a more crucial role when it comes to long-term academic performance. As mentioned earlier, the social media impact is complex and in this particular study the effects of other factors (in this case time management) is prevailing compared to the effects of social media use. Interestingly, the use of social networks can have positive effects such stronger and more effective teacher-student and student-student interactions. Social networks can promote after-class engagement and collaboration. However, at the same time the lack academic language use by students, and the educators' dominance can negatively affect the overall students' academic performance [4]. Therefore, it is necessary to implement standardized evaluation mechanisms that would generalize data and provide a more objective overview of how strong and in which aspects does social media affect students' and their overall education.

Now, social networks are evolving and there is an increased intensity of content creation and distribution. This can negatively affect student behavior as the majority of content is distracting [5]. It seems that social networks are developing in a direction which promotes faster and faster content sharing, distribution of information. This hyper-distribution and hyper-sharing of content can have detrimental effects on students' attention capacity. This is why adequate measures have to be put in place for preventing or reducing the negative aspects of social media use by students within their curriculums.

In this paper the impact of social media on education is reviewed. Additionally, guidelines and suggestions regarding the use of social media in curriculums are discussed. The paper includes three main sections (excluding the Introduction and Conclusion sections). The first section briefly addresses the framework of social media influence. In the second section a review of multiple studies is presented. Here, the key findings and discussions of every study are presented. Finally, in the third section, guidelines and suggestions are discussed.

II. FRAMEWORK OF SOCIAL MEDIA INFLUENCE

With the development of modern information-communication technologies (ICTs) social media is increasingly more versatile and includes website and online applications that enable users to communicate, and collaborate, and to publish and share various content. [6] The application of modern ICT solutions requires adequate planning and

implementation strategies, especially when to content-rich medium (such as social media) introduction into classrooms.

Social media has the potential to engage students in new paradigm of human interaction. If applied correctly, social media can promote critical thinking and to increase overall student participation and engagement [7]. However, Social media and its impact should be viewed through multiple "lenses" as its effect varies in accordance with various other factors. The main framework of social media use in an academic setting involves the request for details and return of details between students and educators. The framework of this interaction includes peer learning, course engagement, knowledge discussion, learning communities, students' achievements, student mentoring, sharing, following and even news [8].

In addition to the engagement and learning aspect of social media influence, it is interesting to note that students tend to actively participate on social media platforms in order to "stay relevant". In other words, students develop a fear of missing out. This is due to the notion that social media and social networks have become a crucial and essential part of student life [9]. Social media can be viewed as potent "medicine" through which education can be improved and enhanced. However, social media can be a potent "poison" as well, distracting students and reducing their productivity and academic output.

Further, motivation and drive towards social media is an important factor that affects the outcome of the social media impact on education overall. The four primary motivational factors include integration, information, personal identity and entertainment [10]. When all of these factors are taken into consideration it is evident that social media use in the educational system is inevitable, and institutions should focus on being "ahead of the curve" meaning that they should implement optimization mechanisms sooner, than corrective mechanisms later.

Overall, the framework of social media influence on education includes the development of ICTs, student engagement, educator skills, content type, and sharing and collaboration intensity. This further implies that social media influence depends on the development of newer and more innovative ICT solutions. Additionally, the capacity in what these solutions are available for the masses (students) also plays a role. Further, educator (teacher, professor) skills are an important part of social media use in the classroom. Strict and at the same time flexibly approach is needed for students so they could utilize the positive aspects of social media platforms. In the next section, review on recent studies in the domain of social media impact on education and students' behavior are presented.

III. REVIEW OF MULTIPLE STUDIES

In the review process of literature in the domain of social media influence on student behavior and overall education, the following findings were noted:

- Social media is a rather complex term that includes several tools and applications including business tools, social networking tools, blogging tools, photo sharing tools, forums, virtual worlds, video content sharing tools, service reviews, and product reviews. [11]. These tools evolve over time along with the modernization and sophistication of ICTs.
- Research showed that social media is more used for social interaction rather than for learning, teaching and for overall education [12]. In the same review study, it was noted that there was a slight resistance from students regarding online learning and the use of social media. However, after their initial response, the students adapted and had a more positive view on the course as time progressed. It can be argued that the initial resistance is not due to the unfamiliarity of students with social media, but rather due to the type of use of social media (learning instead of entertainment).
- Social media in education has been shown to have positive outcomes on students' performance. Alongside the positive effects of social media use in education, there are disadvantages as well. Namely, social media can cause distraction and it is not suitable for exams and quizzes. Therefore, it is recommended that teachers implement other learning management systems into the curriculum [13].
- Students mainly use social media for networking and exchanging e-textbooks and other information. In addition, it was found that 3 to 4 hours a day students use social media for entertainment purposes [14]. This time of use for entertainment can cause issues later on when social media has a wider adoption in curriculums.
- From the aspect of audience size, traditional classrooms can't even compare to social media, as online classrooms or courses can address hundreds and even thousands of participants/students. With the development and wide use of smart devices, learning materials are easily accessible and are practically on-demand

[15]. It was also noted that the success of social media use in education can be partially measured with the number of impressions and engagement intensity.

- When it comes to the security aspect of social media use in education it was noted that there are statistically significant relations and influence of perceived social popularity, perceived content quality, and user satisfaction on education. It was also indicated that security awareness should be increased in social media and education. It is also recommended to identify factors of social media which affect security in education [16].
- Furthermore, in another study the findings indicate that both educators and students are aware of the importance of social media involvement in education, as it enhances collaboration and improves organizational skills. However, faculties should be aware of the negative aspects of social media use, thus limiting its implementation as well as to adequately manage and control the use of social media within courses. [17].
- The use of social media was evaluated as a positive tool for improved collaborative learning and engagement. However, the study revealed that beside the positive aspects of social media use, the majority of female participants noted that they experienced lack of usefulness, even though learning experience was increased. [18].
- Next, social media use was analyzed through its usefulness, perceived risk and students' satisfaction. The findings indicated that positive perceived usefulness of social media had a positive influence on students and their social media use for learning. Further, perceived risk of social media use had a negative influence in the form of discouragement. Finally, the use of social media had an overall positive effect of student satisfaction. [19].
- It was discussed that social networks were more widely used for information distribution and sharing, as well as for real-time communication. On the other side, specialized learning platforms and repositories were used for additional learning and content creation [20].

Overall, the results from various studies indicate the and partially demonstrate the complex impact of social media on education. It can be argued, that due to this complexity, future studies will be welcomed in this domain. Simply, due to the development of ICTs and the changes and innovations which are manifesting in social media requires continuous evaluation and investigation in order to determine the best course of action in regards the implementation of social media in curriculums. In the next section guidelines and propositions regarding social media use in education are discussed.

IV. GUIDELINES AND SUGGESTIONS

After the literature review and the noted findings in the domain social media use and impact on education, the follwoing guidelines and suggestions for social media use in education are proposed:

- social media platforms should be used as earlier as possible in the schooling system in order for students to view social media as learning tool at least as much they view as a source of entertainment;
- social media use should be promoted in a structured manner, emphasizing the importance of collaboration and critical thinking among students;
- students should be introduced to the negative effects of social media on their behavior and their potential academic performance;
- the use of social media in curriculums should be digitally governed and monitored in order to maintain or even improve education quality;
- mechanisms for reducing distraction when using social media in classrooms should be introduced;
- strategic planning is necessary for long-term sustainable solutions regarding the use of social media in classrooms;
- teachers should attain courses for effective and efficient social media use in the classroom with the goal to reduce the lack of necessary technical skills for social media use by the teacher.

In sum, the application of social media in education requires a systematic and thorough approach. This includes the participation of governance institutions, educators, and learners. This is a necessity if the use of social media in classrooms is planned as a long-term addition to the educational system.

V. CONCLUSION

In this introductory review paper the impact of social media use in education was analyzed. The challenges, drawbacks, barriers, as well as the positive aspects of social media use by students was reviewed. Based on the existing body of literature it can be concluded that social media is a strong “tool”

when it comes to enhancing the curriculums and classes. However, this "strength" can be detrimental on students' academic performance if not adequately managed.

The main limitation of this paper is the lack of empirical data collected from educational institutions. This type of data would provide a more thorough insight into the dynamics and complexity of social media influence on the teaching and learning process. Therefore, this current paper provides a solid starting point for such future research. It is also recommended for future studies to address the variability of social media influence depending on the socio-economic and political environment.

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Review of Sentinel-2 applications

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Abstract - Nowadays with satellites monitoring, most easily can be seen daily changes of the land, climate and water. This paper presents a literature review of researches in the field of earth observation, in recent years is done. First an outline of Copernicus and Sentinel-2 data is given. Then, Sentinel-2 applications in remote sensing problems are evaluated. At the end, deep learning and CNN architecture applied on Sentinel-2 images are presented, as well as our next goals.

I. INTRODUCTION

One of the basic fields in earth observation is collecting information about the earth's surface. The obtained data provide a better understanding of our planet and environment we live in, and thus serves as a core for making decision in several different domains. Optical satellites for Earth observation monitor our planet by obtaining images. They obtain images from ground, water, atmosphere and climate changes at different wavelengths of the electromagnetic spectrum [8], [3].

Widely known program for earth observation is Copernicus. Copernicus is European Union's program for earth monitoring. This program offers information based on satellite observations on the earth and non - space data. Copernicus has been especially designed to be suitable for customer necessity. Copernicus' services provide real-time data on a global level, which can be used for local and regional needs.

More recently, this data has become available to the public free. Since the launch of Sentinel-1A in 2014, the European Union has begun the process to set up nearly 20 satellites in orbit before 2030. Sentinel provides images with high temporal and spatial resolution. The Sentinel-2 data is publicly available at https://scihub.copernicus.eu/ as part of the Copernicus program [7].

II. SENTINEL-2

Sentinel-2 is a European mission for continuous, wide-range and high-resolution satellite images. Consist of two identical satellites Sentinel-2A and Sentinel-2B set at 180 degrees. Sentinel-2A launched on 23 June 2015 and Sentinel-2B launched on 7 March 2017. Sentinel-2 satellites covers the following areas:

- all continental land surfaces (including groundwater) between the widths of 84 ° north and 56 ° south,
- all coastal waters to at least 20 km from the coast,
- all islands greater than 100 km2,
- all the islands in the EU,
- the Mediterranean Sea,
- all sealed seas (for example, the Caspian Sea).

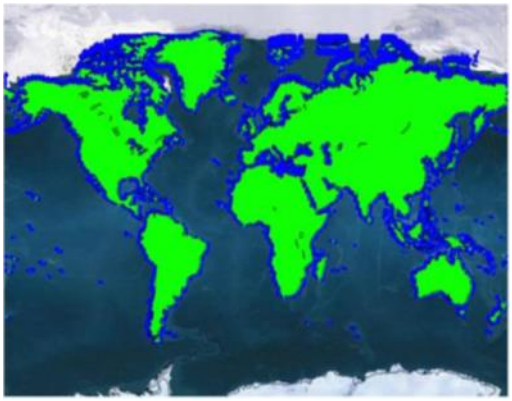

Figure 1. Sentinel-2 Coverage

The Sentinel-2 Multispectral instrument (MSI) consist of 13 spectral bands: four at 10 meters, six at

20 meters и three at 60 meters spatial resolution. The revisit time of one satellite is 10 days, or 5 days if they both work together. A swath width of each satellite is 290 km.

The data acquired from Sentinel-2 are used for:

- Land monitoring (spatial planning, agro-environmental monitoring, water monitoring, forest and vegetation monitoring, carbon monitoring, monitoring of natural resources, monitoring of crops)
- Emergency management (natural disasters - floods, fires, landslides, storms, earthquakes, etc., technological accidents, humanitarian crises (for example, after a period of severe drought), civil crises.
- Security (border surveillance, maritime surveillance, support for external action of the EU).

There are many types of Sentinel-2 products. Products consist of fixed-size granules. Granule is the indivisible part of the product. The size of the granules depends on the type of product. Sentinel products include image data in JPEG2000 format, quality indicators, help data and metadata.

The products of Sentinel-2 are given in the Table 1:

TABLE I. SENTINEL-2 PRODUCT TYPES

name	availability	Data volume	Processing levels
Level 0	not available to users	granule (25x23 km^2)	Payload Data Ground Segment (PDGS)
Level 1A	not available to users	granule (25x23 km^2)	Payload Data Ground Segment (PDGS).
Level 1B	available to users	granule – 27MB (25x23 km^2)	Payload Data Ground Segment (PDGS).
Level 1C	available to users	tiles – 500MB (100x100 km^2)	Payload Data Ground Segment (PDGS).
Level 2A	available to users	tiles – 600MB (100x100 km^2)	Sentinel-2 Toolbox

The radiometric resolution is expressed as an important number, usually in the range of 8 to 16 bits. The radiometric resolution of the MSI instrument is 12 bits, allowing image to be obtained in the range of 0 to 4 095 potential light intensity values. Radiometric accuracy is less than 5%. The radiometric resolution also depends on the detector's noise signal (SNR).

TABLE II. SPATIAL RESOLUTION BANDS AND SPECTRUM

Band number	Central wavelength (nm)	Bandwidth (nm)	Spatial resolution (m)	Part of spectrum	Description
1	443	20	60	Visible/VNIR	Coastal aerosol
2	490	65	10	Visible/VNIR	Blue
3	560	35	10	Visible/VNIR	Green
4	665	30	10	Visible/VNIR	Red
5	705	15	20	VNIR	Vegetation (red edge)
6	740	15	20	VNIR	Vegetation (red edge)
7	783	20	20	VNIR	Vegetation (red edge)
8	842	115	10	VNIR	NIR
8b	865	20	20	VNIR	Vegetation (red edge)
9	945	20	60	VNIR/SWIR	Water vapour
10	1375	30	60	SWIR	Cirrus
11	1610	90	20	SWIR	SWIR
12	2190	180	20	SWIR	SWIR

III. SENTINEL-2 APPLICATIONS

There are so many problems in the scope of earth observation, so application on Sentinel-2 can be noted in many fields, like: spatial monitoring of changes in tropical forests [2], methods for mapping vegetation properties [3], identifying glacial features [4], mapping land use and land cover change [5], remote sensing of eelgrass [6].

Eliakim Hamunyela in his doctoral thesis "Spatial monitoring of changes in tropical forests using observations from multiple satellites" talks about how to improve satellite monitoring of forest changes by addressing key challenges that hinder correct and timely spotting of disturbances in forests from satellite data. More specifically, the thesis assesses whether the problem is with the season, a small-scale omission and low-scale and low-noise forest disorders, the innate noise in the time series of satellite images and inter-sensory differences in the multi-sensory time series. Researches were accomplished in wet tropical forests in Brazil and dry tropical forests with a strong season in Bolivia. In addition, a distinction between the spatial context model and the seasonal model is done. [2]

In paper [3], Juan Pablo collects the latest methods for optimized and automatic assessment of vegetation properties. His main goal was "To analyze, optimize and automate the most up-to-date methods for mapping vegetation properties in the

preparation". A GUI software package called ARTMO (Automatic Radiative Transfer Modeler Operator) was developed. The tool was applied to the assessment of the LAI and the LCC in the agricultural place Barrack, Spain.

Ruben Egbers performs data processing and identifies the glacial features in Sentinel-2 images. The pretension of his research was to examine how Sentinel-2 images are processed and whether these images are useful for the study of glacial features such as snowy peaks. The operations of Sentinel-2 data were made in the Sentinel-2 Toolbox. He investigated mountain range named Karakoram, which includes several long glaciers, such as the Baltor glacier or the glacier Hisspar. Karakoram glaciers are not retreating, but receive a mass (Hewitt, 2005), which makes this area interesting for studying. [4]

The focus of this research was to map and analyze the land use and land cover (LULC) between 1999 and 2017 in Kalmar municipality, with a method for detecting changes in the object. The study of LULC changes is of great significance because there is a decline in agricultural land, a growing population, and a rise in urban areas. The outcome of LULC modification have bigger impact than climate change in the future. Object-based detection of changes between remote scanned images is conducive to the analysis of LULC changes. The research methods consisted of an object-based post-classification method, for detection of LULC changes. In order to achieve higher accuracy of classification, the method was combined with visual inspection and by manual re-classification of the wrongly classified objects. Four LULC classes were mapped and analyzed. Maps showed that between 1999 and 2017, urban land use increased by 7 km2 and 20% and the agricultural lands decreased by 24 km2 and -10%. The main drivers for the loss of agricultural land were the expansion of urban areas and the growth of vegetation. The results of this study have shown that the detection of object-based changes helps to gain insight into LULC changes over time. [5]

In paper [6] was investigate Eelgrass (a seafood with long strips of leaves that grow in coastal waters and salty pads) as an ecologically important and fragile kind of grass as a plant that lives in or near the sea that is common in Denmark and the Northern Hemisphere. The depth of the boundaries of the eelgrass population is used to assess the ecological status of coastal waters, and coverage is used to assess the health of ecosystems. This thesis was used Sentinel-2 images with object-based analysis and diverse machine-learning algorithms for classification of submerged water vegetation in the Roskilde Fjord. The results established that the Random Forest is the most suitable machine learning algorithm for classification of water vegetation, and a parameter on a scale of 10 produces images that receive the highest accuracy of the classification. [6]

In the papers above, Sentinel-2 satellite images were used in remote sensing problems. Despite that, we are more interested about deep learning and CNN as deep learning architecture applied on Sentinel-2 images.

Deep learning is a new machine learning technique that learns features and tasks directly from data. Deep learning can be defined as AI method or techniques for learning in neural networks (ANNs) that contain more than one hidden layer. It is almost everywhere: Object recognition, Object classification, Object detection, segmentation, pose estimation, Image captioning, question answering, Machine translation, Speech recognition, Robotics [19], [20]. Many different architectures for deep learning exist such as deep neural networks, deep belief networks, recurrent neural networks and convolutional neural network. CNN is a combination of biology, math and computer science. CNN is comprised of several layers divided into two parts: feature learning (Conv, Relu,and Pool) and classification (FC and softmax). Every layer transforms an input 3D volume to an output 3D volume with some differentiable function that may or may not have parameters (e.g. Conv/FC do, ReLU /Pool do not). Each Layer may or may not have additional hyperparameters (e.g. Conv/FC/Pool do, ReLU doesn't). A classic CNN looks like

First layer in CNN is always a convolution layer where we use filter to get activation map (feature map) from an input image. There are also two main parameters that we can change to modify the behavior of each layer. They are stride and padding. The value of stride is mostly set on 1 or 2, and the value of padding on 0. The output from the convolution layer is calculated with equation output=(W-F+2P)/S+1. For example, if we have an input size [32x32x3], filter 5x5x3, stride 1 and

pading 0, we will get the output= (32-5+2*0)/1+1=28. ReLU is rectified linear units' layer that applies the function f(x)=max (0, x) to all input values. This layer changes all the negative activations to zero. This layer does not change the size of the volume. Pooling layer or downsampling layer is layer for resizing images that gives on output the maximum numbers from each subregion. The Max pooling function is the most used type of pooling. Neurons in a fully connected layer have full connections to all activations in the previous layer. The last one uses a softmax activation function for classifying to compute the class scores. CNN are mostly applied to images, video and natural language processing [21], [22], [23]. CNN for image classification start with low-level features like curves and edges and then building up more specific concept to recognize the classes. The network is usually trained by using backpropagation [14], [1]. The goal of back-propagation is to optimize the weights in order neural network to learn how to correctly map inputs to outputs. Back-propagation consist of three parts: forward pass, calculating the total error and backwards pass. The most common Convolutional Networks architectures are: LeNet (developed in 1998), AlexNet (2012), ZefNet (2014), VGGNet (2014), GoodLeNet (2015), ResNet (2016), Xception (2017), Convolutional Block Attention Module (2018), Channel Boosted CNN (2018) … Deep learning and convolution neural networks, applied to satellite image recognition problems are presented in the following papers [8] - [13].

Since it is important to have information about the earth, LULC maps were created. LULC maps still took in manual work and data availability after long period (even a few years). Automatic methods for LULC classification exist, but there was a problem when they have a large-scale LULC classification. CNN cannot be directly applied to LULC. There were a small number of bases used to adapt the CNN to LULC classification. After acceptance of CNN architecture, they both were used for classification of Sentinel-2 images. Training data was taken from Sentinel-2. Researcher used annotation from OpenStreetMap database. TensorFlow framework and Inception-v3 CNN architecture were used. The result showed that CNNs were good for LULC classification. [8]

Several methodologies have been proposed for classification of satellite images, but CNN has proved to be one of the better ones and is therefore used in this paper [9]. In particular, a method for classifying a satellite image using CNN architecture was proposed. Six-layer CNN architecture consisting of an input layer, three convolution layers, two sub-sampling layers and at the end a fully connected layer is used. Satellite images were collected to apply the proposed CNN architecture. The database contained 6 classes of different areas (airport, bridge, forest, harbor, land and urban area) each of 200 images or total 1200 images. From each class 50 images were used for training, and the rest 150 for testing. According to the experiments carried out and the obtained results, it was shown that the proposed method for classification could be an encouraging alternative to existing schemes based on extraction for feature.

With the development of INSPIRE, a few Spatial Data Infrastructures (SDI) became publicly available. At the same time, Copernicus satellites (Sentinel) produce huge amounts of image data. For image processing U-net Convolution Neural Network (CNN) architecture was developed. The research was based in Netherlands. They classified six classes: build-up area, water, cropland, forest, grassland and undefined area. A comparison of the Convolution Neural Network (CNN) with the Random Forest model was also performed [10].

A challenge in satellite images is automatic target detection. Khan and al. [11] proposed a system for classifying target and non-target objects. They detected aircrafts. The system they proposed was based on EdgeBoxes and Convolutional Neural Network (CNN). The architecture of CNN contains five layers: two convolutional, two pooling and one fully connected layer. A military dataset consists of 500 aircraft images, 5000 non-aircraft and 26 test images. The test images were taken from Google Earth. The results shown that the proposed system was good for detecting aircrafts in satellite images.

Authors in paper [12] and [13] deal with HSR (high-resolution satellite) images. For image scene classification, [12] proposed an agile CNN architecture known as SatCNN. They have used convolutional layers with many small kernels and obtained average precision of around 99.65% for 40 minutes training. SAT data sets (SAT-4 and SAT-6) were used for training. SAT-4 consist of 500 000 and SAT-6 of 405 000 images covering four/six classes. The use of NVIDIA, CUDA and CuDNN library made convolutions to move more quickly. In the second paper [13] was proposed a new model (multi-scale CNN) for geospatial object detection in HRS images. For training were used NWPU VHR-

10 datasets (positive dataset contains 650 images and the negative dataset contain 150 images) and the average precision of 89.6% was obtained.

IV. CONCLUSION

Sentinel-2 is one of the most essential data acquired for earth monitoring. In this article, we make a literature review (an overview) at recent studies in which researchers used image obtained from Sentinel-2 satellites in order to see the changes in the life environment. In addition, we are interested in research that make image classification using CNN and deep learning. Our aim is using CNN to make classification on Sentinel-2 and INSPIRE images to search for uncultivated workable land in Balkan Peninsula.

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Modelling with Structural Equation Modelling – Application and Issues

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Abstract: Structural equation modeling (SEM) is a comprehensive statistical modeling tool for analyzing multivariate data involving complex relationships between and among variables. SEM surpasses traditional regression models by including multiple independent and dependent variables to test associated hypothesizes about relationships among observed and latent variables. SEM explain why results occur while reducing misleading results by submitting all variables in the model to measurement error or uncontrolled variation of the measured variables. SEM provides a way to test the specified set of relationships among observed and latent variables as a whole, and allow theory testing even when experiments are not possible. Structural Equation Modeling (SEM) is a powerful collection of multivariate analysis techniques, which specifies the relationships between variables through the use of two main sets of equations: Measurement equations and structural equations. Measurement equations test the accuracy of proposed measurements by assessing relationships between latent variables and their respective indicators. The structural equations drive the assessment of the hypothesized relationships between the latent variables, which allow testing the statistical hypotheses for the study. Additionally, SEM considers the modeling of interactions, nonlinearities, correlated independents, measurement error, correlated error terms, and multiple latent independents each measured by multiple indicators.

In this paper will be presented application of relationship between reverse logistics and circular economy using some SEM fit indexes. The process of validating the measurement model requires testing each cluster of observed variables separately to fit the hypothesized CFA model. The statistical test uses the most popular procedures of evaluating the measurement model: Chi-square CMIN (χ2), Goodness-of-Fit Index (GFI), and Percent Variance Explained.

I. INTRODUCTION

Structural Equation Modelling (SEM) is an extension of the general linear model (GLM) that allows the researcher to simultaneously test a set of regression equations. In other words, the purpose of SEM is to examine the set of relationships between one or more exogenous variables (independent variables) and one or more endogenous variables (dependent variables). SEM software can test traditional models, but also allows the examination of more complex relationships and models, such as confirmation of factor analysis and time series analysis. In addition, SEM structural relationships can be graphically modeled to provide a clear understanding of the theory under consideration. Compared to the old multi-variant procedures, several advantages can be noted when using SEM. It performs a verified, rather than a research approach to data analysis (research approach can also be implemented through SEM): - SEM evaluates the parameters of the error variance, but the traditional multi-variant procedures are not able to estimate the measurement error; - SEM can include both observed and latent variables, while previous methods are based only on observed measurements; - The browser can get a unifying frame that corresponds to a number of linear models; - SEM programs provide overall model tests and individual parameter assessment tests simultaneously.

Coefficients, reactions, and variants of the reaction can be compared simultaneously, even in different groups. You can handle long-term data, databases with automatic error correction structures (time series analysis), databases with unusually distributed variables, and incomplete data. Due to these advantages of SEM, it has become a popular methodology in non-experimental research.

II. COMMON TERMS IN SEM

Especially in behavior and social sciences, researchers are often interested in studying two types of theoretical constructions, namely observed, observed (manifested) and latent variables. However, research often has to do with latent variables that cannot be directly measured, such as personality, perception, buying behavior, and so on. Research has used observed, variable to measure latent variables. Observation may include, for example, answers to self-reported attitudes, coded answers to interview questions, answers to surveys or questionnaires, and so on. These measured grades, or in other words observed (observed) or manifested variables, are used to measure latent variables.

A. Exogenous and endogenous latent variables (variable)

Exogenous latent variables are synonymous with independent variables and endogenous latent variables are synonymous with dependent variables. Endogenous variables are influenced by exogenous variables directly or indirectly.

- Exogenous variables
  - "of external origin"
  - Like an independent variable
  - No straight arrows pointing to it
- Endogenous variables
  - "of internal origin"
  - Like a dependent variable
  - Straight arrows point to it (and possibly out of it)

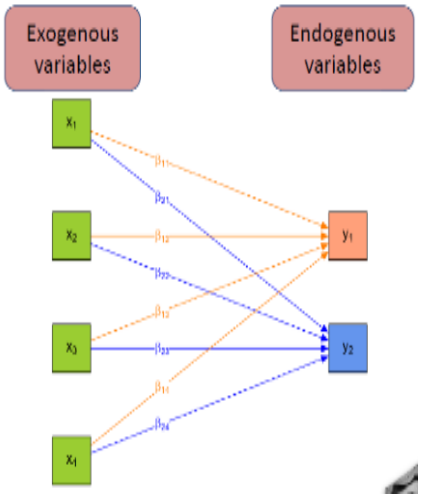

Figure 1. Exogenous and endogenous variables

B. Exploratory Factor Analysis (EFA) and Factor Analysis Certificate (CFA)

Factor analysis was performed to examine the relationships between the sets of observed and latent variables. If the relationships between the excited and latent variables are unknown or uncertain, research factor analysis is performed. Research factor analysis is performed to determine how and to what extent the observed variables are related to their underlined factors. Confirmation of factor analysis is appropriate when the researcher has some understanding (through theory, empirical research, or both) of the latent variable structure.

C. The path diagram

The road diagram is a visual representation of the relationships between variables that are assumed to be present in the study. Basically four geometric symbols are used in path diagrams; circles or ellipses (∘) represent unprotected latent variables, squares or rectangles represent (□) observed variables, single-headed arrows (→) represent the effect of one variable on another variable, and double-headed arrows (↔) represent covariance or correlation . between two variables. Figure 2. is a simple model used to explain the meanings of symbols on a path diagram.

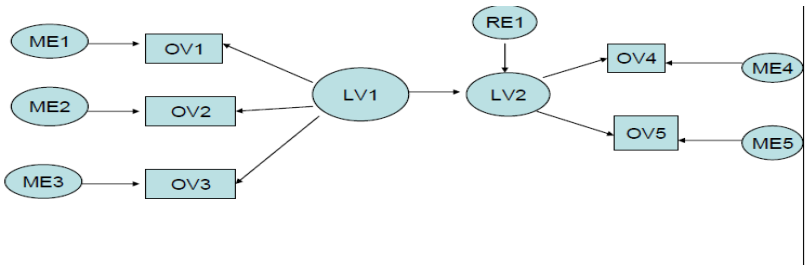

Figure 2. - Simple path diagram

In the above model, there are two latent variables (LV1 is exogenous variable and LV2 is endogenous variable) and five observed variables; three are used to measure LV1 and two are used to measure LV2. In addition, there are five measurement errors (ME 1- ME5); associated with each observed variable and one residual error associated with the predicted factor (LV2). Measurement error of the underlined factor or latent variable through the observed variable is reflected

by a measurement error. The remaining error is an error in predicting an endogenous factor from an exogenous factor. For example, the residual error shown in Figure (RE1) is an error in predicting the endogenous factor (LV2) of the exogenous factor (LV1). The general SEM can be divided into two sub-models; measuring models and structural models. The measurement model shows the relationship between the observed and latent variables. In other words, it is a CFA model, specifying the model by which each measure carries a load on a particular factor. But the structural model shows the relationship between latent variables. There are two measurement models and one structural model discussed earlier. Figure shows an example of a measurement model and shows an example of a structural model and both models are sub-models derived from the model.

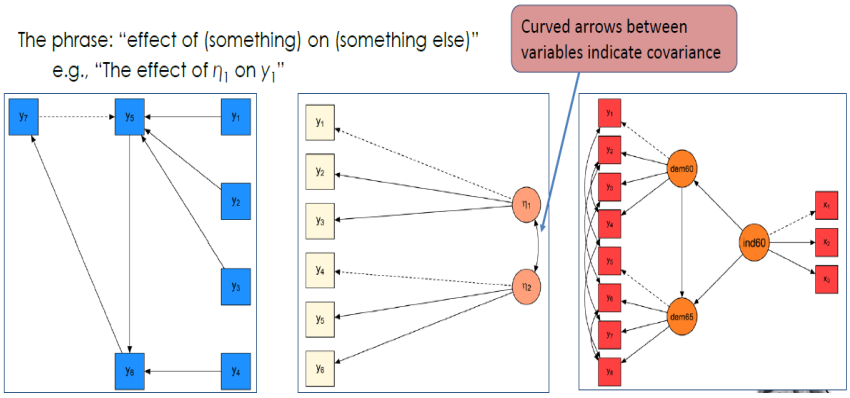

Figure 3. Structural and measurement models

III. DATA PROCESSING ACCORDING TO PART OF THE HYPOTHETICAL RESEARCH FRAMEWORK

The data processing with the SEM-Amos software will process the hypothetical frames (mix of questions) for the results of the Questionnaire on the Impact of the Reversible Logistics of the Circular Economy. The scope of the research emphasizes the interaction of the research components for which the research can be clearly understood. It also illustrates how reversible logistics relates to the Circular Economy and other concepts for achieving the research goal. The circular economy operates according to 3R (Reduce, Reuse & Recycle) - the approach of "Reduction, Reuse (Reuse) and Recycling". Recycling and Reuse (reuse) of waste or already used and obsolete or damaged products is the first major step in changing the ways of thinking of businessmen, but it also represents the overall cultural change in society. Remarkable recommendations of other managers regarding the implementation of the principles of Circular Economy and Reversible Logistics. (Indicator: answer questions no. Q1, Q5, Q6, Q10, Q11, Q 15.). Management of waste collection systems is the notion of zero waste in the company, and the Circular Economy and Reversible Logistics in general have had a positive impact on the process. (Indicator: answer questions no. Q3, Q7, Q10, Q11, Q12). According to experience, recommendations will be given to other managers regarding the implementation of the principles of Circular Economy and Reversible Logistics that would enable zero waste and environmental processes, as well as the relevance of Reversible Logistics in organizations. (Indicator: answer questions no. Q1, Q5, Q8, Q13, Q14, Q15).

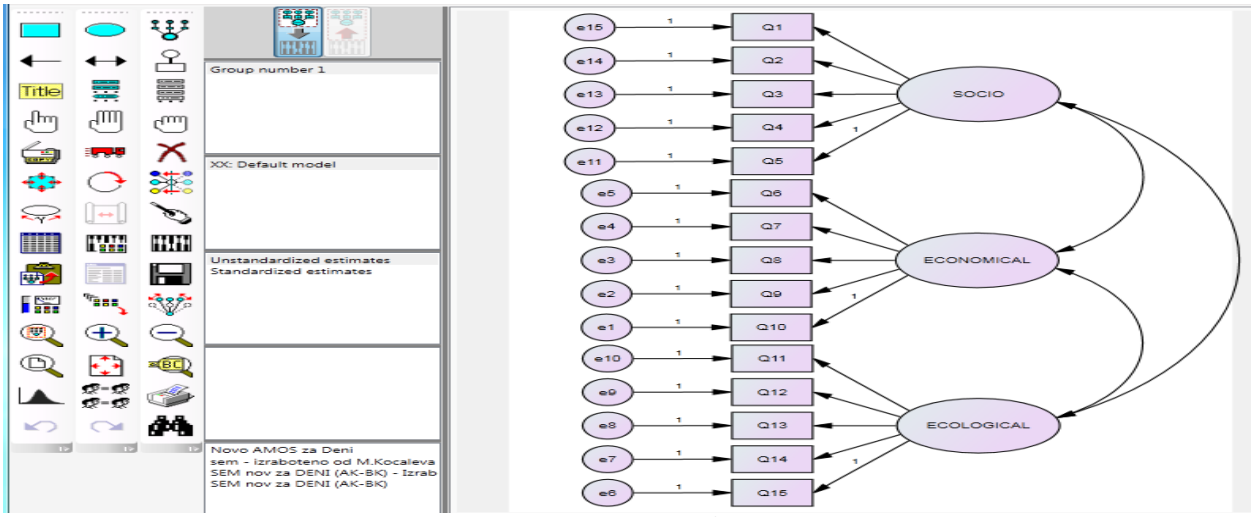

Figure 4. Schematic procedure of SEM-Amos

Table 1. Sum of answers of respondents for mix of questions

TOTAL	300	300	300	300	300	300	300	300	300	300	300
5	50/40	9/8	26/34	70/58	45/25	30/35	40/45	55/40	70/60	6/12	45/35
4	60/30	5/8	20/20	62/50	25/25	30/25	45/50	45/40	62/48	6/6	35/35
3	15/15	42/48	72/68	16/14	50/40	50/58	56/34	40/50	12/18	40/50	60/60
2	30/20	50/62	16/20	9/6	30/20	20/20	10/8	8/10	8/7	55/40	8/8
1	24/16	46/22	10/14	9/6	20/20	14/18	6/6	6/6	8/7	45/40	8/6
	Q1	**Q3**	**Q5**	**Q6**	**Q7**	**Q8**	**Q10**	**Q11**	**Q12**	**Q13**	**Q15**
5	90	17	60	128	70	65	85	95	130	18	80
4	90	13	40	112	50	55	95	85	110	12	70
3	30	90	140	30	90	108	90	90	30	90	120
2	50	112	36	15	50	40	18	18	15	95	16
1	40	68	24	15	40	32	12	12	15	85	14
Total	300	300	300	300	300	300	300	300	300	300	300

Table 2. Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.951	**.974**	**16**

Table 3. Implied Covariances (Group number 1 - Default model)

	Q15	Q13	Q12	Q11	Q10	Q8	Q7	Q6	Q5	Q3	Q1
Q15	1,268										
Q13	-,399	1,191									
Q12	,401	-,014	1,179								
Q11	,373	-,013	,013	1,181							
Q10	-,299	,011	-,011	-,010	1,164						
Q8	-,251	,009	-,009	-,008	,366	1,522					
Q7	-,024	,001	-,001	-,001	,036	,030	1,729				
Q6	-,224	,008	-,008	-,007	,327	,274	,027	1,158			
Q5	-,028	,001	-,001	-,001	,415	,348	,034	,311	1,309		
Q3	-,027	,001	-,001	-,001	,413	,347	,034	,309	,549	1,101	
Q1	-,028	,001	-,001	-,001	,418	,351	,034	,313	,555	,552	1,982

Table 4. Implied Correlations (Group number 1 - Default model)

	Q15	Q13	Q12	Q11	Q10	Q8	Q7	Q6	Q5	Q3	Q1
Q15	1,000										
Q13	-,325	1,000									
Q12	,328	-,012	1,000								
Q11	,305	-,011	,011	1,000							
Q10	-,246	,009	-,009	-,008	1,000						
Q8	-,181	,007	-,007	-,006	,275	1,000					
Q7	-,016	,001	-,001	-,001	,025	,018	1,000				
Q6	-,185	,007	-,007	-,006	,281	,206	,019	1,000			
Q5	-,021	,001	-,001	-,001	,336	,247	,022	,252	1,000		
Q3	-,023	,001	-,001	-,001	,365	,268	,024	,274	,457	1,000	
Q1	-,017	,001	-,001	-,001	,275	,202	,018	,207	,345	,374	1,000

Table 5 Residual Covariances (Group number 1 - Default model**)**

	Q15	Q13	Q12	Q11	Q10	Q8	Q7	Q6	Q5	Q3	Q1
Q15	-,091										
Q13	,100	,000									
Q12	-,161	,426	,000								
Q11	,021	-,089	,076	-,014							
Q10	-,035	,087	,197	-,014	,000						
Q8	-,057	-,096	-,142	,367	,006	,000					
Q7	,584	-,097	,304	,360	-,074	,526	,000				
Q6	,316	,321	,731	-,084	,068	-,195	,419	,000			
Q5	,042	,203	,352	,111	-,110	-,119	,112	,216	,000		
Q3	,082	,264	,412	,138	-,027	,138	,198	,068	-,032	,000	
Q1	,121	,312	,447	,005	-,029	-,425	-,422	,168	,153	-,053	,000

Table 6. Standardized Residual Covariances (Group number 1 - Default model)

	Q15	Q13	Q12	Q11	Q10	Q8	Q7	Q6	Q5	Q3	Q1
Q15	-,874										
Q13	1,339	,001									
Q12	-2,166	6,216	,001								
Q11	,278	-1,304	1,115	-,143							
Q10	-,485	1,275	2,913	-,203	,000						
Q8	-,700	-1,231	-1,833	4,741	,078	,000					
Q7	6,822	-1,173	3,687	4,361	-,896	5,602	,000				
Q6	4,437	4,720	10,818	-1,237	,969	-2,491	5,124	,000			
Q5	,565	2,812	4,904	1,541	-1,460	-1,419	1,287	2,937	,000		
Q3	1,194	3,993	6,258	2,092	-,389	1,777	2,485	,999	-,421	,000	
Q1	1,325	3,510	5,058	,058	-,313	-4,146	-3,939	1,882	1,555	-,581	,000

Table 7. Factor Score Weights (Group number 1 - Default model)

	Q15	Q13	Q12	Q11	Q10	Q8	Q7	Q6	Q5	Q3	Q1
Ecological	,467	,141	-,143	-,132	,104	,052	,004	,062	-,030	-,040	-,016
Economical	-,172	-,052	,052	,049	,105	,053	,004	,063	,096	,130	,051
Social	,068	,020	-,021	-,019	,134	,067	,005	,080	,193	,262	,103

Table 8. Appropriate indices (Group number 1 - Default model)

CMIN **Model**	**NPAR**	**CMIN**	**CMIN/DF**
Default model	25	30,53	3,053

Model	RMR	GFI	AGFI	PGFI
Default model	,233	,745		
Bootstrap:	,000			
Total:	,527			

All tables in the above text stems and are generated through the processing from using the data of SEM-Amos software. In the above tables are presented the following data: Reliability Statistics, Implied Covariances and

Correlations, Residual and Standardized Covariances, Factor Score Weights for Social, Ecological and Economical aspects and Appropriate indices.

IV. CONCLUSION

Modeling is an integral part of the thought process. People think within certain standards and rely on them. It can be said that modeling is a rational, systematic, complex procedure of properly presenting the important features of processes, phenomena or their representations as certain units. Modeling is a systematic research procedure through which real or thought models are made, ie models of sketches, objects, mathematical formulas, etc. The structure of modeling is made up of four factors: passive objective factors-subject to modeling, active subjective factors, means or tools, position in objective reality and conditions. Various software solutions will be used to explain the circular economy, especially reversible logistics (SEM – Sequential Equation Modeling). Finally, based on the data obtained in the case of the research and the model of reversible logistics, a comparative analysis of the processes for design and development of new innovative products will be made. The respondents-respondents 300 in the survey with 15 questions, declared in accordance with each statement or question with answers "5-Excellent", "4-Very Good", "3-Good", "2-Not Enough" and "1- Very little". Of course, the reversible logistics and circular economy model will be a function of future and possible development of innovative activity. SEM can simultaneously test a complex set of regressive equations. Furthermore, SEM may include both observed and latent variables, while previous methods are based only on observed measurements. However, the most commonly applicable or acceptable values, but not always or rarely achievable in research, for fitting (Appropriate indices and Tolerance of appropriate indices) are the following with their limit measures: CMIN / DF = 2 <CMIN / DF≤ 3. Reliability statistics: Cronbach’s alpha=.951

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Representation of the Programming Languages in IT Sector in Zrenjanin

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Abstract: As IT companies follow the latest trends do to clients requirements, companies need to make sure that they use the appropriate programming languages. So choosing a programming language is important for a successful business. The companies operating in Zrenjanin city, which included in this research, consider that it is necessary to focus on a programming language that will be able to fulfill the client's requirements while creating an appropriate application or website. Employees in company have indicated which programming languages they use and why. When students want to decide which programming language to learn, they usually decide for programming language which the most used in companies.

1. INTRODUCTION

The first programming language was Fortran, which was created in 1954. From that period until the 1990s, it was usually the first programming language taught in schools and colleges in Serbia. Beside him were studied Basic and Pascal. Object-oriented programming languages are increasingly used in the 21st century. Object-oriented programming languages such as C ++, Java and C# are programming languages that are most commonly taught in school and college [1]. If a programming language is learned, different types of applications can be developed. Programming languages such as C #, Java, Python, C ++, C, PHP, JavaScript are used to create a special application such as system programming, web application creation, desktop application, mobile application and client web application [2]. They were either mechanical or electromechanical. Programming languages are widely represented in the world today, there are many programming languages. The topic is interesting given that developers are constantly on the lookout for today, so it is important to know which programming languages are the most popular, as this gives a greater chance of student employment. This paper's structure consists of several sections. The Research methodology section explains the research problem, research goal, research questions, hypothesis, place and method of research and sample. The next section is The importance of programming languages. The Final sections are discussion and conclusions.

2. RESEARCH METHODOLOGY

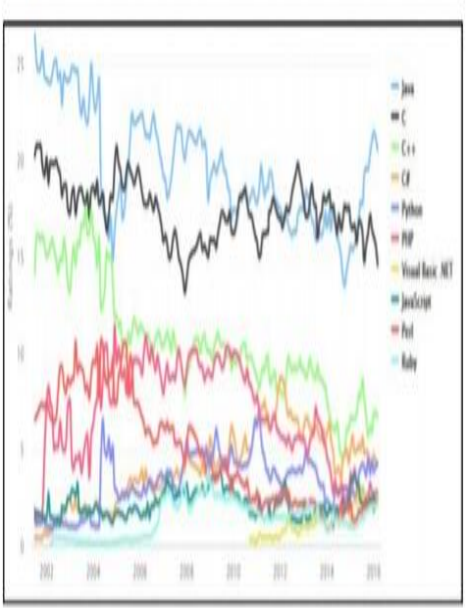
Research is conducted upon the methodology presented as follows:

1. Research problem - Lack of research on this topic in the territory of Zrenjanin, which is considered to be of great importance for students to find a job
2. Research goal – to investigate what is the most widely used programming language in IT sector in Zrenjanin city and why so that future developers have in mind which languages are most used because they are also more likely to get a job if they are learning exactly the programming language required.
3. Research questions – RQ1: What is the most widely used programming language in IT sector in Zrenjanin city?
4. Hypothesis – There are positive view that programming language C# is the largest representation in creating a website or application.
5. Place and method of research - Research will be conducted as theoretical and empirical research. A survey was conducted and distributed to employees of companies in the IT sector in the Zrenjanin municipality, where the analysis shows which programming language is most represented in the IT sector in Zrenjanin.
6. Sample - The survey conducted on this occasion in the period from December 10th to December 17th, 2018 and from December 10th to December 17th, 2019, included respondents from Zrenjanin in 2018 and 2019, who are employed in the IT sector, in four different companies operating

in Zrenjanin. So, the same research was done twice, in 2018 and in 2019. Respondents are from several companies (four companies: Vega IT, Lanaco, Consulteer, Levi 9) located in Zrenjanin, which are very successful and constantly employ people with relevant knowledge in IT.

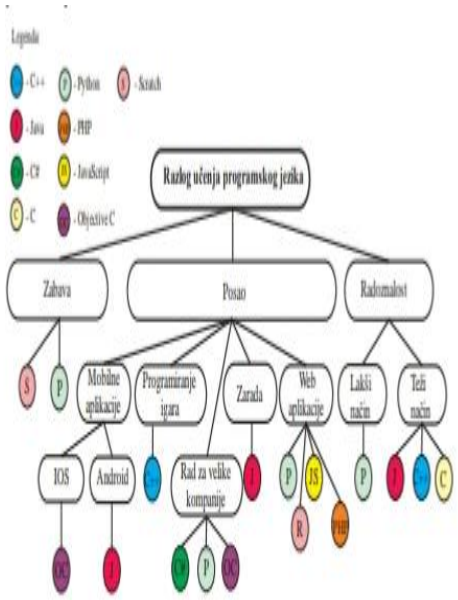
3. THE IMPORTANCE OF PROGRAMMING LANGUAGE

Company "Tiobe Software" [3] provides a monthly overwiev of the most commonly used programming languages in the world. The five most commonly used programming languages are Java, C, C++,C# and Python. TIOBE Programming Community index is an indicator of the most commonly used programming languages for the analyzed month. The estimation is made according to the data obtained by the use of well – known search engines such as Google, Bing, Yahoo, Wikipedia, Amazon and YouTube. The TIOBE index determines in which programming language most lines of code are written for the observed month. Picture number one shows the most commonly used programming languages in the 21st century and it can be concluded that the most commonly used programming languages are Java, C and C++. At the Faculty of Technical Sciences in Čačak, this was also the starting point for the recent years to study these programming languages in the direction of Information Technology [3].



Picture 1. The most commonly used programming languages in the 21st century [3]

Picture number two shows an algorithm for determining the reason for learning programming languages. The most common reason to learn to program is to find a well-paid job. The salary of developers in Serbia is much higher than the average, so in recent years many high school students have opted to study [4].

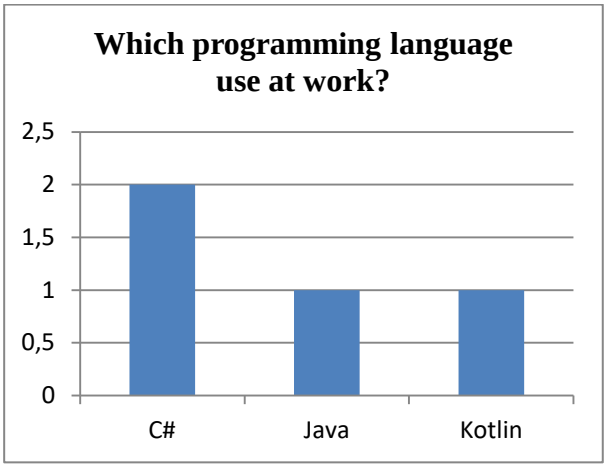


Picture 2. Algorithm for determining the reason for learning programming languages [4].

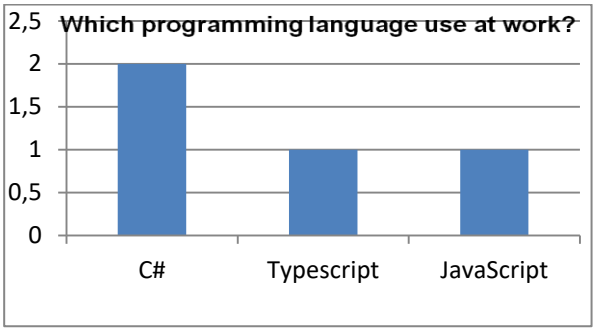
4. EMPIRICAL RESEARCH RESULTS

This section presents the results of empirical research regarding the representation of programming languages in the IT sector in Zrenjanin city. The same survey was conducted in 2018. and in 2019. Respodents are male, over 20 years of age, from four different companies: Vega IT, Consulteer doo, Lanaco company, Levi 9, where all respondents worked for one year, two years or more than two years. In 2018. Respondents stated that they were working in the following programming languages: Typescript, C#, Java, Kotlin and in 2019.: C#, Javascript and Typescript. In 2018, respondents stated that they use C# because they have the most lightweight object - oriented programming language and because the code is highly transparent because complicated things can be easily solved, Kotlin because project so require and Java because that is what clients demand. In 2019, respondents answered that they use JavaScript to quickly build software solutions and implement business logic. They use C# because the company has a collaboration with Microsoft and because the build websites using C# based CMS. A typescript is used because it is the easiest to use AWS service. In 2018, when asked "is it a programming language

they like to work?", everyone escept one respondent are said 'YES'. In 2019 everyone stated that they like to work that programming language which use in firm.

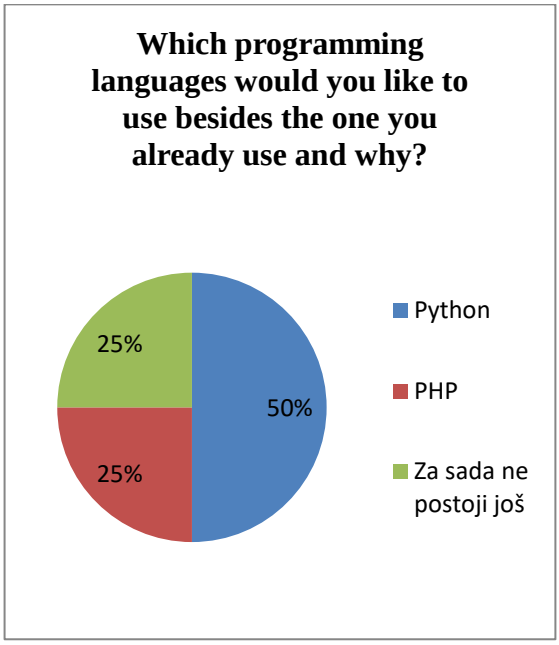


Picture 3. Chart who show the languages used by the respondents in their work in 2018 year

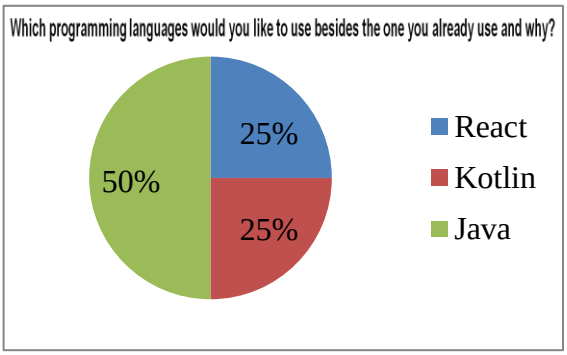


Picture 4. Chart who show the languages used by the respondents in their work in 2019

When asked "Which programming language would you like to use besides the one you already use and why", respondents in 2018 said that they would like to do Python because it is simple and easy to use because it offers many functions and PHP because of its performance. To the same question in 2019, respondents answered that they would like to react in order to improve the development of their mobile applications. After that, they said that Kotlin is the best language for creating an Android application, and some said that they would use Java because they never used an object-oriented programming language.

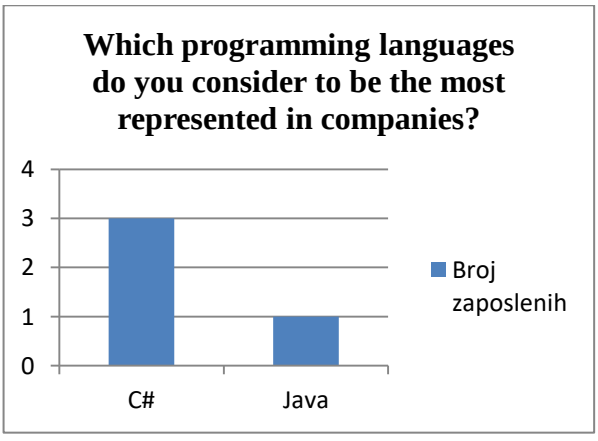


Picture 5. Chart show programming languages which employees would like to work in 2018

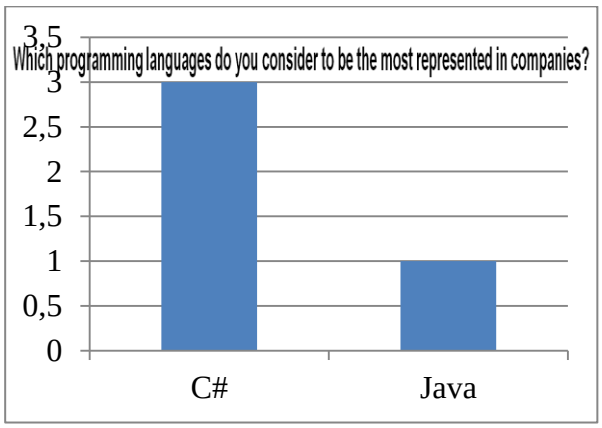


Picture 6. Chart show programming languages which employees would like to work in 2019

When asked "Which programming language is the most represented in the companies in Zrenjanin?", in 2018 most of them stated that it was C# with 50%.

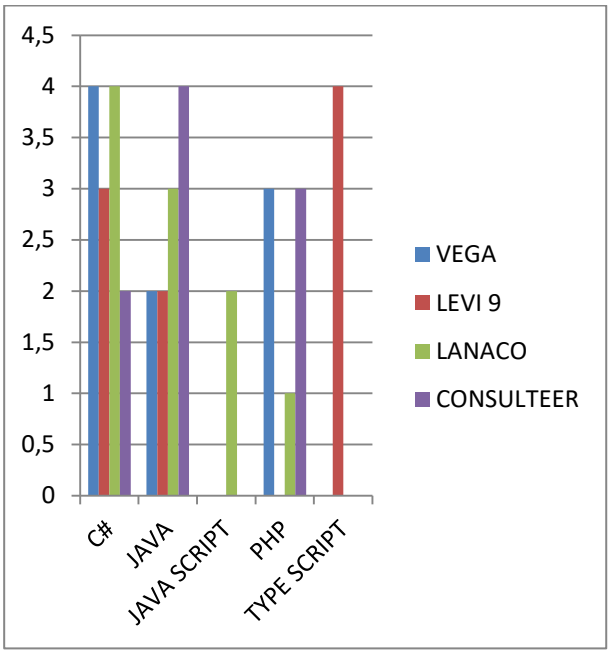


Picture 7. The most common programming language in 2018

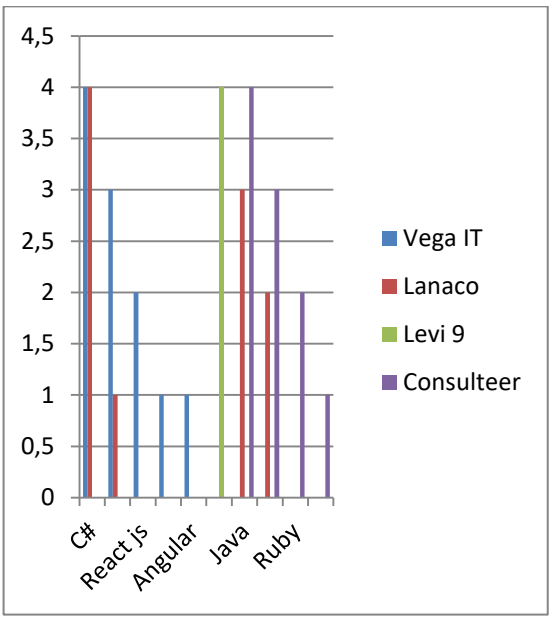


Picture 8. The most common programming language in 2019

Asked "Which programming languages are the most common in your company?", in 2018 they listed C#, Java, Typescript, PHP, JavaScript, while in 2019 they said: C#, Java, JavaScript, PHP, Typescript, React js, VUE js, Angular, Ruby, Python.



Picture 9. The most represented languages in companies in 2018



Picture 10. The most represented languages in companies in 2019

5. DISCUSSION

In future research, the representation of programming languages in the IT sector could be explored, but in a larger area, and could be explored in the same area in some five years, because changes in technology are constant.

6. CONCLUSION

The research conducted at Zrenjanin in four different companies, can conclude that C# is the most represented, in the sense that it is used in each of these companies and when ranked in order of representation in each of the companies, C# was ranked higher in relation to Java, although Java is also used in each firm. According to research from 2018, the following programming languages (excepted C#) were represented in these companies: Java, PHP, Javascript, Typescript, Kotlin. According to research from 2019, the following programming languages (excepted C#) were represented in these companies: Java, Javascript, Typescript, Python, Ruby, PHP, React js, Angular.

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Enhancing EFL Students' Communicative Skills by using Learning Apps

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Abstract - The rapid growth of technology has offered trendy instructional tools for learning English as a foreign language. The world of technology develops fast, attracting new users, among which are university students. With the growing use of mobile technology, students can take advantage of mobile apps to improve their English competence. This paper will reveal the effects of using Apps as an -learning tool for teaching EFL among university students. Different Apps were used to facilitate communication between the teacher and students and restructure the learning workflow. E-learning technologies offer learners control over the content, learning sequence, pace of learning, time, and often media, allowing them to tailor their experiences to meet their learning objectives (Jethro, Grace& Thomas 2012). One of the biggest advantages of using Apps in language teaching is that it helps students and teachers communicate instantaneously. It endorses paperless communication and allows teachers to create classes, post assignments, organize folders, and view work in real-time.

I. INTRODUCTION

The E-Learning tool "Google Classroom" is used in the South East European University (SEEU) especially in teaching English for ESP. This paper will discuss how the E-Learning Google classroom tool improves students' language skills and activates their independent learning.

Activities and resources which are presented by E-learning are represented with an analysis of how they can be used to advance the language skills and autonomous learning of EFL students. In this aspect, Google classroom helps students' organization by putting all assignments and work in one safe place. It also helps teachers with creating, copying, assigning, supervising, collecting, grading, and returning work to students, which usually requires a great deal of time and steps. Google Classroom simplifies these tasks by merging, removing, or organizing them.

This tool is easy to use as it merely requires teachers and students to learn how to post information and documents and how to locate the information. The SEEU already has access to Google Classroom so, teachers can easily log in and invite students to join the group and follow the activities. Most of the students had already experienced using other Google apps, like Docs or Spreadsheets, so they are set for using Google Classroom.

II. METHOD

In this paper, we wanted to relate ESP students' experience of participating in a blended ESP course. Our research aimed to see whether students were satisfied with using Google Classroom in an ESP context and to learn about their perception of the advantages and disadvantages of using Google classroom. Additionally, we asked them about their attitudes towards communication with other students and the teacher using Google classroom.

Prior to the questionnaire, students were given materials on Google Classroom, namely the lessons that had been previously taught. Moreover, different types of assignments and quizzes were in disposal so that the students could practice and prepare for the examination. To encourage students' participation, they were informed that they would be awarded points for participation, which would be calculated with their final grades.

III. PARTICIPANTS

The participants in this study are thirty-six SEEU undergraduate students, between the ages of 18-25, male and female, all in the multicultural classroom setting. Their level of proficiency is upper intermediate to advanced level. They study Law and take English for Specific Purposes classes as mandatory courses.

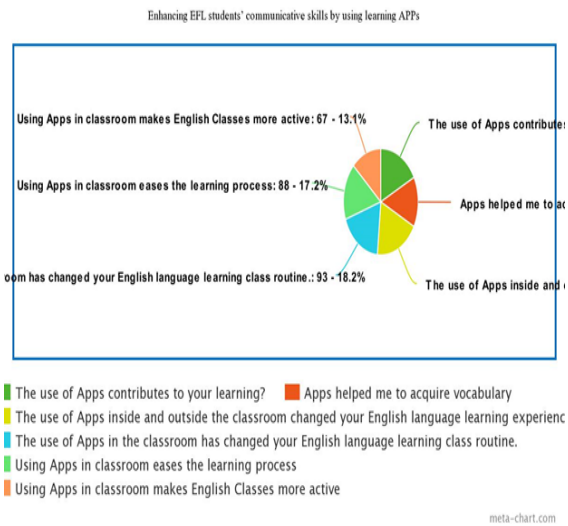
IV. INSTRUMENTS

Study data were collected through student questionnaires that assessed their attitudes toward using Google classroom. The questionnaires were designed in the form of a 5-point Likert scale ranging from "Strongly Disagree" to "Strongly Agree" with values 1-5 assigned to each alternative.

The teacher had posted the questionnaire in Google classroom.

V. RESULTS

When it comes to using Google classroom in an ESP context, most students claimed that using Google Classroom had positive effects on their learning. Most of them favored the possibility of studying when it suits them, then the possibility of choosing the learning material. A very small number of students stated that they did not like studying employing a computer. Conversely, some students proclaimed that they liked the approach because all the required material was available in one place. Many students stated that having direct contact with a teacher is very important to them as they can comprehend better. Considering the teaching material posted on Google classroom, students were generally satisfied with the material they were provided with. Concerning their opinion on the possible improvement of their knowledge of English almost half of the respondents assumed that their knowledge improved. When it comes to the type of study, students preferred the combination of the two given options: classroom and through computers. As for using technology in an ESP context, most of the students liked it. Regarding the question of whether this kind of communication made it easier for them to follow the lectures, about half of the students expressed that it did not quite make it easier. When asked for the effectiveness of the discussion forums as a useful tool to improve learners' writing skills in English, most students considered forums as helpful for improving writing skills in the target language. Regarding the question of what kind of device students use to access Google classroom, where different possibilities were offered to students, many students chose more than one option and the results assert that the most frequently used device for students is still the personal computer.



VI. CONCLUSION

Considering the students' responses, it can be argued that digitalization in the classroom has become a necessity: The study revealed that the best option is blended learning. Most respondents pointed at the possibility of choosing time and place that suited them as an advantage. On the other hand, the impossibility to have enough face to face contact with a teacher and other colleagues was counted as a disadvantage. Students' perception was that teaching in the classroom was very beneficial for them as it helped during their learning process. Students declared that they are not willing to do some activities by themselves, for example, reading. Many students were aware of the importance of the teacher in a learning process.

We can easily observe that incorporating Google classroom into the ESP classroom encourages interaction and boosts students' confidence regarding their knowledge of English as well as their independence. Furthermore, they will likely develop learner autonomy, which will help them learn faster and in more diverse ways.

The Internet has opened the doors to knowledge and the construction of a collective intelligence outside the traditional academic structures. Google Classroom is a tool that offers a combination of learning happening inside and outside the classroom. Therefore, the use of Google classroom should be encouraged in any higher education institution, since the main agents in current higher education are students rather than teachers (Attard et al., 2010). Students need to actively participate in their process of knowledge construction, and Google classroom enhances this active participation, access, and sharing of information. The wide variety of activities and resources on the Google classroom needs to be stimulated in the English language Modules to increase the time that students interact with the language. This will motivate students to work autonomously, which will encourage life-long learning.

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Usability Evaluation in Selecting Educational Technology

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Abstract - Usability is important to consider when selecting technology for educational use in a learning environment. It can influence learning and teaching experience, and consequently adoption and retention of educational technology. The objective of this study is to (1) analyze and systematize usability methods and attributes that scholars have considered in the context of educational technology selection in higher education, (2) analyze pedagogical criteria, and (3) the learner/teacher perspective in the identified approaches, as well as to (3) identify future research perspectives in this regard. Therefore, a systematic research review has been conducted and 45 papers have been selected and analyzed. Analytical methods, particularly expert assessment, have been more often reported than empirical methods. The most frequent usability attribute is ease of use. Most of the studies have addressed pedagogical criteria to some extent. Almost a half of the studies have attempted to consider the learner/teacher perspective by involving actual or prospective users. There is a need for a relatively simple and efficient, yet effective enough, usability evaluation that fits well into the educational technology selection. However, it is mostly unverified how well the reported approaches meet this need. Notwithstanding, there are positive examples that deserve attention and further research.

I. INTRODUCTION

Higher Education Institutions (HEIs) face rapidly changing technological advancements. Through the use of Information and Communication Technology (ICT), educators in HEIs need to discover or adapt ways for enhancing student learning, performance and satisfaction [1]. However, in a myriad of ICT platforms and applications available today, choosing the appropriate ones for students is time-consuming, difficult and troublesome process for institutions and educators [2][3]. The selection process usually relies on a number of criteria such as functionality, pedagogical concerns, usability, etc. These criteria vary depending on the technology and the learning context.

Usability is an important, yet demanding selection criterion. Inadequate usability may make learning more difficult [4] and may even affect student's achievement [5]. Moreover, usability is seen as an important factor in mitigating learner frustration and anxiety [6][7]. Poor usability of educational technology can leave negative consequences on the learning experience and motivation of learners [6].

Consequently, usability may influence directly or indirectly educators' decision about educational technology integration [8] and students' willingness to use or to continue to use educational technology [9][10][11].

According to one of the most cited definitions, which was provided by International Organization for Standardization (ISO), usability is "the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of us" [12]. Nielson has provided another highly cited definition of usability through its five attributes: learnability, efficiency, memorability, errors and satisfaction [13]. In addition to his vision of multidimensionality of this concept, many other attributes have been proposed in literature and used in practice to operationalize and evaluate/measure usability. According to another view, usability definitions may serve to explain what usability is, whereas the usability measuring techniques may be unrelated directly to usability elements (e.g., identification and description of usability problems) [14].

Consequently, a variety of evaluation methods have been employed to measure usability. One of the basic classifications includes analytical methods, which are conducted by usability experts (e.g., inspections), and empirical methods, which require participation of real users, thus involve usability testing and inquiry methods (questionnaires and surveys) [15].

Some authors have argued that usability of educational technology, i.e., technology employed for educational purposes, cannot be measured in the same way as usability of other technology because of the specific nature of learning. On those grounds,

several frameworks and methodologies that include both so-called technical and pedagogical usability have been proposed [16][17][18][19].

With the expansion of various types of ICT that are free, easy to access and useful for educational purposes, educators/teachers more and more become evaluators and decision makers in the selection process. A careful approach to usability when selecting or reconsidering technology already in use increase chances that users' effort is invested into teaching and learning effectiveness, and not into teaching and learning how to use technology. Yet, extensive usability evaluation is demanding and, thus, usually conducted or facilitated by usability experts in contexts rather different then technology selection. This brings up the question how the challenge of usability evaluation is met in learning environments of higher education when (re)considering the use of technology.

This systematic review aims at examining and analyzing what usability methods and attributes/criteria have been proposed or employed in studies on educational technology selection, and how they have been employed. Moreover, the review investigates whether and how pedagogical criteria have been addressed along with usability criteria, and how the learner and teacher perspective has been considered in the identified approaches.

The review highlights the need for fostering educators' competencies in evaluating, selecting and integrating educational technology. In this regard, the future research perspectives that have been identified or implied in the article can be worthwhile to consider. Moreover, it informs educators/teachers and interested parties on prospective usability approaches that can be taken when evaluating and comparing technology alternatives. At the same time, the review warns of disputable validity and effectiveness of some approaches that have been proposed in literature.

II. METHOD

A systematic literature review has been conducted according to Kitchenham [20]. The following subsections describe the method details.

A. Research Questions

The following research questions have been formulated:

RQ1: What methods have been proposed or employed in the context of educational technology selection to evaluate usability?

RQ2: What usability attributes, i.e. criteria, have been proposed or employed in the context of educational technology selection?

RQ3: How have pedagogical criteria been considered in the identified approaches?

RQ4: How has the learner and teacher perspective been considered in the identified approaches?

In addition, the types of studies, as well as the categories of educational technology have been reported.

B. Search Strategy

The search for relevant studies has been performed by using the following recognized sources: SCOPUS, ACM, ISI (Web of Science & Web of Knowledge) and IEEE digital libraries.

All the papers published before 2019 have been considered. After testing several search strings for retrieving relevant studies, the resulting search string has been as follows: (usability OR 'ease of use' OR 'easy to use') AND (educational OR learning OR e-learning) AND (software OR platform* OR system* OR technolog*) AND (evaluation OR evaluating OR assessment OR assessing) AND (selection OR selecting OR choosing).

The search has also involved following up the references and the citations of the selected papers.

C. Inclusion Criteria

The following inclusion criteria have been defined:

- A paper introduces a novel approach of educational technology evaluation, reports on an application of the existing evaluation approach, or presents a comparative study of educational technology, all in the context of technology selection.
- The evaluation approach reported in a paper involves, or is based on, usability criteria and/or methods.
- The evaluation approach is well described and applicable in higher education.
- The paper is written in English.

D. Selection of Primary Studies

First, the search and selection of primary studies have been conducted by using the selected digital libraries. Then, the backward and forward snowballing has been conducted.

In the first phase, the title, abstract and keywords have been examined for all of the papers. In the second phase, the whole paper has been read and assessed for consistency and precision in writing.

The selection process has been facilitated with a template that had been developed to register relevant information about each resulting paper (ID, Reference, Type of publication, Name of the conference or journal, etc.)

E. Data Extraction Strategy

1178 studies have been obtained from the digital libraries. After inspecting the papers, 40 papers have been selected for the analysis phase based on the inclusion criteria.

In addition, the 306 references have been followed up after excluding books, standards, handbooks, website references, and renowned publications whose topic is not relevant for the review. The inspection of the referenced papers has resulted in selection of 7 additional papers.

The citations have been tracked by using Google Scholar. The large number of citations of some papers has been narrowed down by browsing within citations with the search terms 'select*', 'choose' and 'usability'. The inspection of the 480 retrieved citing papers has resulted in selection of 9 additional papers.

After excluding 6 duplicates and a paper whose full text is not available, 49 relevant papers have been obtained. Due to the quality issues, specifically inconsistencies and imprecision in the writing, 4 of the relevant papers have been discarded. This makes in total 45 papers obtained for analysis.

For the purpose of data extraction and analysis, a template has been created (Study Reference, Type of Educational Technology, Evaluation Criteria Proposed, Usability Evaluation Approach, etc.).

III. RESULTS

This section presents the results of the data analysis.

A. Types of Studies

The following types of studies have been distinguished:

- comparative study (35.6%) - evaluates and compares a set of educational technology with the primary or secondary purpose to help decision makers in technology selection;
- methodology proposal (33.3%) - introduces a method(ology) for educational technology evaluation and/or decision making for the purpose of selection;
- technology selection (15.6%) - a study on educational technology selection conducted in a specific learning environment;
- model proposal (8.9%) - introduces a quality, evaluation or decision-making model that encompasses aspects found relevant for selection of a certain type of educational technology;
- criteria investigation (6.7%) - comprised a correlational study on selection criteria and two empirical studies on criteria elicitation.

Most of the model and methodology proposals also include technology evaluation/selection case studies or comparative studies to demonstrate the applicability of the model/methodology.

B. Categories of Educational Technology

Over 40% of the studies have focused on e-learning platforms. 8.9% of these studies have focused specifically on open source e-learning platforms.

The four studies (8.9%) have dealt with educational technology in general. The remaining 48.9% studies have addressed different types of educational technology, such as dictionaries on smartphones [21], MOOC platforms [22], tutorial creation software [23], virtual learning environments [24], etc.

C. Usability Evaluation Methods

A usability evaluation method that has been most often reported in the studies is expert assessment (21 studies). The other reported methods are: mixed approach (7 studies), user testing (4 studies), questionnaire-based evaluation (3 studies), heuristic evaluation (2 studies), checklist-based evaluation (2 studies) and survey (2 studies). Finally, two papers have introduced a new method. The remaining two studies have not considered any evaluation method due to their focus on selection criteria investigation.

D. Participants in Usability Studies

In more than a half of the studies (23 out of 45), participants such as students, faculty members and experts (other than the authors) have been reported. Two papers have avoided reporting the category of participants.

Participants have been involved in all types of studies except for checklist-based evaluation. Students have been the most frequent participants since they have participated in 14 of the studies

involving user testing, surveys and questionnaire-based evaluation.

E. Usability Attributes / Criteria

61 usability attributes have been specified in 39 of the analyzed studies. The remaining 6 papers have dealt with heuristics.

The usability attributes considered in more than five of the analyzed studies are ease of use (12 studies), (perceived) usability (8 studies), satisfaction (7 studies), efficiency (6 studies), effectiveness (5 studies), learnability (5 studies). Ease of learning and learnability are considered as the same attribute.

Most of the usability attributes have been proposed in only one of the studies. They typically have the terms "ease" or "easy" in their names, e.g., ease of access, ease of finding information, easy and fast access to contents. Such attributes may be considered as a subcategory of ease of use.

In addition, over 60% of the studies have reported the use of at least one usability metric for measuring the specified usability attributes. Subjective metrics such as scores based on different scales (e.g., a 1-to-5 rating scale) have been dominantly employed. Several studies have used objective metrics such as task completion time and task completion rate for expressing efficiency and effectiveness.

F. Pedagogical Criteria and Concerns

Two approaches have fully integrated usability and pedagogical criteria. Squires and Preece [19] have proposed the 'learning with software' heuristics by combining usability heuristics with socio-constructivist criteria for learning. Similarly, the checklist of Bednarik et al. [25] has comprised the consequent parts devoted to technology, usability and pedagogy to guide educators in selection of educational software.

Two studies have considered technological and pedagogical aspects in their model proposals for selecting e-learning platform [26][27]. Likewise, the methodology proposal for selection of software tools for IT programs by Parker [28] has involved pedagogical features. Furthermore, a quantitative evaluation model that assesses attributes of LMS platforms introduced by Osma, et al. [29] has encompassed pedagogical criteria.

In addition to usability, King and Newman [30] have considered pedagogic issues and potential enhancement of students' employability skills as selection criteria. Similarly, Albarrak, Aboalsamh, and Abouzahra [31] have considered "curriculum mapping and planning" criteria. Among other criteria, the comparative study by Bastos and Machado [21] has involved "student perception of the pedagogical potential".

2 out of 3 studies on criteria investigation have resulted in categories of both pedagogical and usability criteria [32][33].

In addition, the pedagogical concerns have been more or less marginally addressed in many of the studies by considering features/functionality (e.g., [34]) and usefulness/utility (e.g., [35]) of the given technology.

IV. DISCUSSION

This section discusses the results according to the research questions. Usability evaluation methods, usability attributes/criteria, pedagogical criteria and learner/teacher perspective have been discussed respectively.

A. Usability Evaluation Methods Proposed or Employed (RQ1)

The dominant approach used for usability evaluation in the selection context is expert assessment. Used as an umbrella term, expert assessment has comprised simple qualitative reviews, such as learner or teacher reviews, quantitative assessments, as well as mixed assessments. It has been mostly conducted by the authors themselves. If we assume that they have taken the expert position, users' perspective is rarely taken into account. In addition, there is no much evidence of systematic assessment activities, expertise, or the number of the assessors. Therefore, the effectiveness of such methods is questionable.

What is not questionable is the need for simple and efficient (yet effective enough) usability evaluation approaches. This is evident in both analytical and empirical categories. It might be a reason why heuristics have not been proposed or employed more often. Another reason might be unfamiliarity of researchers/educators with this approach. Moreover, the focus of some studies on multiple criteria decision analysis has arguably contributed to the prevalence of quantitative assessment.

With regard to empirical methods, user testing, when conducted, has been mostly informal and has involved a small number of participants, dominantly students. The more formal methods have required expertise and experience, even resources such as equipment, which are presumably common in

Human Computer Interaction (HCI) university departments, but rarely beyond that. Therefore, the rare use of formal usability evaluation methods in selecting educational technology is not surprising.

It is somewhat surprising though that inquiry method has not been more often employed as a relatively simple and fast way to collect learners' and teachers' perception towards usability problems, and even collect some subjective usability metrics. A reason could be a viewpoint that the selection process is over when educational technology is introduced into a learning environment. However, there have been several approaches that oppose this viewpoint. To this end, usability evaluation or verification in the second (post-implementation) phase of the selection process, as well as field studies within the selection process with teachers' and learners' direct involvement could be a feasible approach.

Metrics can be a useful aid in comparing multiple technology alternatives. However, they have to be carefully selected, collected and interpreted. The use of a single metric, i.e., a metric obtained from a single measuring technique, like in most of the analyzed studies, can be misleading.

Whether new or existing, effectiveness of the reported usability approaches in selecting educational technology is largely debatable. Most of the studies lack a scientific evidence of effectiveness and validity of the approach in the given context. More empirical studies are needed to address the identified research gap.

B. Usability Attributes / Criteria Proposed or Employed (RQ2)

Ease of use and, to somewhat smaller extent, 'perceived usability' have been the most frequently considered attributes/criteria in the analyzed studies. Many specializations of 'ease of use' have been noted, each in only one (e.g., ease of peer interaction) or two (e.g., ease of discussion with other learners) of the studies. In most of the cases, it is not quite clear why the particular usability attributes have been chosen and how they have been defined. It is possible that different terms have been used for the same attribute, even when it is not so obvious, like navigability and ease of navigation.

As standard usability attributes, effectiveness, efficiency and satisfaction [12] have been employed in the selection context to some extent, mostly in user testing. Usability attributes have been selected according to ISO/IEC 25010 [36] in one of the studies. No other standards have been considered when selecting usability attributes.

C. Pedagogical Criteria Proposed or Employed (RQ3)

More than a quarter of the studies have explicitly involved pedagogical criteria along with usability criteria in the educational technology selection process. Moreover, a considerable number of the studies have marginally addressed them through consideration of functionality and utility/usefulness of the technology. Some of the studies, however, have had a specific focus on 'common' usability, or usability with several technical criteria such as accessibility, personalization, etc.

Although usability and pedagogical appropriateness have been typically seen in literature as complementary, only a couple of earlier approaches has attempted to fully integrate usability and pedagogical usability. Most of the studies more or less acknowledge both these aspects and evaluate them by using simple assessment methods, or separate methods/practices. The latter allows some well-known usability evaluation practices to be applied when addressing usability criteria in the selection context. However, the analyzed studies have mostly failed to address complementarity of these two aspects more profoundly.

D. Learner and Teacher Perspective (RQ4)

The authors of the analyzed studies recognize the importance of considering the end user perspective when selecting educational technology. This is why they have addressed the usability criteria at all. Nevertheless, most of them have not involved learners and educators/teachers in the selection process. It is understandable for teachers, since most of the studies have been small scale, and probably only the authors themselves have been involved in teaching.

University students have participated in more than a third of the analyzed studies. Participation of both students and teachers in usability studies on educational technology is highly advisable.

Most approaches for eliciting the learner/teacher perspective have been based on a single method/practice, which, without questioning the validity, limits their potential. The promising results could be expected from the mixed approaches. The joint practices of user testing and inquiry ensures an insight into usability evaluation from two perspectives: objective and subjective. Such efforts

are rare though, presumably due to educators' perceptions that they are difficult to take and time-consuming, or educators' unfamiliarity with this kind of approaches.

Although under-applied, inquiry practices could be quite useful for obtaining the learner perspective from a larger number of learners. This has proved as feasible in the two-phase approaches in which the second phase implies the use of a preselected technology in a learning environment. The learner perspective elicited in an actual learning environment could be more revealing. The inquiry practices can also be useful in complementing each other (quantitative vs. qualitative) and complementing other practices.

Interestingly, there have been some attempts to consider the learner perspective by engaging students as learner experts. Although the procedures have not been described in sufficient detail, this could be a practice worth investigating further.

The perspectives of students and teachers have been considered jointly in few studies. None of the studies investigating selection criteria has not involved both, the learner and teacher perspective.

V. CONCLUSIONS AND FUTURE PERSPECTIVES

Analytical usability methods prevail over empirical methods when selecting educational technology. Moreover, less formal methods prevail over more formal ones in both analytical and empirical categories. Specifically, expert assessment, which comprises informal reviews, quantitative and mixed assessment, is dominantly employed. User testing, whether separately or within a mixed approach, is employed almost two times less than expert assessment. It is mostly informal and involves small number of participants, mainly students. The inquiry methods are more used on a small scale (to complement user testing and heuristics) than on a larger scale and separately. Although the use of a single usability practice is not recommended, mixed approaches are under-applied.

Consequently, a significant number of usability attributes are reported, but most frequently ease of use and (perceived) usability. However, selection of usability attributes is not fully corroborated theoretically or empirically in many of the approaches.

Pedagogical criteria are, if not fully or partially integrated in the identified selection approaches, then marginally considered within the selection criteria of functionality and usefulness/utility in most of the studies. Yet, complementarity of usability and pedagogical appropriateness should be better addressed.

Scholars recognize the need for considering the learner and teacher perspective in the given context, but this comes with many difficulties. Less than a half of the studies attempted to elicit the learner/teacher perspective by involving actual or prospective users. Nevertheless, there are some promising results worth further investigation.

There is a clear need for relatively simple and efficient, yet effective enough, usability evaluation approaches that fit well the process of educational technology selection. However, effectiveness of the reported usability approaches, whether new or existing, is mostly unexplored or disputable, and requires further research in the given context or in particular sub-contexts. There is also enough research space for proposals of new approaches, or adapted usability and HCI practices with careful consideration of the educational context. Simple tools that facilitate the evaluation and selection should be considered as a part of some of these proposals. In addition, research in this area would benefit of more focused studies investigating usability attributes and metrics.

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3D Modeling Solutions in the Cloud

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Abstract –The article presents cloud solutions for 3D modeling, which can be used in technology education to create and visualize technical objects, when working on the design and solution of various technical and creative tasks. You offer SketchUp Free and Autodesk Tinkercad software solutions with an intuitive and easy touse interface.

I. INTRODUCTION

Cloud Computing's main idea is for users to access powerful computing and disk resources without being interested in the physical location of these resources, their support and management [1]. The integration of cloud technologies into technological education is conditioned by public needs and expectations for the modernization of the learning process[2].In the classroom of the future, students will have an electronic device that will provide access to homework and other learning resources in the cloud. there will be no heavy textbooks, all materials will be available as long as there is an Internet connection. This innovation will give students and teachers great freedom, and they will be able to work on their projects from school, home and anywhere else. One of the problems of modern pedagogy is the declining interest of students to study and gain knowledge. For this reason, it is necessary to establish a mechanism for forming students' motivation in order to be able to purposefully influence it, in which teachers will be able to effectively manage the learning process [3]. One option to increase students' motivation to learn is the skillful use of cloud technologies in their learning.

II. CLOUD SOLUTIONS TO CREATE 3D MODELS

SketchUp *Free and Autodesk Tinkercad cloud solutions* provide just as many lye tools as desktop applications. Important advantages of cloud solutions is that created 3D models can also be viewed and edited over mobile devices, do not require the purchase of software, and created models are stored in the cloud.

SketchUp FreeSketchUp Free's cloud solution is a powerful tool for 3D network modeling, which is free. An Internet connection and a Google Account are required to work with this solution.SketchUp's core 3D modeler works directly in the web browser. For storage of created models, 10 GB is provided in trimble connect cloud storage.SketchUp Viewer's app can view 3D models on your mobile device. Created models can be imported into SKP, JPG, PNG file types, and display SKP, PNG, STL file types.The 3D gallery allows access to user-generated and manufacturer-made models.

SketchUp Free is located at:https://www.sketchup.com/plans-and-pricing/sketchup-free.

The working screen of SketchUp Free is shown in (Figure 1).

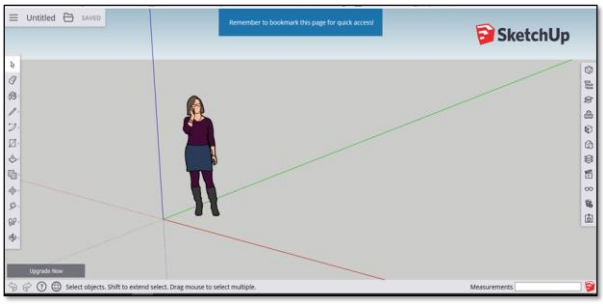

Figure 1 The working screen of SketchUp Free

To create models with Google Sketch Up, you need to draw edges and faces using a few simple tools. It will take you almost no time to study them. With the Push / Pull tool you can turn any board into a 3D shape. In addition, the software works with Google Earth, which allows you to deploy scaled aerial photos directly from there or use SketchUp to create models that can be seen in Google Earth.

Figure 2 shows a 3D model of a housewith aSketchUp**.**

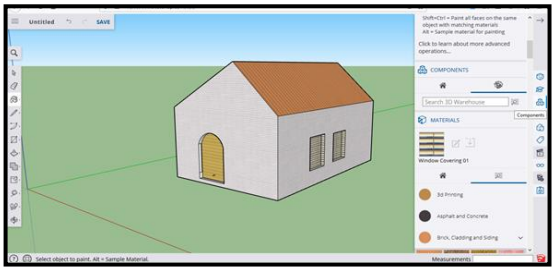

Figure 2 shows a 3D model of a house

SketchUp for Schools

SketchUp for Schools is a free version of SketchUp available to any primary or secondary school signed up with G Suite for Education. With SketchUp for Schools, students around the world have access to free and intuitive 3D modeling tools that enable creative expression and skill development from a young age [4].

Autodesk Tinkercad

The Autodesk Tinkercad cloud solution has a very simple interface. The site, located at: https://www.tinkercad.com/, has completely free training in the basics of working in this 3D editor.

In order to use the functions of the editor, site registration is required. The service is ideal for simple projects with the ability to organize subsequent 3D printing.

The Autodesk Tinkercad work screen is shown in figure 3.

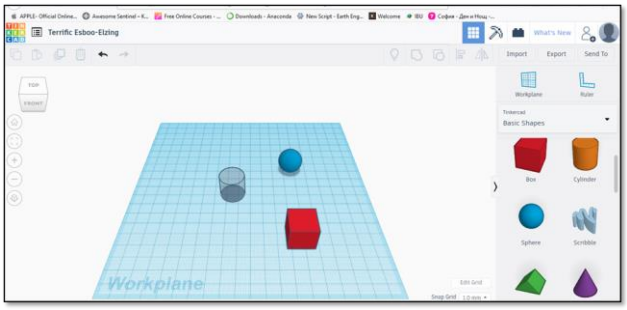

Figure 3. The working screen of Autodesk Tinkercad

Autodesk Tinkercad has a library of ready-made elements, which helps to quickly create 3D models. An online textbook is available. All tools are free. Autodesk Tinkercad has an electronic circuit modeling environment that includes the following modules:

- Editor for electronic circuits.
- Emulator for operation of the main electronic components.
- Emulator for the Arduino controller.
- Sketch editor.
- Debugging and project simulation system using Arduino.

Figure 4 shows an electrical circuit, which includes: voltage source, electric switch, wires and consumer.

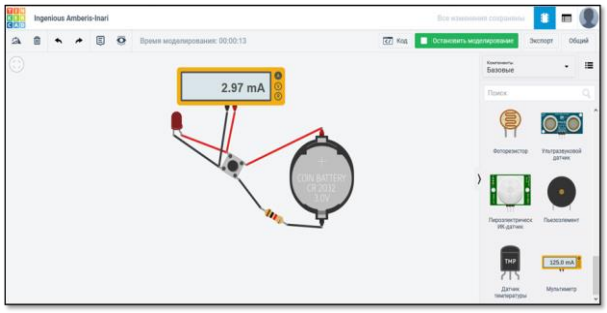

Figure 4. Electronic circuits

CONCLUSION

Cloud technologies are evolving and very soon all aspects of our lives, including education, will be affected. Cloud technologies provide new opportunities for the realization of pedagogical goals and change the educational environment and ways of communication between teacher and students, leading to an increase in their motivation to learn.The application of cloud technologies in the educational environment allows to ensure mobility, accessibility and timeliness of the created 3D models. Cloud technologies for 3D modeling can be a useful tool in education that stimulates creative thinking of students, activates the process of learning new concepts and generating ideas. Mastering and using cloud solutions to create 3D models is a challenge for both teachers and students.

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Possibilities of Using Big Data Analytic in Police Work

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Abstract: The extensiveness of the data available is conditioned by the existence of technical devices whose readings connect to the Internet as both a challenge and a resource. However, in modern conditions, the main problem is not the collection and storage of large amounts of data, but the extraction of useful information from that data. This is also the essence of Big Data analytics. It represents selection and analysis, that is, intelligent decision-making based on a large amount of data collected. Gaining an advantage from its use is a high priority for members of the Ministry of the Interior. This is due to the growth in the use of numerous information systems, reliance on intelligence, eavesdropping and reconnaissance technologies (criminal intelligence, combating cybercrime), as well as the collection of a wealth of public administration data (biometric data, vehicle registration, residence and residence). The rapid processing of data and the development of analysis tools should be in the function of enabling timely and accurate data to be received by field staff (on road traffic safety, crime mapping, etc.). This paper points to the importance of correctly and fully interpreting such data in the limited period of time necessary for efficiency above all in police work. Unsurprisingly, significant financial investment by individual countries into the resources that would gain the ability to accumulate data and process it using Big Data analytics is a contemporary trend.

I. INTRODUCTION

Data management and analysis has always been a major challenge for society as a whole, and for the police and other employees of the Ministry of the Interior. The application of modern technologies today leads to the collection of an extremely large number of unstructured data, which poses a great challenge to relational databases. However, data collection and storage alone does not provide input to decision makers without selecting and analyzing such data. Creating analytical departments in the police and other appropriate services, which rely on large database instruments in their work, significantly improves the efficiency and effectiveness of the work of these entities.

Accordingly, this paper deals with a newer way of accessing work with a huge amount of data, which can be referred to as Big data analytics. Therefore, it represents how the data, which by the use of modern technologies will be collected, reduced, analyzed and used. Big data analytics is important because it enables the collection, storage, management and processing of huge amounts of data at high speed, which is inevitable in modern conditions.

II. BIG DATA

The term "Big data" is a relatively recent date (first used in 1997) and is a system based on a specific information technology. Refers to large-scale structured or unstructured data, that is, to signify large datasets that exceed traditional storage methods by volume.

For example, a Google search yields 275 million Big Data views in 2017, of which 25.8 million are news, 53.3 million are videos, and 760,000 are books; 35.9% of the total findings were issued in the US; to the period from 01.01.2000. to 31.12.2011. 93.2 million data were published while in the period from 01.01.2012. do 10.04.2017. 741 million data entered; in the last 60 minutes compared to the search time 15,100 data were published; etc.

Data that is stored, and characterized as voluminous, is considered to exceed the capacity of commercial storage devices. To generate this type of data, to put it simply, information technology based on hardware, software and objects that send information to the server is used:

Hardware - Servers and clouds of considerable capacity that function as a central storage unit,

Software - tools and applications that connect objects to a server

Objects that send information to the server - e.g. TETRA devices.

The phenomenon of “Big Data”, or “Big Data” analytics, is definitely characterized by: volume, velocity, variety although other characteristics (complexity, probability, sensibility, quality, value, etc.) are also mentioned.

Volume - Many factors contribute to the introduction of data volumes (transaction data stored for years, textual data constantly coming from social networks, etc.). In the past, too much data has created storage problems, but with today's pricing and storage capacity, this is no longer a problem. Still, other problems arise, including determining the importance of certain data in large masses.

Variety - Today, data comes in many different formats. Here we have traditional databases, text files, e-mail, video, audio, financial transaction data, etc. According to some estimates, about 80 percent of the data are non-numerical, but they still need to be included in the analysis and decision-making procedures regarding them.

Velocity - Data processing speeds are two things. The first is the speed of data production and generation, and the second is the speed at which data must be processed to meet certain criteria. Timely response and fast data processing are a major challenge for the largest companies in the world.

III. DATA SOURCES

The development of technologies used to process large amounts of data has contributed to the development of certain areas where such analyzes can be used. For example, great progress can be seen in the field of health or transport. In health care, the number of premature babies can be monitored and, depending on the obtained data, it can be estimated when a certain intervention is needed. In traffic, by analyzing a large amount of data generated by cameras placed on highways, it is possible to predict and regulate congestion and reduce the number of traffic accidents, save fuel, etc.

Data is obtained from a huge number of different sources and comes in different forms. With the rapid development of sensors, smart devices and social networks, data has become more complex, primarily because it now includes not only traditional structured data, but also unstructured data.

Although structured data seems to be well known, in fact, structured data is gaining a new role in light of the Big Data approach. The development of technology enables the emergence of new sources of structured data - often in real time and in large quantities. Such data sources are divided into two categories, computer or machine-generated data and human-generated data:

Computer-generated or machine-generated data - The term machine-generated data usually refers to data produced by a machine without human influence. For example, we classify sensor and web log data in this group

-Sensor data: Examples include radio frequency ID (RFID) tags, GPS data, and more. For example, RFID is rapidly becoming a popular technology. Miniature computer chips are used to track devices remotely. Another example of sensory data sources are smartphones that have sensors such as GPS.

-Web log data: When servers, applications, networks and the like work, they record different information about their activity. The amount of this data can become huge, and this data can be used, for example, to predict security breaches.

Human-generated data - this is data that is provided by people interacting with computers.

Unstructured data is data that does not follow a defined format. Unstructured data is actually the most common data, their number ranges up to 80% of available data. Until recently, however, the technology did not support other ways of working with this data other than storage and manual processing. Unstructured data can be found everywhere, because most people and organizations function on the basis of unstructured data. As with structured data, unstructured data can be machine or human generated. Some examples of machine-generated unstructured data are: satellite images (GoogleEarth), seismic images, etc.In any case, the main problem today is not the collection of large amounts of data, but the selection and extraction of useful information from them. And it is Big data analytics that enables the obtained data to be understood and to make optimal use of their value.

IV. BIG DATA ANALYTIC TECHNOLOGY

Technologies that are classified as "Big data" technologies not only support the ability to collect large amounts of data, but also enable their understanding. The main goal of the Ministry of Interior that has access to big data collections should be to use most of the relevant data in its work to make various right decisions. With the development of computer technology, it is now possible to manage huge amounts of data, which previously could only be processed and used with the help of supercomputers, and at a great cost. System prices have dropped and as a result of new techniques for distributed processing are currently in the focus of use. The real breakthrough in Big data technology happened when companies like Yahoo, Google, and Facebook came to realize that they could make money from the large amounts of data their products generated. These companies were faced with the task of finding a way in the form of some new technologies that will allow them to store, access, process and analyze huge amounts of data in real time, so that they can make a lot of money and use the amount of data they have and who participate in their networks. The resulting solutions have led to changes in the data management market. Some of these technologies will be explained further in the paper.

A.Spark

Apache Spark is an open source project developed under the auspices of the Apache Foundation, and is a tool for fast and efficient processing of large amounts of data, and is one of the easiest Big data tools for learning and development. The reason for this lies in the philosophy behind the project, which is based on principles such as a single engine for the development of end-to-end data processing applications, whether batch, streaming or interactive data processing, development using rich and simple APIs, which will support performance optimization, integration with different systems where data is stored, given that moving data between systems is a set of operations, and integration with different components. Spark enables the use of the total RAM memory of a computer cluster to perform complex and demanding tasks when working with data. It's easy to scale - it's very easy to expand the total capacity of a Spark cluster by simply adding RAM or adding a new machine to the cluster.

A mistake that is often made when it comes to Spark's position in the Big Data sphere is that Spark is considered a replacement for Hadoop. Spark may replace some components within Hadoop, such as MapReduce for data processing, but we still need some other Hadoop components, such as HDFS data warehouse. In the previous period, great efforts were made in the development of Spark components used in data processing. The ease of development of Apache Spark applications is reflected in the very rich APIs that are supported in the programming languages Scala, Python, Java and R. API implementations retain some basic concepts from these programming languages that can help in data processing. So if you are developing a machine learning algorithm using the MLlib component in PySpark (Python API for Spark), the calculations will be performed using a NumPy library that is very efficient for tasks like this.

Another use case is streaming data processing. Spark is a very handy solution for tasks like this, and I use it when I need to process, say, Twitter data coming through streaming. Because it integrates easily with various messaging systems, such as Apache Kafka, you can feed the Spark Streaming application with a variety of data from different sources.

B. Hadoop

Search engine innovators such as Yahoo! and Google have been tasked with finding a way to extract meaning and value from the vast amount of data their systems collect, ie. to understand at the same time what information they collect, as well as how to incorporate that information into their business and improve their business. Hadoop allows companies to easily manage large amounts of data. Hadoop lets big problems be broken down into smaller ones so analysis can be done quickly and cheaply. By breaking down these big problems into smaller parts that can then be processed in parallel, and after the processing is completed, this information is collected and grouped in order to issue the final results. Hadoop is a software framework derived from MapReduce and BigTable systems. Hadoop allows MapReduce-based applications to run on large clusters of regular hardware. It is designed to parallelize data processing using nodes to increase computation speed and reduce response. Hadoop consists of two main components, a highly scalable distributed file system that supports the amount of data measured in petabytes, while the other component is the MapReduce system.

C. Mapreduce

MapReduce is a solution introduced by Google as a way to efficiently execute a set of functions over vast amounts of data in a serial way. The map component distributes a programming problem or

task to a large number of systems and manages task scheduling in a way that balances load and manages error recovery. After the distributed processing is completed, another function called "reduce" is called, which joins all the elements back together to provide the result. One example of MapReduce usage could be the task of determining how many pages of a book are written in each of some 50 different languages. MapReduce is a programming model for processing large data sets using parallel, distributed algorithms in a cluster.

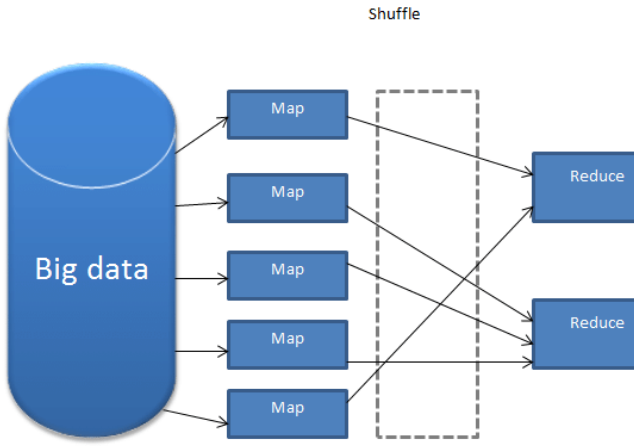

Figure 1. Mapreduce workflow

V. BIG DATA ANALYTIC IN POLICE WORK

It has already been pointed out that Big Data analytics is about analyzing, forecasting, and intelligent decision making based on the large amount of data collected. Gaining an advantage based on its use is a high priority for both the police and other employees in the Ministry of Interior. This is due to the growth in the use of numerous information systems, reliance on intelligence, eavesdropping and reconnaissance technologies (criminal intelligence, combating cybercrime), as well as the collection of a wealth of public administration data (biometric data, vehicle registration, residence and residence).

The mentioned growth of the use of such funds burdens the activities of employees in MoI because a large amount of data for processing is accumulated. The rapid processing of data and the development of analysis tools should be designed to enable field staff to receive timely and accurate information (eg on road safety, crime mapping, etc.).

A particular problem is undoubtedly the (un) availability of experts capable of analyzing large amounts of data and then correctly interpreting different types of complex data structures based on their skills and work experience. This actually reflects the importance of the application of algorithms and Big Data computerized instruments, the application of which creates a sufficient amount of information of satisfactory quality.

Thus, during just one day of a simple complexity mission (eg in traffic control), the drone delivers to the control center 10 terabytes of data, of which only 5% is subject to analysis while the rest is stored. The lack of conditions for analyzing the remaining 95% of the data minimizes the overall quality of the decisions made at the tactical decision level.

High-quality video connectivity, high-resolution photo uploading, text content transfer such as coordinates, sensor readings and more make up such a high transmission capacity. In doing so, Big data enables the drone to collect video-audio data during the flight and to provide algorithmic "readout" through the video, which identifies traffic problems.

Admission of new members of the police force is an important element of the quality of police work. Big Data analytics tools (such as Google Trends, Google AdWords, and Google Correlate) provide layered insights into changes in the younger population's view of policing over time; bring the advertising of suitable jobs closer to those who search for possible jobs in that sector on the Internet (according to the way they are searched, it is possible to predict what the candidate searched on the Internet for several months before applying for a job), and the like. This improves the process of advertising the Ministry of the Interior in the media space, attracts candidates for admission and anticipates the intentions of those interested in admission to the service.

It is rightly considered that big data analytics enables more efficient police action by reducing the time of searching voluminous data, and at the same time increasing the processing speed of collected unstructured data, thus detecting hidden patterns and recognizing anomalies or similar information that can serve better and faster decision-making suppression of criminal activities.

The collection of an extremely large amount of data and the need to select and analyze those with intelligence and security implications, concludes that there is a need to improve existing practices to control, analyze and track the activities of individuals or groups through Big Data analytics creation of special Big Data departments within the analytical segment of intelligence and security agencies, not only in large and specialized services, but also in all others. Namely, in all countries there is a need for greater control of the telecommunication traffic of citizens in the country and abroad, in the sense that the data is adequately manipulated and quality intelligence is created. Therefore, it is not surprising that among the announced new jobs for the highly qualified workforce of the German BND service (Bundesnachrichtendienst), about 67% are jobs for IT specialists and cyber-infrastructure specialists.

CONCLUSION

It is indisputable that the extensiveness of the available data is conditioned by the existence of technical devices whose readings are connected to the Internet as both a challenge and a resource. For example, video analytics are of increasing importance, which implies the generation of information based on video content (eg eavesdropping and surveillance, etc.). However, in modern conditions, the main problem is not the collection and storage of large amounts of data, but the extraction of useful information from that data. Today's technologies provide an opportunity to understand such data and reap the value of it. This is the essence of Big Data analytics.

This paper points to the importance of correctly and fully interpreting such data in the limited period of time necessary for efficiency above all in police work. Unsurprisingly, significant financial investment by individual countries into the resources that would gain the ability to accumulate data and process it using Big Data analytics is a contemporary trend. Thus, for example, the effectiveness of Big Data analytics for policing has already been validated using a similar methodology to identify unregistered vehicles in some Chinese cities (Shanghai).

Within the framework of criminal intelligence, the fight against cybercrime, the application of special investigative techniques (raster search), crime mapping and other modern forms of police work, it concludes the need to improve existing practices to control, analyze and monitor the activities of individuals or groups through Big Data analytics. The problem of collecting extremely large amounts of data and selecting and analyzing them also points to the need to create special Big Data departments within the analytical segment of police and security services, not only in large and economically advanced countries but also in other countries. Therefore, it is not surprising that among the new job openings for the highly qualified workforce of the German BND (Bundesnachrichtendienst), as many as two thirds are jobs for IT specialists and cyber infrastructure specialists.

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Example of Clustering Using K-Means Method in Python

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Abstract: The goal of clustering is to sort the data by similarity, based on a predefined number of clusters. We will demonstrate an example of clustering as such. The idea is to implement an application that, based on the input data from Excel spreadsheets, will display results after clustering. In particular, we worked on random data, which we enter from two tables. The results will be presented in 2D as well as in the 3D model.

I. INTRODUCTION

One of the most basic characteristics of human beings is the ability to group similar objects into groups, the so-called. classification. The grouping of similar objects into categories dates from the very inception of the planet earth, when the first humans had to distinguish different objects that had some of the same or similar characteristics. Classification can be defined as the process of classifying subjects in a field of science into classes, groups of subjects having a common characteristic that differ from other groups in that characteristic, whereas cluster analysis or clustering is the main task of research data retrieval and a common technique for statistical analysis. data, which is used in many fields, including machine learning, pattern recognition, image analysis, information retrieval, data compression, and computer graphics.

II. THE CONCEPT OF CLUSTERING

Cluster analysis is the task of grouping a set of objects in such a way that the objects within the cluster are similar to each other and thus different from the objects of other clusters. Unlike classification, we do not have an "exact" solution here:

- Algorithm performance evaluation is much more difficult than classification
- The suitability of the solution depends on the domain and the application case
- one and the same solution can be evaluated differently in different application cases
- requires the involvement of domain experts to evaluate the solution

The cluster analysis process consists of two basic steps:

1) selection of an appropriate measure of distance (similarity),

2)the choice of a clustering algorithm, that is, a series of procedures for grouping elements so that there are small differences within the cluster and large between clusters.There are different algorithms for solving clustering problems. However, there is no objectively the best algorithm for clustering, because a particular algorithm can produce good results on one dataset and bad on another because clustering depends on the dimensionality, structure and type of data. There are hierarchical and non-hierarchical methods, including the k-mean method, which is the subject of our research. Non-hierarchical sub-clustering methods, more reliable than hierarchical ones, assume that the number of clusters known in advance, or as with some methods, varies during the clustering process.

III. K-MEANS METHOD

The k-means method is one of the simplest, but also the most well-known classification algorithms. Over time, several algorithms have been developed that deal with the clustering process, such as X-means, Kohonen SOM, DB Scan, hierarchical cluster algorithms, and certainly the most popular is the K-means algorithm. K-means is an algorithm that groups data into K clusters, where the number of K clusters is determined in different ways and depending on the preferences of the decision maker. Because it is difficult to determine what is the true number of clusters in the data, the algorithm is most often implemented multiple times, so based on the measure of cluster quality or on the basis of confirmation of cluster quality bythe decision maker decides that the result is satisfactory.

The idea behind partitioning a dataset is to provide a partition of n objects in k disjunct clusters. By definition, an object can belong to one cluster and each cluster must have at least one object (otherwise they would have fewer than k clusters). The classification algorithm is usually iterative; the initial step is usually improved in each subsequent step as long as there are improvements. Defining the initial partition requires a priori specification of the number of clusters. Suppose that a "measure" of

how good a partition is represented by a function J whose value is reduced as far as possible to achieve further optimization of results. A general algorithm for all methods of this type would be:

1. Determine the initial partition in the k cluster and derive a value for the function,
2. Change the partition to reduce the value as much as possible, leaving k unchanged,
3. If new reductions are not possible, the process will stop and the number of clusters existing at that moment will be the final number of clusters. Otherwise, we go back to the previous step.

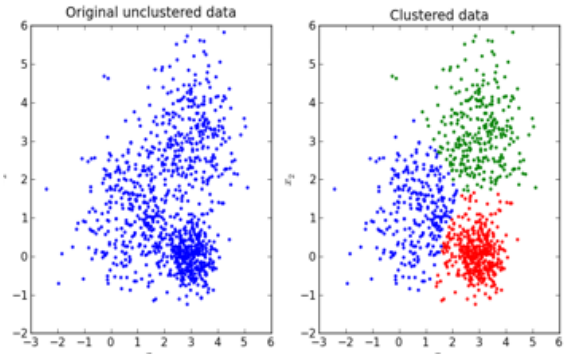

Figure 1: Example of data before and after clustering

IV. GRAPHICAL USER INTERFACE (GUI)

At the very beginning, we will create a user interface with the Tkinter library. We will specify the appropriate width and height of the GUI. When the application starts, a new window opens. The window will contain one label (where we enter the name of the application). Below the name will be two buttons that import data (one button enters a file, the other a directory with multiple files). Then, the user is allowed to enter the desired number of clusters in a specific field. Finally, we will have another button that will generate the k-means algorithm and display the data graphically.

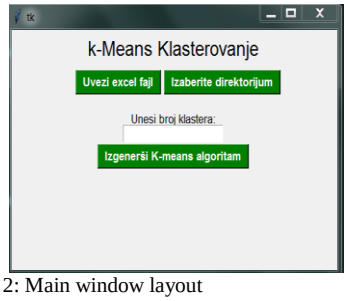

Figure 2: Main window layout

V. 2D MODEL DISPLAY

Clicking the "Import Excel file" button opens the file dialog, window for selecting a file that is called via the getExcel function. The pandas library reads an Excel file from the given columns, in this case x and y. In the event that the file cannot be loaded in the specified manner, an error is thrown.

When we select the desired file, enter the desired number of clusters in the Enter cluster number field. The field is blank by the time the number is entered. When the number of clusters is taken, the code defines the variable that k-means will make. Receives these clusters as a parameter and loads the document. A variable is created that will contain the centers of the cluster, as well as a label that will list what the centers are. After that, the real canvas that will accept that figure is to define the figure that is currently blank and adjust the appearance of that figure. The x and y axes from the file are defined, the label in the k-means itself is adjusted, as well as the color settings, and then the centroids around which the data will be distributed. After that, pressing the "Generate K-means algorithm" button results in a clustering result in the form of a graphical 2D view, using the getKmeans function, which will be shown in Figure 3.

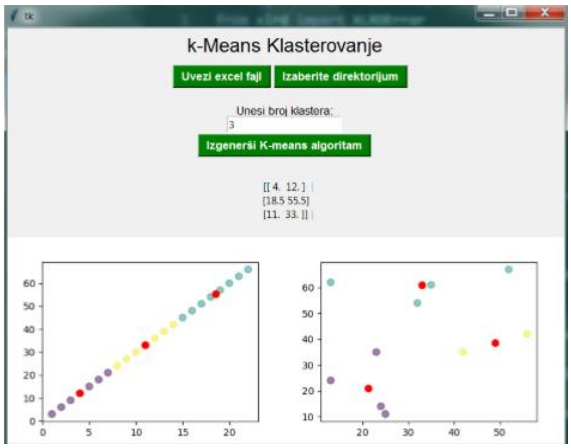

Figure 3. 2D display of clustering results

VI. 3D MODEL DISPLAY

To get a 3D view of the results, we must first add one more column of z to our tables.The clustering process is done in the same way as for 2D display, you just need to make some changes to the code. The left side of the next image shows a clustering result of data entered from a single file, while the right side of the image shows a clustering result imported from a directory.

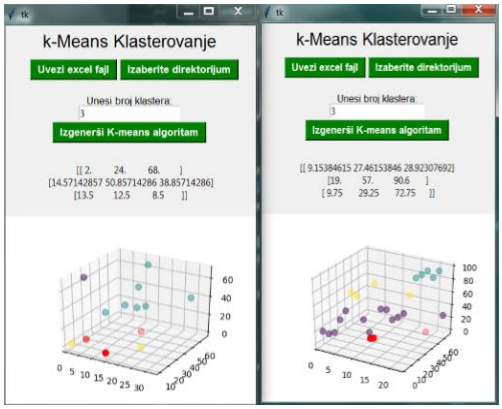

Figure 4. 3D view of clustering results

CONCLUSION

Cluster analysis is widely used in many scientific fields. Cluster analysis techniques are used to find clusters. groups, in an a priori unclassified multivariate data set. Although cluster analysis techniques are very useful for data analysis itself, they require careful attention in order to avoid the wrong solutions. Many cluster analysis methods have been developed and numerous studies have shown that there is no best method, but it depends solely on what we want to get. we show. In order to successfully apply the cluster analysis technique, it is necessary to study well the data from which the conclusion will be drawn and the direction in which the analysis itself will go in order for the appropriate model to be applied. Clustering respects the orderliness of nature itself, where objects do not tend to be distributed randomly and evenly. Nature has the property of grouping. Clustering is performed when classes for object sorting are not known in advance. What makes clustering even more possible is to reduce the number of cases being analyzed by treating clustered cases in a cluster equally, and it is sufficient to analyze only the representative of each cluster, etc. As clustering is applied in more and more fields (psychology and other social sciences, biology, statistics, mechanical learning, data research, etc.), existing algorithms need to be refined and new algorithms with less time and space complexity need to be refined. To achieve this, it is also necessary to discover new techniques and data structures that will be used in algorithms and contribute to their efficiency

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Example of Fuzzy-based Search Mechanism in Python

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Abstract -The example that will be described in this paper is about to present a concrete use of fuzzy logic. It shows possibilities and certain advantages of fuzzy logic. The basic idea is to compare the fuzzy and the ordinary search, thereby pointing out the basic differences in both the inference and the data processing itself. In particular, several files of different extensions with 30 cities from the territory of the Republic of Serbia were given. These cities will first be loaded and then examined to see if there is a match to the string entered by user. By examining, we will see if it is necessary to enter the correct name, as well as how the fuzzy search works, in this case by using the Python fuzzywuzzy library.

I. INTRODUCTION

Artificial intelligence has evolved in two basic directions, namely the study of natural intelligence and the attainment of intelligent behavior by applying different approaches, that is, by not applying natural systems. When it comes to the application of artificial intelligence, expert systems, robotics and neural networks are among the many fields. Perhaps not so well known in the field of artificial intelligence applications, and quite important and useful and that this work will further address, are the fuzzy systems. Fuzzy logic, occurs in the 1920s, as a theoretical, "possible" solution. From then until today, fuzzy has come a long way and reached the very center of artificial intelligence, and some things have become almost unthinkable without such solutions. "Fuzzy-based control systems are used in many consumer electronic devices to fully adapt to changes in the environment. Fuzzy logic concepts and techniques have also been used profitably in linguistics, behavioral sciences, disease diagnostics and even market analysis."[5]

II. FUZZY LOGIC

LotfiZadeh was the first to define fuzzy logic in 1965. and explained it as "an ambitious effort to close the gap between mathematics and the human intuitive way of thinking, speech and interaction with the world."[1] Fuzzy logic is a form of artificial intelligence, i.e. type of logical solution with multiple values, where they can be any real number from 0 to 1. In other words, fuzzy deals with partial accuracy. The value of accuracy is in the domain of total accuracy and complete inaccuracies.Fuzzy sets rests on mathematical principles, but understanding the stage of the meetings, they rely on the understanding of classical, discreet sets. An element's affiliation with a classic, discreet set is final and determined entirely, i.e. element, either belongs or not (either has a value of 1 or 0). Fuzzy sets have not seen as affiliation, but in the degree of belonging. This degree is derived from the interval [0, 1], namely belonging to the function that mirrors every universal set element in this interval of real numbers. In this way, the system becomes significantly adaptive.However, it is important to make a difference between the fuzzy sets and the probability. Although at first glance fuzzy logic resembles a probability, differences are significant. It is likely to examine the accuracy of accidental events, while the fuzzy logic has to deal with inconclusive and inadequtions. A good example of such a comparison would be a "tall man" statement. Namely, that would be the case for the fuzzy logic, while the probability would be applied for recurrence and symbolized by incidental process. We can conclude that the fuzzy logic is dealing with the subjectivity of man, whereas the probability is more and more objective in statistics and science.

III. APPLICATION CONCEPT

The primary idea of this example is to compare the fuzzy and regular search. It has been given several files of different extensions (*.txt*, *.csv*, *.docx*, *.xslx*) with 30 cities from the area of the Republic of Serbia. It should be mentioned that the availability of Python libraries plays incredibly big role when it comes to development of intelligent systems such as this one. This application was developed in Python v3.8 and pip installer v19.3, whilst versions from

libraries such as: Tkinter, FuzzyWuzzy, docx, xlrd are: 8.6, 0.17.0, 0.8.10, 1.2.0, in order. Based on the use of these libraries, thecities will be loaded first, and then questioned whether there is a match with

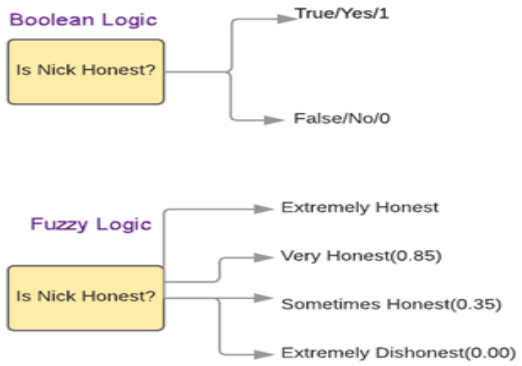

Figure 1 Fuzzy and Boolean logic compared

the entered string. We will be using Python library FuzzyWuzzy for fuzzy search. The basic purpose of this library is to work with the strings, which is also the most common example of fuzzy. Therefore, this example relied precisely on this library.

IV. GUI BASE

In order to achieve the desired goal, which is certainly an adequate input for the user, it had to contain the GUI creation. In the example of our application, the Tkinter library was used to create a graphical interface in the first place, after which it was given the appropriate width and height. When an application runs, the main window is started.Enabling adequate interactivity was possible through the Tkinter function of Askopenfilename. It opens a window for selecting the file from which the search will be done. The window opens by pressing the "Fuzzy pretraga" (eng. Fuzzy search) or the "Obicnapretraga" (eng. Regular search) button.

V. FUNCTIONALITY

In this chapter, we will describe the features that were used to make searches of this application completely usable:

- get_matches (query, limit) - collects the accuracy match of the input with the strings from the files. The base of the function is fuzzywuzzy module process and it's function extract(). Parameters:
- query - forwarded by the function pass_value () in GUI button, or the last saved value for the query that this function will process.
- limit - the number of results that will be shown. On graphical interface user is able to specify the number on an input field next to 'Unesitebrojtraženihvrednosti'(eng. 'Enter the desired number of results').
- Function city() called to get the array of cities.
- city () - checks the file extension. So if the selected file ends, let's say, *.docx*, it will open it, and it will put the list of cities in an array, that will then be returned (and used weather in regex or fuzzy search).
- re.search(query) – regex search function. Query is passed with pass_value() function in GUI button.

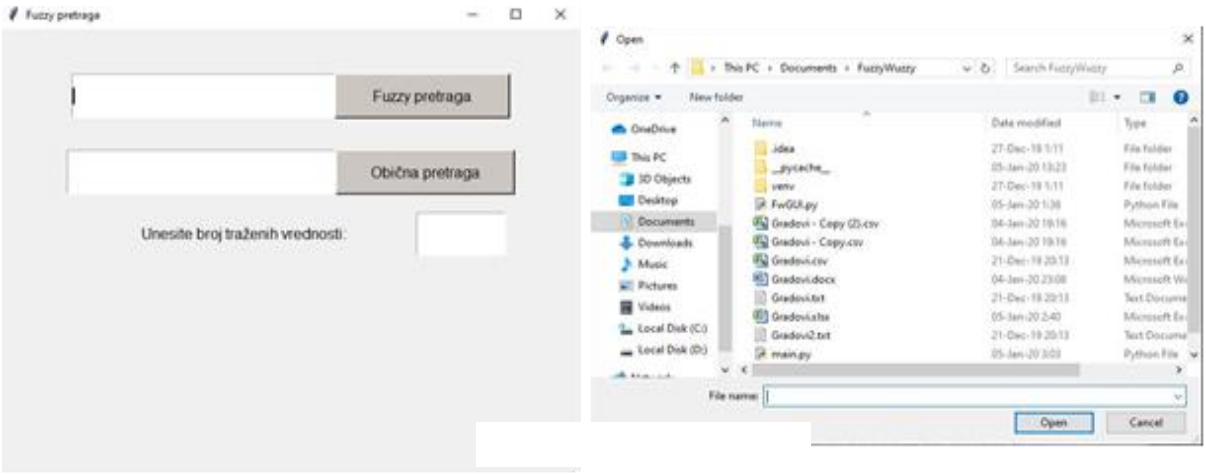

Figure 1 GUI and dialog frame

Figure 2 GUI and dialog frame

VI. SEARCH RESULTS AND COMPARISON

We came to the final testing and comparison of searches. On the one hand, we have fuzzy search for which it was necessary to provide several parameters as described above. On the other hand, a "regular" search, by regex. We will do an example of comparing two searches over a .docx file. We'll do a fuzzy search first. As we can see in Figure 3, the number entered specifies the number of results that are displayed. This means that the fuzzy function goes through the whole sequence, finds matches, and then sorts the results by largest. So by choosing 4 results we actually get the 4 best results, shown with their match percentage. The most results that can be displayed depend on the amount of data in the file itself, in our case 30.

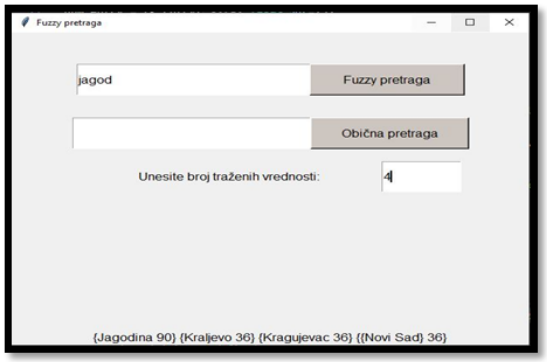

Figure 3 Fuzzy search

Also, it is important to note that the search fuzzy first of all looks to see if there is an entire string match. If it doesn't find the whole, it breaks it down into smaller units and/or characters. For this reason, as well as the length of the names of cities, as a result, we get some cities where the text is not contained, in our example **Kraljevo**, **Kragujevac**, **Novi Sad**. Thus, **Kraljevo** contains **j**, **a**, **o**, **Kragujevac** contains **a**, **j**, while **Novi Sad** contains **o** and **a**. **Jagodina** has the largest match because it contains a complete string in its name.

Next, we move on to a regular search. We will enter the same text as forthe fuzzy search and select the same .docx file. As the image itself shows the result is **None** the exact match was not found at all, even though there is a **Jagodina** in our file that contains the same string as the entered text. However, as **Jagodina** has a capital letter**J** and the entry passes a low caps**j**, the search throws out that there are no results. We would get the same case when typing a space, as the first character in our entry. The spacing may be followed by the exact name of the city, however, it is ignored by the fact that there is no city with the initial character being the spacing. The search will only work after typing the required entry with the correct record, in this case in capital letters.

This search is not perfect by itself, as it throws out the coordinates of the string we are looking for in the file (the file is viewed as a coordinate system). Nevertheless, although it can be modified, we have left the original form, to show all the vulnerabilities of ordinary comparisons.

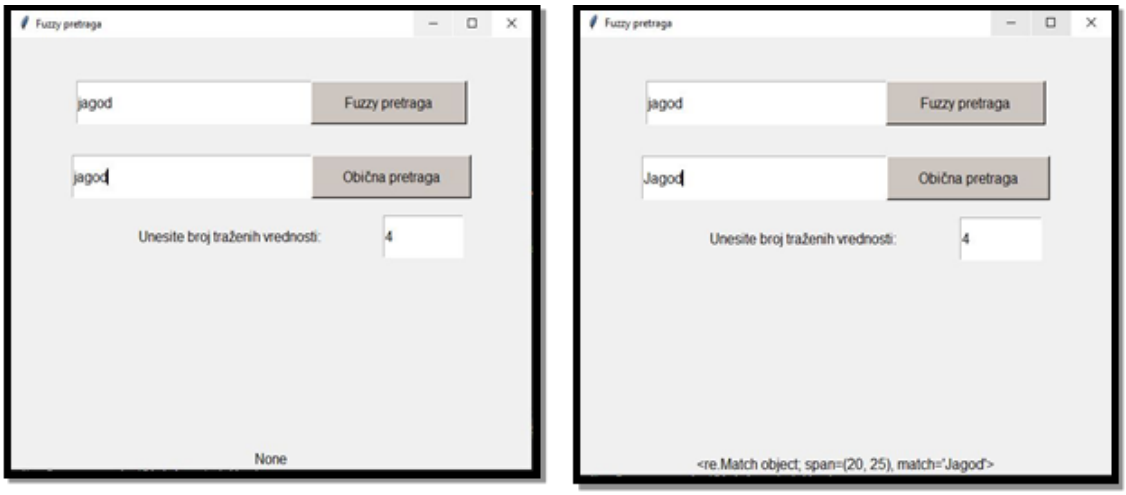

Figure 4 Regex search with and without first capital letter

We got the same results with other types of files that can be opened (described above).

The figure 5 shows the most significant results regarding the differences between these searches. In addition to the aforementioned differences when it comes to lowercase and uppercase letters and spacing, one shortcoming can be observed in the search fuzzy. Namely, fuzzy search (as well as the

regex search) does not recognize the Latin letters **š**, **č**, **ć**, **ž**, **đ**. The problem itself lies with Python, so the application itself should be specifically tuned for this purpose. However, in addition to this shortcoming, the fuzzy search found a result at least when it comes to larger strings, such as in Figure 5example 4. There the only negative result is in the case of **Ša**, because by not recognizing the letter **š**, only the letter **a**remains, which is contained in almost every given city.

	A	B	C	D
1	Redni broj	Upit	Fuzzy pretraga	Obicna pretraga
2	1	"Beograd"	[Beograd 100] [Bor 60] [Sombor 46]	Match(2,9)='Beograd'
3		"Be"	[Beograd 90] [Beocin 90] [Bor 67]	Match(2,5)='Beo'
4		"ogr"	[Beograd 90] [Bor 67] [Sombor 60]	Match(4,7)='ogr'
5				
6	2	"arandjelovac"	[Arandjelovac 100] [Vranje 75] [Kragujevac 64]	none
7		"ar"	[Novi Pazar 90] [Pozarevac 90] [Zajecar 90]	Match(128,130)='ar'
8		"ovac"	Arandjelovac 90] [Leskovac 90] [Vladimirovac 90	Match(10,14)='ovac'
9				
10				
11	3	"Uzice"	[Uzice 100] [Loznica 50] [Subotica 46]	Match(290,295)='Uzice'
12		"U"	[Krusevac 90] [Subotica 90] [Uzice 90]	Match(290,291)='U'
13		"ce"	[Novi Becej 90] [Pancevo 90] [Uzice 90]	Match(153,155)='ce'
14				
15				
16	4	"Šabac"	[Šabac 90] [Požarevac 46] [Vršac 44]	none
17		"Ša"	[Arandjelovac 90] [Beograd 45] [Jagodina 45]	none
18		"aba"	[Šabac 86] [Arandjelovac 60] [Novi Pazar 60]	Match(287,290)='aba'
19				
20				
21	5	" sad"	[Novi Sad 90] [Arandjelovac 60] [Beograd 60]	none

gex

Figure 5 Different results comparing fuzzy and regex

If we dwell briefly on this result, we will notice that the fuzzy for cities with the same degree of match is sorted in the order in the file. The same case occurred in example 2, the case of **ovac**. So, the fuzzy itself sorts the best results, but the problem can arise when matches occur. We then need to know the location of our desired result in the file or request a larger display volume.

VII. CONCLUSION

Created application whose main task is to compare searches, where the first search works on the principle of fuzzy logic, while the second does not have this possibility, is another in a series of indicators that makes fuzzy logic very popular and increasingly present among computer systems. This artificial intelligence concept is an indispensable part of all modern technology, and this time it justified all expectations by delivering the required results with a fairly simple implementation of this technology. A search using fuzzy logic will give the user significantly better results than a search that does not have this capability in itself because of the relevance of the results.

Acknowledgement

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User Experience in Development of the Web Applications

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Abstract – This paper presents the principles of user experience in relation to the user interface. A website was created as an example of improving the user experience.

I. INTRODUCTION

UX doesn't mean one thing. One of the greatest pitfalls for newcomers is trying to understand UX as a field separate from other related fields (like web development, technical communication, etc.)[2][3].

UX is an interdisciplinary field. UX is a way of looking at the world that involves making decisions beyond data with humans firmly in mind.

User experience is the overall experience a user has with a company's products or services. Good and bad user experience design is determined by how easy or difficult it is to interact with each element or aspect of a product or service.

"User experience is determined by how easy or difficult it is to interact with the user interface elements that the UI designer have created.[2]"

Is the user flow smooth, seamless, and intuitive, or is it confusing and unwieldy? Does the button color and position encourage people to click, or make them hesitate? Does adding more detailed steps to the onboarding process add clarity? Does improving the content of a page increase conversion? UX design is responsible for answering questions like these. But how?

UX design mainly involves research to understand things like customer pain points, potential market gaps, and competitor analysis. Besides focusing on a deep understanding of users and unmet market needs, UX also takes into account the business goals and objectives to build products that align with the company's visions and missions. UX best practices improve user interactions and perceptions of products and services as desired by the company.

II. PRINCIPLES

Principles of user Experince are well known as Strategies for simplicity[3]. There are four strategies:

- Remove
- Organize
- Hide
- Displace

III. STAGES

There are 5 main stages of every UX proccess, they are:

- Empathize
- Define
- Ideate
- Prototype
- Testing

Often this cycle is repeated, with each iteration bringing the product closer to perfection. Moreover, the stages are always one after another. Testing should be done intermittently with design to incorporate the results in later designs

IV. UX IN DEVELOPMENT

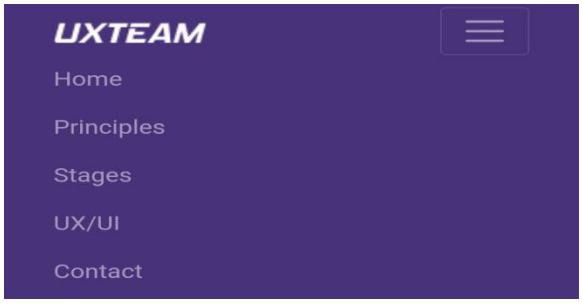
Creating ultimate User Experince is not a simple task. So **first step** is to understand usersneeds, to emphathize with user. " Empathy is crucial to a human-centered design process such as design thinking because it allows you to set aside your own assumptions about the world and gain real insight into users and their needs.[5]"

In **second step** user's problems need to be defined. These definitions are called problem statements.

Next step, **the third**, is to start drawing, create wireframes. Brainstorming is "well accepted" in this stage.

Creating landing page – Designers nightmare. Landing or home page is what user see when start to

interact with your web app. Landing is position where user need to feel comfortable, that is starting position for research of web site. Everything what user don't realy need must be hiden or displaced. Like links to other pages, place it in "hamburger" menu. They still be easy to find but won't be in users way to find informations.



Different sizes and weights of fonts will represent principle of organisation. Also users need to have navigation all the time on screen. For that is used special Bootstrap class called sticky-top.

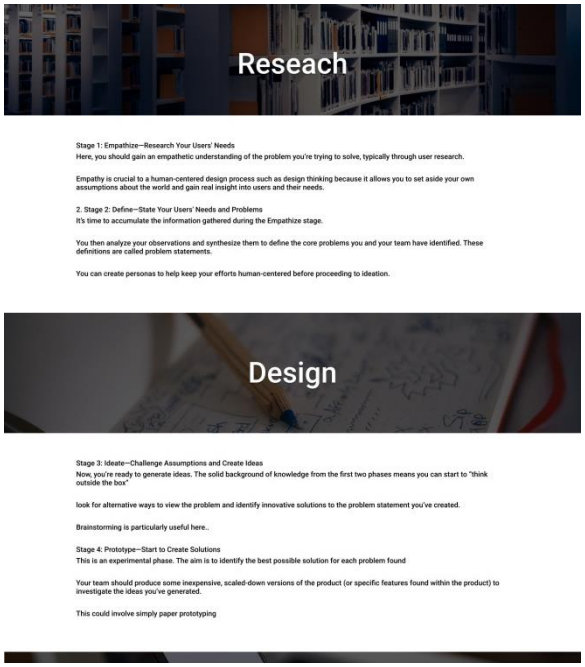
<nav class="navbarnavbar-dark sticky-top">

Creating Principles web page

For start it's easy to see principle of organization and grouping. Elements are easily displaced on page. Clear section brakes giving user feel of achivmnet when finish reading one of sections.

Creating Stages web page

Comparing to Princles page users have images as background. Images giving closer feel what's happening in selected stage

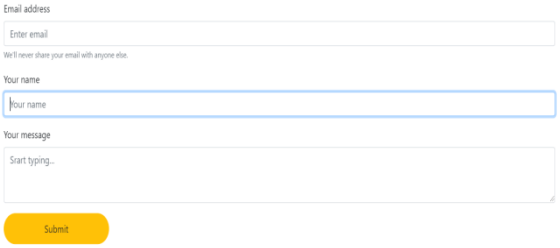


There are 3 sections and five Stages. Some section contain more then one stage because they are similar, so they are grouped.

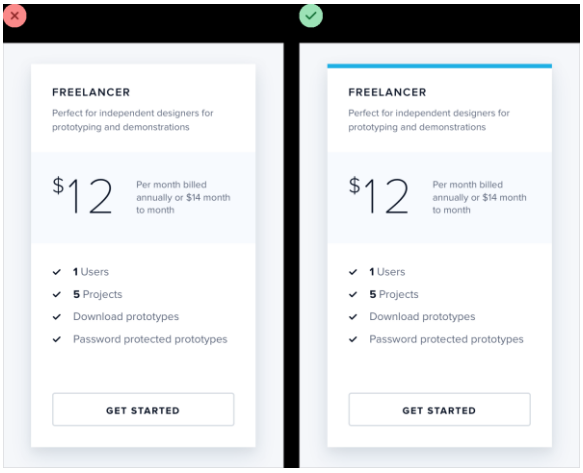
Creating UX vs UI web page

The core of understanding difference between User Experince and User Interface is here. There are defnitions for UX and UI. With pointed out differences.Also, user can read why are UX and Ui so important. Why they are critiacal components that can make or break a product. And how important is to work closely together to decide how a product looks and functions.

Creating Contact page



One of the easier task but need to be take cared of. Most users hate forms, they don't want to spent more than few minutes on filling the blanks[7].



Most of visual design was created by advices from Refactoring UI[6]. With few modifications to make it to fit design better.

Fourth step creation of the prototype. Developers never make complete app in this step. Prototype need to have some functions.

After prototype is developed the next step, the fifth step is testing. Tester need to click on every single button, to interact with every design element. Some testers test not just functionality, they test more and find proper solution how something can be better done. That is called Quality Assurence[8].

V. USED TECHNOLOGIES AND SOFTWARES

Figma

One of the most powerfull software for designers. Figma is a vector graphics editor and prototyping tool which is primarily web-based, with additional offline features enabled by desktop applications for macOS and Windows. [9].

HTML

“Stands for "Hypertext Markup Language." HTML is the language used to create webpages. "Hypertext" refers to the hyperlinks that an HTML page may contain. "Markup language" refers to the way tags are used to define the page layout and elements within the page[10].”

CSS

“Stands for "Cascading Style Sheet." Cascading style sheets are used to format the layout of Web pages. They can be used to define text styles, table sizes, and other aspects of Web pages that previously could only be defined in a page's HTML.”[11]

TypeScript

TypeScript is an open-source language which builds on JavaScript, one of the world’s most used tools, by adding static type definitions. Types provide a way to describe the shape of an object, providing better documentation, and allowing TypeScript to validate that your code is working correctly. Writing types can be optional in TypeScript, because type inference allows you to get a lot of power without writing additional code[12].

Angular

Angular is an application design framework and development platform for creating efficient and sophisticated single-page apps.

Angular is a TypeScript-based open-source web application framework led by the Angular Team at Google and by a community of individuals and corporations. Angular is a complete rewrite from the same team that built AngularJS [13]

Bootstrap

Bootstrap is a free and open-source CSS framework directed at responsive, mobile-first front-end web development. It contains CSS- and JavaScript-based design templates for typography, forms, buttons, navigation, and other interface components.[14]

Visual Studio Code

Visual Studio Code is a free source-code editor made by Microsoft for Windows, Linux and macOS. Features include support for debugging, syntax highlighting, intelligent code completion, snippets, code refactoring, and embedded Git.[15]

VI. CONCLUSION

Goal for this paper were to show all processes and stages that need to be done before showing product to users. And importance of User Experince when designing and developing web sites and web applications.

UX designers need to be up to date with modern technologies and best practices. They need to think like designers and like eveyday users. Therefore their criticism on developersworkv need to be strict. Becouse users demant “top shell” product. In era when “Time is money” users don’t have time for bad products.

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Examining Attendance, Performance and Interest in a CS Course in Relation to Students' Achievement Goal Orientation and Self-Evaluation

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Abstract – There has been a lot of research related to the prediction of students' interest in a course and course performance. The findings are especially important for those fields (and courses) with high failure and dropout rates, such as computer science. Although many research in computer science education involve various motivational and learning strategy frameworks (like achievement goal orientation and Motivated Strategies for Learning Questionnaire – MSLQ), very few involve interest, attendance and self-evaluation. In this study, the aim was to see whether students' achievement goal orientation and self-evaluation of their pre-faculty programming knowledge are related to course performance, attendance and interest in an introductory computer science course. Additionally, we wanted to see if attendance and interest relate to course performance. The findings suggest that only task-approach has a positive correlation with final test scores (but not with mid-term test scores), and that all AGO constructs except other-avoidance correlate positively with interest. Also, attendance has a positive correlation with mid-term test scores (but not with final test scores) while interest has a positive correlation with both mid-term and final test scores. Finally, we suspect that attendance and mid-term test findings may be somewhat influenced by course and faculty policies.

I. INTRODUCTION

Although programmers and software engineers are sought by the market and job offerings are tempting, both common sense and experience have shown that not everyone can be a good programmer. Failure and dropout rates for computer science (CS onward) courses have always been high, thus widening the gap between market needs and available workforce. Consequently, a lot of effort has been put into research in order to produce some means to predict course performance and interest (and even procrastination [7]) in the field of CS based on students' motivation, learning strategies, self-efficacy, gender and so on [6, 8, 12, 13, 14, 15].

One widely used framework (and corresponding tool) for measuring students motivation is the Motivated Strategies for Learning Questionnaire (MSLQ) [10], and another also commonly used is the achievement goal orientation theory and framework (AGO onward) [1, 2, 3, 4, 9, 13]. Although both have been thoroughly tried and tested (and have significant overlaps), the AGO framework has seen some updates in recent years [4, 13] and is used in this research.

Achievement goals are broad categories of learners' aims/targets/purposes in evaluative learning settings [1, 9]. The primary goal of a learner with mastery (task) goal orientation is learning and mastery of a task for its own sake. Such learners are intrinsically motivated and tend to judge themselves in a self-referenced manner, based on their past attainments or their perceived task self-efficacy. Their focus is on effort and improvement. On the other hand, learners with performance (ego) goal orientation consider their achievements relative to the performance of others, in terms of interpersonal and normative comparisons. These two goal orientations determine different consequences in achievement contexts.

In addition to motivation, students' interest in the course topic is also an important research variable [5, 15]. Both short-term interest and long-term interest may be of importance, because the former relates to the course being attended, and the latter affects election of future courses [5]. We, as teachers, also believe that class attendance and self-evaluation (of previous experience and knowledge) can be important variables to take into consideration. Attendance is an indicator of student engagement while self-evaluation reflects students' perception on their previous CS experience and knowledge.

The research presented in this paper is focused on trying to establish if there are any relations between

CS students AGO scores and self evaluation scores with attendance, performance and interest in CS. One part of the research contains confirmatory studies regarding related work, while the other explores new potential relations in CS settings.

II. RELATED WORK

Achievement goal orientation (AGO onward) theory [1, 9] distinguishes between mastery goals (focused on task mastery) and performance goals (focused on demonstration of competence/ability to others). This mastery-performance goal dichotomy was subsequently revised to include a distinction between performance-approach and performance-avoidance goals [2]. The former is about striving to demonstrate competence and outperform others, whereas the latter refers to the objective of not performing worse than others and being perceived as incompetent. Elliot and McGregor [3] have further distinguished mastery-approach goals (aiming to improve one's knowledge and skills) and mastery-avoidance goals (avoid failure in learning, competence decline, and the like). This 2×2 framework has been widely used in educational research.

The latest version of the AGO framework (the 3×2 model used in this research) proposed by Elliot, Murayama and R. Pekrun [4] consists of 3 goals and 2 valences for each goal (positive and negative) resulting in 6 constructs (goal orientations): task-approach, task-avoidance, self-approach, self-avoidance, other-approach and other-avoidance (See Table 1). The idea proposed by the authors was to separate the mastery goal from the 2×2 model into two different constructs and therefore standards for evaluation: task-based competence (focusing on the task itself) and self-based competence (focusing on one-self's previous performance). The performance goal was renamed into "others" goal and still refers to demonstration of competence/ability when compared with others.

TABLE I. THE 3×2 AGO FRAMEWORK GOAL CONSTRUCTS [4]

Valence	**Goal**		
	Task	***Self***	***Others***
Positive valence	Task-approach *(focused on the attainment of task-based competence, e.g. "Do the task correctly")*	Self-approach *(focused on the attainment of self-based competence, e.g. "Do better than [I did] before")*	Other-approach *(focused on the attainment of other-based competence, e.g. "Do better than others")*
Negative valence	Task-avoidance *(focused on the avoidance of task-based incompetence, e.g. "Avoid doing the task incorrectly")*	Self-avoidance *(focused on the avoidance of self-based incompetence, e.g. "Avoid doing worse than [I did]before")*	Other-avoidance *(focused on the avoidance of other-based incompetence, e.g. "Avoid doing worse than others")*

There is another recent version of the AGO model proposed by Shell and Soh [13] which includes three goals (learning, task and performance) and two valences (approach and avoidance) and is very similar to the 3×2 model [4]. However, the 3×2 model was used in this research instead, only due to the many studies confirming it's validity in various settings.

AGO research in psychology education has proven that task-approach is a positive predictor of intrinsic motivation, learning efficacy and absorption in class, while the other-approach component positively correlates to course performance [4]. The same study has shown that other-avoidance correlates negatively with course performance and that self-approach and self-avoidance are affecting only energy in class, while task-avoidance does not relate to any specific variables [4]. In another study which involved the 2×2 AGO model [3], it was shown that mastery-approach positively affects interest in psychology, while performance-approach only has an effect on the final grade [5]. It was also proven that interest itself has a positive effect on the final grade [5]. Mastery-approach orientation, in general, is often associated with positive academic outcomes, whereas performance-avoidance approach was found to be correlated with negative academic outcomes [11]. However, it is important to note that course performance in all three studies was measured by tests with multiple-choice/open-ended questions where memorization of facts is the key to performing well [4, 5, 11].

In CS, however, exams may take the form of multiple-choice tests, but it is more often that students have to solve some programming task by creating a programming solution [15]. This involves more than memorization of facts – it requires combining various programming constructs while adhering to programming language rules and task requirements. It seems less surprising that motivation research in introductory CS courses suggests that intrinsic motivation (MSLQ construct similar to AGO mastery was measured) correlates positively to total exam scores [8], instead of extrinsic motivation (similar to AGO performance). In a study employing the AGO framework [15] it was found that mastery-approach positively correlates with interest and final exam grade, while performance-approach negatively correlates with interest and has no relations with exam performance (contrary to [4, 5, 11]). The same study has shown that prior programming experience is not correlated with neither mastery nor performance but can predict interest in CS.

In another group of studies employing the alternative AGO framework by Shell and Soh [13], it as found that task-approach positively correlates with (course) achievement, knowledge retention, self-regulation, knowledge building and engagement [12] and that task-avoidance negatively correlates with self-regulation. It was also found that initial course motivation (AGO scores) changes during the semester [6], mostly that learning-approach, task-approach and performance-approach drop from initially high values and that learning-avoidance increases. It is therefore not surprising that initial motivation was found to be a weak predictor of course performance [14] and that the teachers should aim to: get CS students to set positive learning goals and help them make positive learning experiences [6], as well as maintain positive goals high throughout the semester [14].

III. GOALS AND RESEARCH QUESTIONS

The primary goal of this research was to explore students' motivation (as defined in the 3×2 AGO model [4]), self-evaluation (on pre-faculty knowledge) and course outcomes in an introductory CS course, as well as possible relations between:

- AGO and course attendance, interest, and performance.
- Self-evaluation and course attendance, interest, and performance.

The secondary goal was to explore our presumptions on whether attendance and interest are related to course performance.

IV. METHODOLOGY

A. Educational and research setting

The study was carried out in the 2019/20 academic year and involved 2nd year information systems students enrolled in an introductory course on object oriented programming. The course lasted 13 weeks and involved 1.5 hours of lectures and 1.5 hours of computer labs per week during which students had been learning Java and using the Eclipse development environment. The course was preceded only by one-semester programming course in C language from the first year.

The assessment involved two tests (mid-semester test – 35 points and final test – 65 points) where students were given programming tasks to complete in the computer labs in limited time. The tasks in each test involved creating simple Java programs based on the provided requirements, but also correcting non-syntax errors in the code that was provided. These two tests enabled practical measurement of performance (acquired programming knowledge and skill) and the scoring was such that deep understanding of the material was needed in order to get high scores (similar to [15]).

Out of the 682 enrolled students, 215 decided to take part in the study (130 female, 85 male) with GPA ranging from 6.33 to 10.0 (M = 7.97, SD = 0.767). Average students' age was 20.62 years.

B. Data collection and analysis

The students' AGO scores, self-evaluation and interest scores were obtained through an online questionnaire administered during class in the fifth week of the course (one week before the mid-semester test), so students could get familiar with the course and adjust their initial motivation (in accordance with [6, 14]). The questionnaire consisted of four sections: general data, AGO, interest and self-evaluation. Those who did not attend the classes when the questionnaire was administered, but wanted to take part in the research, were asked to fill it out in the following week.

Participating in the study was voluntary, with no effect on students' course grades. The invited students were informed about the purpose and conditions for participation in the research. The questionnaire was not anonymous and students gave their signed consent for using this data together with GPA, course test scores and attendance data for research purposes provided that their identities were kept hidden.

For the AGO part of the questionnaire, items from the 3×2 AGO model were translated to Serbian and used [4]. This questionnaire has 18 statements (items) in total – three per factor. Students' level of agreement with each statement was elicited on a scale from 1 to 7 (1 being "Totally disagree," 3 - "Not sure," and 7 - "Totally agree"). Individual factor scores were calculated as average values from the corresponding three item scores. The Cronbach alpha test (Table 2, Cr. α column) suggests good internal consistency among corresponding items except for a somewhat lower value for the task-avoidance items ($\alpha = 0.62$). This may be due to the questionnaire being translated.

Students' interest in the course was measured by using a standard 10 item questionnaire with each statement being elicited on a scale from 1 to 7 (1 being "Totally disagree," 3 - "Not sure," and 7 - "Totally agree") [5, 15]. Final interest scores were calculated as average values from the corresponding 10 item scores, with one item score being inverted as predicted by the questionnaire.

Self-evaluation consisted of a qualitative description on pre-faculty programming experiences

as well as a self-evaluation score on a scale from 1 to 5 (5 being the highest score).

Lab attendance was formally tracked, and students were aware of this. There were three extra points for regular attendance (attending at least 10 out of 13 labs) but no consequences for not attending. Both attendance and test scores were recorded via private-based spreadsheets and paired up with other data for further analysis.

V. RESULTS

A. *Descriptive statistics*

The descriptive statistics (Table 2) suggest that students' motivation was, in general, very high concerning the task-approach, task-avoidance, self approach and self-avoidance AGO constructs, and that other-approach and other-avoidance were more moderate. Students' interest was also very high.

TABLE II. AGO AND INTEREST SCORES

Factor	Min	1stQ	Med.	3rdQ	Max	Cr. α
Task-approach	3.667	6.000	6.667	7.000	7.000	0.82
Task-avoidance	3.333	5.500	6.333	7.000	7.000	0.61
Self-approach	1.000	5.333	6.333	7.000	7.000	0.80
Self-avoidance	1.333	5.000	6.000	7.000	7.000	0.75
Other-approach	1.000	2.333	4.000	5.000	7.000	0.91
Other-avoidance	1.000	2.833	4.333	5.667	7.000	0.90
Interest	2.300	5.800	6.300	6.800	7.00	0.93

In the qualitative ("descriptive") part of the self-evaluation on their previous programming experience, 46.52% of students stated that they mostly learned programming in high school, 6.97% said that they mostly learned programming themselves, while 46.51% stated that they did not learn programming before the faculty. In the self-evaluation score, most students evaluated their pre-faculty knowledge and experience in programming as low or very low (Figure 1).

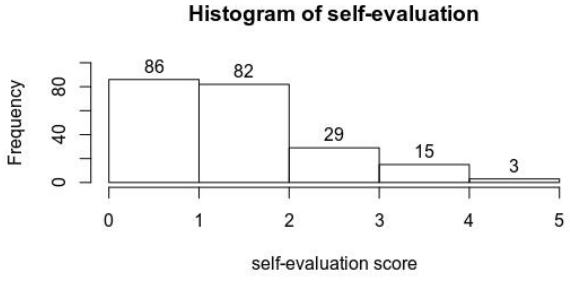

Figure 1.Self-evaluation on pre-faculty programming experience

Student attendance distribution was also not normal, and average attendance was high, peaking at 10 attended classes (Figure 2).

Mid-term test scores (Figure 3) were also not normally distributed (Shapiro-Wilk, $p < 0.01$), but did seem to have a flattened, bell-shaped distribution. Twenty students had not attended the mid-term test.

Final test scores (Figure 4) were not normally distributed (Shapiro-Wilk, $p < 0.01$), but did seem to have a left-skewed, bell-shaped distribution. Twenty seven students had not attended the final test.

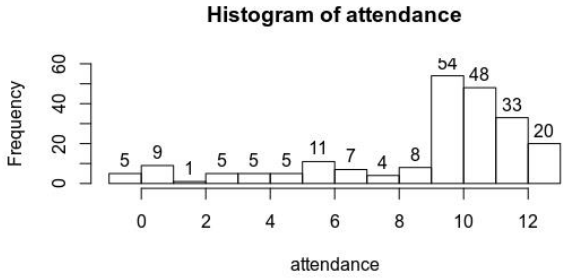

Figure 2.Student attendance histogram

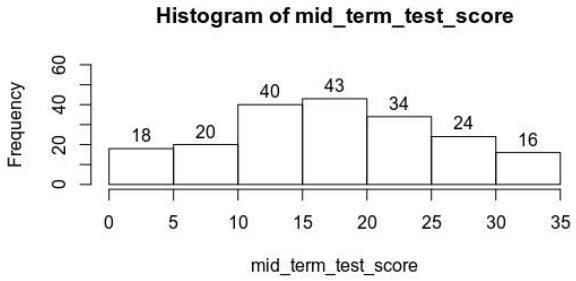

Figure 3.Mid-term test score distribution

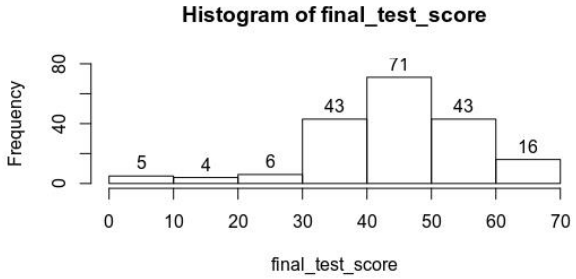

Figure 4.Final test score distribution

B. *AGO and self-evaluation – relations with attendance, performance and interest*

The data suggest that task-approach has a weak positive correlation (Spearman) with interest and the final test score (but not the mid-term test score), and that task-avoidance, self-approach, self-avoidance

and other-approach also have a weak positive correlation with interest (Table 3). The data also reveal that attendance is not correlated with any of the AGO constructs. Finally, tests have shown that self-evaluation scores are in weak positive correlation with interest and performance (mid-term and final test scores), and that no statistically significant correlations with attendance could be found.

TABLE III. AGO AND SELF-EVALUATION CORRELATIONS

	Attendance	**Interest**	**Mid-term test score**	**Final test score**
Task-approach	$r_s = 0.0472$ $p = 0.49$	$r_s = 0.2799$ $p < 0.01$	$r_s = 0.0122$ $p = 0.86$	$r_s = 0.1979$ $p < 0.01$
Task-avoidance	$r_s = 0.0332$ $p = 0.63$	$r_s = 0.1529$ $p < 0.05$	$r_s = 0.0124$ $p = 0.86$	$r_s = 0.0884$ $p = 0.23$
Self-approach	$r_s = - 0.0237$ $p = 0.73$	$r_s = 0.2005$ $p < 0.01$	$r_s = -0.0694$ $p = 0.33$	$r_s = 0.0667$ $p = 0.36$
Self-avoidance	$r_s = -0.0476$ $p = 0.49$	$r_s = 0.1997$ $p < 0.01$	$r_s = -0.0379$ $p = 0.59$	$r_s = 0.1273$ $p = 0.08$
Other-approach	$r_s = -0.0629$ $p = 0.36$	$r_s = 0.2190$ $p < 0.01$	$r_s = 0.0396$ $p = 0.58$	$r_s = 0.0816$ $p = 0.27$
Other-avoidance	$r_s = -0.0211$ $p = 0.76$	$r_s = 0.1184$ $p = 0.08$	$r_s = 0.0066$ $p = 0.93$	$R_s = 0.0363$ $p = 0.62$
Self-evaluation	$r_s = 0.0551$ $p = 0.42$	$r_s = 0.2182$ $p < 0.01$	$r_s = 0.2213$ $p < 0.01$	$r_s = 0.1538$ $p < 0.05$

C. Attendance and interest – relations with performance

The data suggest that attendance has a weak positive correlation with the mid-term test score only, and that interest has a weak positive correlation both with the mid-term test and the final test score (Table 4).

TABLE IV. ATTENDANCE AND INTEREST CORRELATIONS WITH PERFORMANCE

	Mid-term test score	**Final test score**
Attendance	$r_s = 0.3112$ $p < 0.001$	$r_s = 0.0974$ $p = 0.18$
Interest	$r_s = 0.2441$ $p < 0.01$	$r_s = 0.2148$ $p < 0.01$

VI. DISCUSSION

A. Descriptive statistics

The data suggests that students' motivation regarding all task and self goals was very high, both in positive and in negative valences (approach and avoidance). We, as teachers, interpret this as students being motivated to do their tasks well, improve their knowledge and do better than they did before. However, at the same time, students avoided not doing well both in task completion and with regards to their previous performance. This is somewhat in line with previous research where initial course motivations with positive valences were very high [6] – although in our research motivation was measured five weeks into the semester (one week before the mid-term test). On the other hand, the other-goal scores were moderate and, to our surprise, the other-approach goal scores (performing better than others) were lower than the other-avoidance goal scores (avoid under-performing when compared to others). This means that students wanted to avoid under-performing more than they wanted to outperform their colleagues.

The qualitative self-evaluation statistics convey that nearly half of the surveyed students did not learn programming before the faculty. It is our interpretation that many of those that had learned programming did not feel that they have learned well. The self-evaluation scores reflect this – 168 out of the 215 surveyed students evaluated their pre-faculty programming knowledge as low or very low.

The course policy to give additional points for regular attendance (attending 10 classes or more) seems to have motivated students to attend classes regularly. Attendance among the surveyed students was high, peaking at 10 attended classes.

Mid-term test scores have a very symmetrical distribution meaning that both low, average and high scores are present, with most students doing averagely. This is somewhat expected as students have only one chance to take this test (per academic year, as stated in the faculty policy) and the test results affect a large proportion of the total course score (35 out of 100 points). Students have to take this test even if they haven't prepared for it well.

Final test scores have a left skewed distribution, meaning that above-average scores prevail. This is also expected as this test can be taken several times during the academic year, and students can take the test again if they are not satisfied with their score.

B. AGO and self-evaluation – relations with attendance, performance and interest

The task-approach goal has a weak but positive correlation with the final test score, which is in line with previous research in CS education [12, 13, 15], but is contrary to the psychology education research findings, where only performance-approach positively affects exam performance [4, 5, 11]. Again, this could be due to the type of assessment being taken (as noted in [15]): multiple-choice/open-ended questions where memorization is key to success (psychology), versus programming tasks where deep knowledge is necessary. What is still unclear is why task-approach (or any other AGO construct) is not correlated with attendance or the mid-term test score. It is our assumption that both the course policy (additional points for attending 10 classes or more) and the mid-term test policy (only one chance to take this test), have driven students to

embrace the desired behavior and, perhaps, behave differently than they normally would.

The data also suggest that all AGO constructs except for other-avoidance have a weak positive correlation with interest. Some positive correlations were expected (task-approach and self-approach, similar to [15]), however, other-approach proved to have a positive correlation with interest, while a similar study resulted in a negative one being reported [15]. It is unclear why task-avoidance and self-avoidance have a positive correlation with interest. No studies, both in CS and psychology education, report similar findings.

The tests have shown that self-evaluation scores on pre-faculty programming experience and knowledge have weak positive correlations both with performance (mid-term and final test scores) and with interest. It seems that students who report higher levels of pre-faculty knowledge in CS are more interested in CS during faculty (similar to [15]), and achieve better performance in CS courses (which is not surprising). However, self evaluation scores are not related with attendance in any way.

C. Attendance and interest – relations with performance

The tests have shown that attendance has a weak and positive correlation only with the mid-term test score (and no correlation with the final test score). We, as teachers, interpret this finding as follows: regular lab attendance can help students achieve higher mid-term test scores as this test can be taken only once during the academic year (due to faculty policy). However, students can prepare for the final test in a more relaxed manner and catch-up with missed lessons later during the semester, and this is why regular lab attendance may not be so important.

The data also suggest what we presumed to be true: interest in CS is positively correlated with performance (both mid-term and final test). This is in line with similar findings both in psychology [5] and CS [15] education.

CONCLUSION

Introductory CS course students from our study were very motivated to do their tasks well, improve their knowledge and do better than they did before. At the same time, they were highly motivated to avoid doing worse than (they did) before, both generally and with regards to course tasks. They were moderately motivated to outperform their peers, but wanted to avoid under-performing their peers slightly more. Attendance was high, but it is unclear was it because of students' pure motivation or due to the course policy on additional points.

Only task-approach proved to have a weak but positive correlation with the final test score, and all AGO constructs except for other-avoidance had a weak positive correlation with interest. Self-evaluation scores were proved to have weak positive correlations with performance (mid-term and final test scores) and interest. Attendance had weak and positive correlation only with the mid-term test score, and we believe that this may be due to faculty policy on mid-term tests. Finally, as expected, interest in CS was positively correlated with performance (both mid-term and final test).

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Collaborative Virtual Reality Usage in Educational and Training Process

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Abstract –This paper focuses on a utilization of advanced virtual reality approaches and technologies as especially progressive tools in the context of online education, training and testing. The purpose of the utilization is to allow easier, faster and more attractive education and training in the areas containing topics and concepts that are not easy to comprehend or that are too expensive to be carried out in the real world. The paper explores collaborative virtual reality and its role in online education, primarily from the LIRKIS G-CVE utilization point of view. LIRKIS G-CVE is a web-based collaborative virtual reality system, based on the A-Frame and Networked-Aframe software solutions. LIRKIS G-CVE is described and three of its educational and training applications are presented: virtual environments for a university course dealing with virtual reality, an environment for patient rehabilitation and another one for an industrial training. Plans for LIRKIS G-CVE utilization in elementary, secondary and high school education are outlined, too.

I. INTRODUCTION

Modern information technologies penetrate almost every aspect of our lives. Virtual reality and related technologies [1] are also a part of this phenomenon. The recent COVID-19 pandemic situation noticeably increased the importance of online learning.There is a growing demand for more interactive and smart solutions and online learning is starting to be preferred even in the areas dominated by the classical approaches. The online education has relatively good results in its current form,where it offers digital content using standard multimedia (audio, still images and video). However, to explain more challenging concepts from areas such as physics, biology, chemistry or history, itwould require significantly more interactive presentation of the content. One of the most developing technologies that could significantly increase the level of interactivity is virtual reality (VR) [2].

Research and development activities related to the utilization of VR in online education are one of the priorities of the LIRKIS laboratory at the home institution of the authors. The LIRKIS laboratory (Laboratory of Intelligent Interfaces of Communication and Information Systems) is an excellent laboratory for research, development and teaching applications in the area of parallel, distributed and networked computing systems for solving computational problems in the processing of graphic data and virtual reality with a primary focus on information systems and visualization, intelligent interfaces and human-computer interaction in the context ofHCI and HCM-T [3].

The online learning - relatedactivities carried out at LIRKISstry to usevirtual reality technologies for simpler, faster and more effective learning process, including communication between students and educators.They focus on the collaborative, or shared, virtual reality where the participants can not only immerse into virtual environments but also communicate with each other. For such immersion and collaboration we developed LIRKIS G-CVE (Global Collaborative Virtual Environments), which is based solely on web technologies. This means that a user needs only a web browser to use the environments.

In the rest of the paper we explore collaborativeVR and its role in online education, primarily from the LIRKIS G-CVE utilization point of view. It is organized as follows: Section II overviews the current state of collaborative VR with respect to two main ways of delivering immersive VR content – CAVE facilities and VR headsets. Section IIIdeals with LIRKIS G-CVE and section IVdescribes selected cases of its deployment in training and education.The conclusionoutlines plans for its future utilization in this area.

II. COLLABORATIVE VIRTUAL REALITY

A virtual environments usage expands the possibilities of user collaboration in real-time. According toFlavianet al. [4], collaborative systems represent a specific architecture and technological equipment for a creationof collaborative activities. The authors of[5] emphasize the need for a physical or virtual (in a form of avatars) presence of users in collaborative environments. The basic types of collaborative VR environments are systems based on Cave Automatic Virtual Environments (CAVE) and systems based on VR headsets(data helmets).

The basic goal of VR CAVE systems is to immerse the whole body of the user into a virtual environment (VE). They are usually designed for more than one user, so users may collaborate in VE naturally, as in the real world. Another advantage of VR CAVEs is that 3D objects are displayed in the realistic scale with respect to the users [6]. From the point of view of Muhanna[7], a VR CAVE system can be considered as hardware or software expandable to support a wide range of technologies - hardware and software subsystems. However, the subsystem for external components integration must be reliable and robust. Then the quality of the system and module compatibility and the possibility of system adaptation with respect to various input subsystems, modules and devices are increased. Utilization of VR systems increases the need for natural interaction between the user and VE. In the case of collaborative environments, it is important to mediate the natural interaction between all users in real time. According to [8], in a virtual CAVE system, the way of natural interaction between users is highly efficient and realistic. Natural collaborative bonding involves all sensory immersion without the need to implement virtual avatars. Users collaborate in a physically shared space where they really see each other. Communication between the users is realized in a natural way and there is no need to use an external technology for communication channels. From the point of view of the basis of natural communication, the interaction between users is intuitive without the need to learn gestural, voice or touch control. Probably the most significant disadvantage of CAVE systems is their cost, both to build and maintain a CAVE. Another disadvantage is that the space inside a CAVE is limited, usually to about 5 to 10 people. It should be also noted that the perception of the 3D environment is different from different spots inside the CAVE. The perception can be fixed by using so-called off-axis projection for VE rendering, which, together with user position may provide perfect perception from any point inside the CAVE. However, such fix will work for one user in the CAVE only, which makes natural collaboration inside a CAVE uncomfortable.

The second approach uses VR headsets, also called data helmets or head mounted displays (HMD). One headset provides VR experience for one user only. This means that when multiple users wish to collaborate in a VE, each of them has to wear a headset. The development of VR headsets focuses on increasing the performance while decreasing the size, weight and power consumption. They represent cost-effective alternative to VR CAVEs.

A VR headset usually depends on an external computational unit (a computer) that processes input from the headset and produces an audiovisual output, played and displayed by the helmet [9]. The headset and the computer communicate via full duplex channels. As high transmission rate is required, the communication is usually realized by a data cable. Some headsets, such as Oculus Quest or Microsoft HoloLens, have an integrated computational unit, so no cable connection with an external one is needed. This increases the user comfort but limits the system performance. As in the case of CAVEs, VR headsets are, in principle, extendable by additional modules and subsystems.

The concept of collaborative environments in the VR headset-based systems is built uponthe possibility of sharing the same VE by multiple users in the same time. It is important to be able to process input data from each user individually. In the end, each user in a group sharing the VE should be able to realize its own inputs (activities) without blocking the activity of other users. The usage of headsets makes it possible to separate the users physically while they share the same VE. For each user, his or her interaction with the VE is unique and observable by other users in the same VE. As the users usually do not see each other in the real world, they are represented by 3D objects, called avatars, in the VE. From the VE distribution point of view, the users may share the same physical space or may be connected via a computer network (Internet) [10]. VR headset-based collaborative virtual environments are limited by the number of users connected in the same time. If we have a VE, shared by n users (u_1 to u_n), then adding a new user u_{n+1} increases the load of systems of u_1 to u_n as they now have to render also the avatar of u_{n+1} and possibly perform other computations related to it. Of course, it also increases the load of the computer system managing the VE and its users.

Contrary to CAVE systems, the possibilities of natural, physical, interaction between users with VR headsets is very limited. It is only possible if the users share the same physical space and the headsets have see-through displays or other means to capture the surrounding environment and mix it with the representation of the VE. In other cases, alternative means have to be implemented. One of the most significant problems of user communication is the representation of hands and their animation. To provide the most natural representations of hands and arms, additional devices(controllers) are used. They determine the position of the user's hands precisely and make it possible to compute a skeletal model of the hands and arms, which allows rendering their believable representation in the VE. To decrease performance requirements, simple models are used. The need to animate hand and arm movements may significantly contribute to the load increase when

more users join the VE: Each movement of an arm, hand or a finger of any user should be rendered to be seen by other users [11]. To improve the system performance, an approach where only the hands of the headset user have detailed animation is often used. For the avatars of other users, which he or she sees inside the VE, only simplified models are used (e.g. fingers don't move).

One issue related to collaborative VR is how to manage real-time manipulation with objects in a shared VE. The authors of[12] prefer that only one user can manipulate with an object at given time moment and it is the responsibility of the corresponding VR system to decide which user will be allowed to interact with the object. The reason for this is to prevent collisions and blocking of the object by simultaneous attempts to manipulate with it. According to [13], blocking the interaction with the shared object for all users except one is not an ideal approach for collaborative VR. However, allowing multi-user interaction requires a software component that calculates the combined effect of the interactions and updates the object accordingly. Considering online learning context, a variation of the first approach may be suitable for most of the scenarios. The variation dwells in selecting a user that is the only one able to manipulate with the object while the other ones only observe it. In online learning, this user will be the teacher. In addition, the teacher may be able to pass the rights to manipulate with the object to another one, representing a student. It is also possible to allow each user to manipulate with his (her) copy of the object.

III. LIRKIS GLOBAL COLLABORATIVE VIRTUAL ENVIRONMENTS

The LIRKIS G-CVE (Global Collaborative Virtual Environments) [14],[15], developed by and under the supervision of the authors, represents an immersive VR system, which utilizes web technologies to provide multi-user connection. Its architecture (Figure 1.) is based on the Entity-Component-System software architectural pattern, which offers high flexibility to create various VR applications and extensions of CVE on different complexity levels. Each entity can contain multiple, fully reusable components, which can be mixed according to the final use. Considering that the LIRKIS G-CVE is supported by web technologies and services, it is only natural that the JavaScript programming language has been chosen for its implementation stage. The communication between the system and users is based on client-server architecture to share data over the network. The LIRKIS G-CVE provides client-side rendering (CSR) to be able to processmore complex virtual environment with a variety of visual effects, lights and shades.

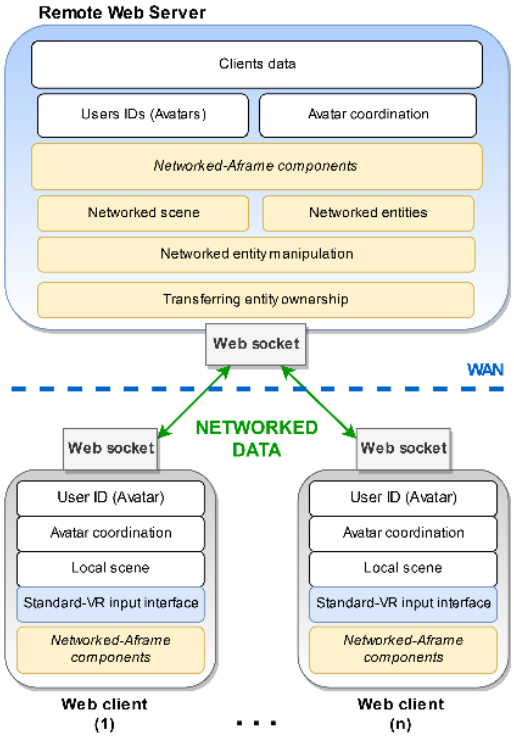
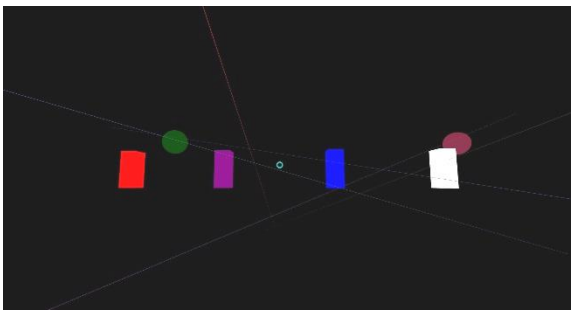


Figure 1. LIRKIS G-CVE system architecture

Users can share the virtual environment (their avatars) no only visually. In LIRKIS G- CVE, users can manipulate the environment using three interaction methods. The first type of interaction was implemented using ray-casting method (Figure 2. a). The Raycaster[16] includes a 2D line extended from a user towards the direction where it checks its intersection with surrounding objects (Figure 2. b). Because of this feature, it is possible to move the object in a way similar to a 3D pointer or a laser control. A 3D object can be selected and then manipulated. The second type of interaction involves 3D object collision detection between the user and the surrounding scene (Figure 2. c). Each collision is processed by 3D volumes called bounding boxes (3D colliders) that wrap around the objects [17]. The 3D collider can be formed into various shapes such as a primitive box, a cube, a sphere or a cylinder. Utilization of 3D colliders positively affects object selection and manipulation through 3D pointers and VR hands, which can collide with surrounding objects.

Thanks to the fact that LIRKIS G-CVE is implemented using standard web technologies (primarily JavaScript and HTML), it can be deployed on virtually any computing machine that offers a web browser (e.g. PC, Android mobile devices, IoS mobile devices, MS Hololens or Oculus Quest) without the need to install any additional software.

a)



b)

c)

Figure 2. The LIRKIS G-CVE Smart-client interface (SCI): a) SCI Raycaster intersection. b) Hand and gaze-based interaction. c) Bounding volumes collision detection.

IV. LIRKIS G-CVE IN EDUCATION AND TRAINING

The aforementioned properties of LIRKIS G-CVE make it very suitable for both education and training. It is therefore no surprise that it has been already employed in such activities.

A. University Courses

LIRKIS G-CVE is integrated to the Virtual Reality Systems master course at the home institution of the authors and it is also a subject of several diploma theses under their supervision. Via LIRKIS G-CVE,students learn how to developtheir own virtual environments. After creating the environments they can add various features, such as animations, colliders or scripted events. The students may share their creations with classmates and friends and let them test the environments. Teachers can enter the environments for evaluation.In addition, teachersuse special, educational, shared virtual environments for step-by-step explanation of individual features of virtual objects, for example how to implement and use araycaster in real time.

Figure 3. One of the virtual environments, available via LIRKIS G-CVE,as used in the Virtual Reality Systems master course: overall view (left) and view from the Student2 position(right).

Provided that VE are hosted at a site offering an online integrated development environment (e.g. https://glitch.com/), teachers can also check and correct students' source code in real time. Because the VE and corresponding source code are available online, the teachers can switch between online and offline (classical) form of teaching instantly, without any problems. The only difference is that online communication tools, such as Cisco Webex, Microsoft Teams or Google Hangouts, are used instead of direct, person-to-person communication. Such form of online education with LIRKIS G-CVE has been successfully carried out during the recent pandemic situation in the summer semester of 2020. An example of a VE used during the semester can be seen in Figure 3.

B. Patient Rehabilitation

A project for a rehabilitation (training)of patients after a stroke, who lost control over one arm, is another case of LIRKIS G-CVE usage. Both the patient and the therapist can cooperate in virtual therapy environment (Figure 4.) without the need to share the same physical location.

Figure 4. Patient's view during the rehabilitation process using LIRKIS G-CVE.

The virtual environment in this context is intended to replace a mirror where the patient sees his or her healthyarm and can image controlling the paralyzed one. In the VE, the patient sees a virtual representation of the paralyzed arm, which moves according to the brain activity of the patient. This LIRKIS project uses virtual and mixed reality hardware such as Oculus Quest or MS HoloLens and a built-in web browser. The patient performs the training following the therapist's instructions. The therapist is able to observe the training activity and instruct the patient in real time. Unfortunately, this application cannot completely replace the patient's full rehabilitation process and, of course, its success depends on the patient's overall condition and diagnosis.

C. Industrial Training

LIRKIS G-CVE is also about to be used for employee training in an industrial environment. In cooperation with a partner from the area of electricity distribution a virtual environment for its new employees training is under development. The motivation to develop such environment comes from the current situation, where two approaches to the training are commonly used. The first one is a theoretical course and the second one is a practical training on real devices. Both approaches require noticeable resources and time. In addition, the theoretical lectures don't deliver adequate results in many cases. On the other hand, the real working environment should be an ideal one for the training but such practical approach requires reserving the real environment for the training and a presence of experienced employees (instructors) who oversee the training. Utilization of virtual environments has the advantage of providing a practical training without the need to allocate real workspace or instructors: The VE can offer an animation, which explains how to carry out the corresponding task correctly and scripts, together with triggered events, can be used to guide the employees during an interactive part of the training where they try to perform the tasks by themselves. Another advantage of VE utilization is elimination of the risk of accidents during the training. As in the previous cases, there is no need for the trainees and instructors to be at the same place physically. In fact, as mentioned above, the presence of the instructors is not required for the significant part of the training.

The current state of the training virtual environment, developed within LIRKIS G-CVE, can be seen in Figure 5. The environment offers a virtual form of real electrical devices with which the trainees interact. It also allows creating specific scenarios with custom evaluation criteria. In addition, it is possible to record the training process and replay it from different points of view. They include the position of the trainee, the instructor position and several pre-set cameras, such as a high-angle shot.

Figure 5. LIRKIS G-CVEemployee training environment: a high-angle shot with an instructor in front of electrical devices (a), the electrical devices as seen by a trainee (b), replay of a recorded training with controls on the left (c) and administration screen with a scenario settings dialog (d).

V. CONCLUSION

As it has been shown, LIRKIS G-CVE is a suitable solution for online collaboration in web-based virtual reality, with a variety of application areas in mind. While the patient rehabilitation and industrial training environments can be considered experimental and under development, the environments used for the Virtual Reality Systems (VRS) course offer a ready-to-use solution for online education, proved during the onset of COVID-19 emergency.

Regarding future applications of LIRKIS G-CVE in the area of education, we would like to focus on elementary, secondary and high schools. Here, we plan to prepare virtual classes, which will deal with more complex topics that can be demonstrated in a form of interactive presentations or experiments. In principle, the utilization of LIRKIS G-CVE in this context will be similar to the one in the VRS course and tools for online communication will be included to provide full-featured online learning. We intend to prepare the environments not only for healthy pupils but also for handicapped ones, following our long-term cooperation withPavolSabadoš special boarding school in Prešov, Slovakia.

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Methodology For External Quality Control of Higher Education Institutions

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Abstract – This paper presents the methodology for external quality control of higher education institutions with an emphasis on the obligations of the institution. It is assumed that the standards and procedure for external quality control of higher education institutions are prescribed by the provisions of the Rulebook on standards and procedure for external quality control of higher education institutions. Higher education institutions are obliged to prepare documentation for external quality control also, and in accordance with the Instructions for preparation of documentation for external quality control. The procedure is initiated by the Commission for Accreditation and Quality Assurance (as the National Entity for Accreditation and Quality Assurance in Higher Education-NEAQA body), in accordance with the conditions and deadlines prescribed by the Law on higher education. The NEAQA prescribes a standardized, independent and professional procedure for quality assurance of higher education institutions on the territory of the Republic of Serbia. The head of the higher education institution manages external quality control procedure. The application of the unified procedure contributes to the development of the system of quality assurance of higher education institutions and their competitiveness on the EU education market.

I. INTRODUCTION

In accordance with the Law on Higher Education [1] and the Strategy of the National Entity for Accreditation and Quality Assurance in Higher Education [2]; the National Entity for Accreditation and Quality Assurance in Higher Education (hereinafter: the NEAQA) performs the following tasks: accreditation, external quality control of higher education institutions and units in their composition, evaluation of study programs, quality assurance in higher education.

The NEAQA's vision is to become a leader in the development of quality assurance systems in the Western Balkans and thus become a significant partner in the European Higher Education Area [2].

The mission and tasks of the NEAQA are to establish and improve the quality of higher education in the Republic of Serbia in accordance with international standards [3] in cooperation with key partners, which will increase the level of competitiveness of domestic higher education [2]. The key partners of the NEAQA in the system of quality assurance and quality improvement of higher education institutions are students, business entities and public institutions. The Commission for Accreditation and Quality Assurance (hereinafter: the Commission) is a professional and executive body of the NEAQA [1,2,4]. The role of the Commissions is the external control of the quality management system in higher education institutions. (in according to a predetermined methodology by the National Council for Higher Education). The control of the implementation of the prescribed quality management system should result in the improvement of quality and the inclusion of higher education institutions in the European Higher Education Area.

The subject of this paper is the external quality control of higher education institutions. The aim of this paper is to present the methodology (procedure) of the external quality control of higher education institutions with an emphasis on the obligations of the institutions. In this paper, it is assumed that the standards and procedure for external quality control of higher education institutions are prescribed by the provisions of the Rulebook on standards and procedures for external quality control of higher education institutions [5] (hereinafter: the Rulebook). It is also assumed that higher education institutions are obliged to prepare documentation for external quality control and in accordance with the Instructions for preparation of documentation for external quality control of higher education institutions [6].

II. THE PROCEDURE FOR EXTERNAL QUALITY CONTROL OF HIGHER EDUCATION INSTITUTIONS

A. The review of the presciribed methodology for external quality control of higher education institutions

The National Council for Higher Education has prescribed rules for the external quality control of higher education institutions, which is implemented by the NEAQA. The procedure of external quality control of higher education institutions according to the standardized procedure is carried out by the Commission. This is derived from the Law on Higher Education [1].

The Rulebook [5] sets out the standards and procedure for external quality control of higher education institutions. All higher education institutions in the Republic of Serbia shall be subject to the procedure for external quality control of higher education institutions. The procedure is required to be carried out by universities, faculties, colleges, colleges of applied studies, academies of applied studies. The procedure is mandatory by all higher education institutions, regardless of the type of founding act and ownership.

The procedure for external quality control of higher education institutions is carried out by the Commission [1,5] on a regular basis: in the fourth year of the accreditation cycle; during the accreditation of a higher education institution. The procedure can also be carried out extraordinary, as well as at the request of the Ministry or the National Council for Higher Education. Regular procedure for external quality control is based on a self-evaluation report submitted by a higher education institution [1,5]. The self-evaluation report is an integral part of the quality assurance system of the institution.

Procedure for external quality control of a higher education institution is initiated by the Commission [5]. The Commission has developed and prescribed the Instruction for the preparation of documentation for external quality control of higher education institutions [6] which serves as a binding basis and guide for institutions for systematic implementation of external quality control methodology and preparation of required documentation according to prescribed standards [5].

The Commission shall obtain the documentation necessary for conducting the procedure for external quality control from a higher education institution that is subject to external quality control. The documentation shall contain [5]:

- name, headquarters, responsible person (rector, dean, president, director);
- memorandum of association and work permits issued;
- study programmes conducted;
- self-evaluation report;
- a work plan for at least the current and next year and a report on work in the previous year;
- data on students;
- data on enrollment policy: criteria and manner of ranking and enrollment of candidates;
- data on teaching staff;
- data on library and IT equipment;
- data on premises and equipment: proof of ownership/lease, evidence of urban conditions, data on area and structure and data on technical equipment (number, purpose, age);
- balance sheet and income statement for the previous year, financial plan for the current and next year, report on operations with sources of financing and method of use of financial assets.

A higher education institution shall submit referred documentation within 15 days from the date of receipt of the Commission's request.

In order to determine the facts of importance for an external quality control, the Commission for Accreditation shall propose a review committee consisting of [5]:

- three teachers from higher education institutions from the list established by the National Council [7], and shall propose one of these teachers for a president of the review committee;
- one student from the list of students established by the Student Conference of the Serbian Universities, ie Student Conference of Academies for Applied Studies of Serbia;
- one expert for certain areas from among employers, professional or vocational associations, labour markets, chambers, proposed by appropriate organizations.

Members of the review committee must not be in conflict of interest, especially if they or their close relatives are in employment or any business or other

arrangement in an institution that is the subject of an external quality control procedure. The Commission shall submit the referred proposal to the Director of the NEAQA [5]. Director of the NEAQA shall appoint the review committee and its president with the prior declaration of the reviewers that they are not in conflict of interest. The Director of the NEAQA shall also appoint a coordinator from the professional service of the NEAQA.

Decision on appointment of a review committee for external quality control of a higher education institution with the indicated names of the president and members of the committee shall be published on the website of the NEAQA [5].

The review committee for external quality control of a higher education institution shall determine facts of importance for decision making by direct inspection of the work of a higher education institution, and the coordinator shall deliver notification about its visit to the higher education institution not later than 15 days before the planned visit.

The higher education institution is obliged to provide the review committee with all required information, free access to and inspection of the teaching process and management process, inspection of the available premises, meeting with teachers, students, non-teaching staff, self-evaluation commission, alumni organization, as well as everything else of importance for the procedure of external quality control [5].

The review committee shall analyse the documentation for an external quality control and prepare the preliminary report on the reviewer`s report template, in accordance with the instructions [8,9], in which it assesses [5]:

- whether self-evaluation was carried out on the basis of standards for self-evaluation and quality assessment of higher education institutions and study programmes [10];
- which standards [10] during self-evaluation and quality assessment were fully fulfilled, which were partially fulfilled, and which were not fulfilled;
- which areas of operation of the higher education institution in a qualitative way are satisfactory, which are partially satisfactory and which are unsatisfactory.

Based on the analysis and assessment, and after visiting the institution, the review committee shall produce the Report and submit it to the coordinator. The coordinator shall submit the Report to the higher education institution which may, within 15 days from the date of submission of the report, submit any objections on the facts specified in the Report [5].

fter expiry of the deadline, the review committee shall prepare a proposal of the Final Report, in Serbian and a summary in English, based on the Report and accepted objections from the higher education institution, and submit it to the Commission for consideration.

The Final Report shall contain the following [5]:

- analysis and assessment of fulfillment of the standards for external quality control of the higher education institution;
- deficiencies regarding the fulfillment of the standards for external quality control of the higher education institution;
- proposals and suggestions for improving the quality of the higher education institution.

Commission shall consider the proposal of the Final Report at its first session after obtaining the proposal. In the process of consideration of the Final Report proposal, the Commission may ask the review committee for additional explanations and supplements to the Report. If the Commission fails to adopt the Final Report it will order the review committee to supplement the Final Report proposal, in accordance with the Commission's objections and suggestions within a deadline not exceeding 30 days. The Commission shall submit the Final Report to the higher education institution which was subject to the external quality control and the applicant for an extraordinary control within 15 days from the date of adoption [5].

If the higher education institution fails to fulfill its quality obligations, in the Final Report the Commission shall impose remedy to the higher education institution for correction of identified deficiencies and follow-up for a period of six months from the date of submission of the report. A higher education institution that is not satisfied with the Final Report may express an objection to the NEAQA within 15 days from the date of receipt of the Final Report [5].

The Final Report to which the higher education institution did not express an objection within the deadline, as well as the report adopted by the Commission after expiration of a period of six months, shall be published on the official website of the NEAQA.

If the Final Report is negative, the NEAQA shall, within 30 days from the date of publication of the Final Report, issue a decision on revoking the accreditation of the study programme or accreditation of the higher education institution [5].

Against the decision on revoking the accreditation, a higher education institution may file a complaint to the National Council of Higher Education, through the NEAQA, within 15 days from the date of receipt of the decision. The National Council of Higher Education shall reject the complaint when it finds it to be inadmissible, untimely, or filed by an unauthorized person. The National Council shall appoint a Complaints Board within 30 days from the date of receipt of the complaint on the decision [5]. The National Council of Higher Education shall, within 30 days from the submission of the proposal of the Complaints Board, issue a decision by which it may refuse the complaint or annul the first instance decision if it determines that there was any failure in the procedure of external quality control and refer it back to the NEAQA for reconsideration.

B. Standards for external quality control of higher educational institutions

Standards for external quality control of higher education institutions (hereinafter: Standards) are an integral part of the Rulebook [5] and Instructions for the preparation of documentation for external quality control of higher education institutions [6].

One of the important segments in the process of external quality control is to determine the facts whether the higher education institution, which is the subject of external quality control, meets the prescribed Standards. Based on the established facts about the fulfillment of the Standards, the appropriate steps in the algorithm for external quality control are applied, as shown in the previous subchapter of this paper.

Standards for external quality control include [5,6]:

- Standard 1: Using the results of self-evaluation of a higher education institution.
- Standard 2: Method of external quality control.
- Standard 3: Areas of the external quality control.
- Standard 4: Result of the external quality control of a higher education institution.
- Standard 5: Organization of and participants in the procedure for external quality control.
- Standard 6: Procedure for the external quality control.
- Standard 7: Reporting.
- Standard 8: Periodical controls.
- Standard 9: Improvement of the procedure for external quality control.

Each Standard [5] is structured. It contains a descriptive part, accompanying documentation, tables, appendices [5,6]. Standards [5,6] require appropriate interpretation of data from the institution, which is the subject of external quality control. They form an integral part of the documentation for the external quality control and are filled in by the institution according to the presented methodology.

III. ANALYSIS OF THE OBLIGATIONS OF THE HIGHER EDUCATION AND THE HEAD OF INSTITUTION

In the prescribed and presented procedure of external quality control [1,5] the higher education institution has appropriate obligations related to the preparation of documentation. The higher education institution must fulfill his obligations in a certain order and within predetermined deadlines.

In order to successfully implement the external quality control procedure, the higher education institution may appoint a special team (e.g. commission, board, etc.) to prepare the documentation. It is very important to systematically follow the individual steps from the Instructions for preparation of documentation for external quality control of higher education institutions [6] and correctly interpret the required data according to the tables. It is also necessary to prepare the annexes according to the Standards.

It is extremely important in the process of external quality control to establish communication with the NEAQA, as a key partner in the process of submitting/reviewing of documentation.

The head of the higher education institution should pay attention to the fact of the level of responsibility, which it bears on behalf of the institution. The head of the higher education institution (e.g. director, dean, president of the academy of vocational studies) of a higher education institution, in accordance with the Law of higher education [1] shall guarantee [5]:

- that the external quality control documentation has been produced in accordance with the standards for external quality control;
- for the accuracy of the data in the external quality control documentation of a higher education institution.

The head of the higher education institution signs the documentation from the request for external quality control on behalf of the institution, which is the subject of external quality control. The head of the higher education institution should timely approve and make the payment of the appropriate fee for external quality control, according to the valid price list determined by the NEAQA. He is also responsible for the preparation of the protocol of the visit of the review committee.

The head of the higher education institution, in essence, manages the entire procedure of external quality control in the institution, which is the subject of the same, because according to the Law on Higher Education [1] it is responsible for the legality of the work of the institution he heads.

According to the above, the head of the higher education institution organizes and monitors the entire work of the institution and consequently, all segments of the implementation of the external quality control procedure. He is also responsible, on behalf of the institution, in the procedure of administrative supervision [1], the timeliness and accuracy of the execution of the work entrusted to him.

IV. CONCLUSION

In accordance with the Law on Higher Education, the National Council for Higher Education has prescribed rules for external quality control, in order to establish a system of quality assurance (and control) in all higher education institutions in the Republic of Serbia. The NEAQA performs quality control of all higher education institutions in a standardized, independent and professional manner. The methodology for external quality control is prescribed by the Rulebook on standards and procedures for external quality control of higher education institutions. The Instructions for preparation of documentation for external quality control of higher education institutions serves as a detailed guide to higher education institutions for the practical application of standards and the entire methodology. As a result of the performed procedure of external quality control by the NEAQA, the higher education institution received the Final Report which states the advantages but also and the shortcomings noticed in the procedure of external quality control. Partial non-compliance of the quality assurance system, which was noticed in the institution, must be corrected and brought to the prescribed level of quality through the prescribed measures. The submitted proposals and suggestions in the Final Report represent a challenge for the institution in terms of improving the quality of all segments.

The head of the higher education institution is responsible for the entire work of the institution and thus for the implementation of the procedure of external quality control of the higher education institution (according to the dynamics and methodology) which is prescribed and presented in this paper. By applying the standardized methodology, the unique system of quality assurance (and control) enables higher education institutions to raise the quality of their own work in a transparent way with key partners.

The application of the unified procedure contributes to the development of the system of quality assurance of higher education institutions and their competitiveness on the EU education market.

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An Overview of the Most Influential On-line Media

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Abstract - Increased use of online media is changing people's lives. Thanks to online media, the way of people's connection and cooperation in a wider social context, at work and in civil society has changed significantly. The great influence of increased use of online media is beneficial to both individuals and society. It enables unprecedented levels of communication, social interaction and community building beyond the boundaries of time, place and social context. It enables the democratization of knowledge. New learning methods are possible as well as ways of working whose provide better opportunities for all human society.

In this paper, selected online media will be analyzed in order to stress their importance and influence in society. It was selected: blog, e-magazine and video edition.

I. INTRODUCTION

Communication between people begins with emergence of human society itself, what has changed throughout history are its means and ways. If we look at the very beginnings of human society, we can say that the primary ways of communication were verbal, symbolic and visual, with the aim of expressing basic needs and survival in the fight against nature. With the development of human civilization, new media appeared and communication improved: from drawings, the appearance of letters and the written word, through Gutenberg's machine, to radio and television. Thanks to the mentioned media, richer communication has been enabled, as well as a far greater influence in society. A new era in the development of media and communication began with the appearance of the Internet when classic media acquired online properties. As a result, printed media, radio and television are becoming online and changing their classic form to adapt to the possibilities offered by the Internet. For instance, popular print magazines and newspapers have their online editions enriched with multimedia content and interaction with users in order to preserve and increase the influence, as well as the number of readers. Journalism is no longer classical in a way to require specially trained staff, because others can also be journalists. The ability to retain the user's attention and interest is especially valued. In this paper, selected online media will be analyzed in order to stress their importance and influence in society. Media that were selected are: blog, e-magazine and video edition. [1]

II. THE MOST INFLUENTIAL BLOGS IN THE WORLD AND OUR COUNTRY

The blog emerged as an internet genre in the 1990s and it was an online diary into which bloggers could enter observations from their private lives. Today, it is considered a phenomenon of mass communication – 30000 new blogs are published every day – because they represent a fresh, uncensored form of expressing views on any topic from social, political or private life. Bloggers around the world often present important information to the public, reveal government secrets, initiate political crises and scandals, and report from places affected by natural disasters or war-torn countries. They encourage the leading media to follow their footsteps and in that way participating in shaping public opinion. Large companies and individuals no longer have to wait for the media to place information about their communication activity, but can simply, in addition to the existing site or independently, create their own blog within a few hours and communicate directly with the targeted users. Alternatively, they can choose a blogger who covers a specific target group and allow them to try out the product or service they want to present to the public or simply follow a topic of interest. Thus, a blogger becomes a kind of brand advocate or a satisfied customer, providing a personal presentation of the product, and it is known that there is nothing more effective than a friendly recommendation. This is especially effective for companies dealing with new technologies. For instance, at the beginning of the launching campaign of their products Siemens and Nokia sent their latest phones to influential bloggers in France at first. [2]

Among the most popular areas for blogging are those that provide great traffic and earning power. These are: tourist blogs, health blogs, lifestyle blogs, blogs about technology and games and parent blogs.

Ten blogs that are the most read and influential are: [3]

1. Billboard – https://www.billboard.com/

According to Hot 100 and Billboard 200 this is the best known blog, which lists the most popular songs and albums on a weekly basis. It shows news, events and music industry mainstream.

2. The Verge – https://www.theverge.com/

The Verge is an ambitious multimedia information source founded nine years ago to examine how technology will change the lives of active audiences in the future.

3. Vogue.co.uk – http://www.vogue.co.uk/

This is the blog about fashion, trends, latest news, catwalk photos and designers.

4. TMZ – https://www.tmz.com/

It shows interviews, videos and photo galleries covering the latest entertainment news in Australia and around the world. The articles primarily cover the lifestyle of celebrities, focusing on health, beauty, fashion, as well as travel.

5. Gizmodo – https://gizmodo.com/

Gizmodo was originally launched as part of the Gawker Media Network, a blog on design, technology, science and science fiction, but contains political articles as well.

6. Business Insider – https://www.businessinsider.com/

This blog is example of top business journalism that informs readers about economic news, as well as interviews with top entrepreneurs. There are also educated predictions, trend analyzes and tips on how to improve your business.

7. Entrepreneur – https://www.entrepreneur.com/

The blog that shows: business news, events, book recommendations and interviews with successful entrepreneurs. It is updated daily and has its own magazine.

8. Fast Company – https://www.fastcompany.com/

With an editorial focus on technology innovation, world-changing ideas, leadership, creativity and design, FastCompany also provides readers with economic news and advice on how to better run their business.

9. TechCrunch – https://techcrunch.com

TechCrunch, founded by Michael Arrington and later sold to AOL, remains one of the leaders reporting on technology industry news.

10. MarketWatch – https://www.marketwatch.com/markets

MarketWatch shares the latest industry news and in-depth analysis to ensure that investors get the most important information they need.

The presence of blogs is a huge and increasing number of celebrities are attracting the attention of the public through this online media. Beside them, blogging can be done by everyone else, and blog success depends on the topic as well as the skill to attract and retain readers.

One of the most influential bloggers in the field of information technologies in our country is Istok Pavlović – https://www.istokpavlovic.com/blog/.

Istok Pavlović started blogging in 2007 by devoting himself to the topic of internet marketing, which made him famous. It seems that nothing particularly new in that area can be written, because so many people write about it, but only a few texts by Istok Pavlović dissuade that:

1. Something new and different can always be written from this area;

2. It is possible to show your advantages over the competition with just a few texts;

3. It is possible to stand out very quickly concerning the competition when presenting the subject in which the blog writer is an expert.

The most important thing is that when the user reads the text, he can really solve a problem, or that the problem finally becomes understandable to him. Istok's way of writing, that is, his ability to present something that is difficult and complicated in a simple way, is the key to the success of this blogger.

Beside good content, blog design is also very important. It should be simple and accessible to every user. The world's most respected web design magazine Smashing Magazine published this blog at the top of its list of the best designed blogs in the world. Also, this blog has appeared on Mashable.com, as well as on hundreds of other sites that are good examples of web design, and its success is the result of Istok's overall commitment.

The most successful blog project in Serbia is Brana's divine world – https://branasdivineworld.com/. This blog has transcended the boundaries of a fashion blog and has grown into a lifestyle blog that encompasses various aspects of interest: from books, movies, music and

photography, through cosmetic topics to the inevitable fashion moment.

Branislava Antović founded this blog in 2010 in order to provide a place for her own sake where she will be able to express herself, both through clothing combinations and through words. Over time, the blog becomes a reflection of all her interests and it is no longer focused only on fashion.

In 2013, Branislava was declared a style icon of the Chictopia site, which has over half a million of users globally. In the same year, she received recognition from PC Press magazine for one of the five best blogs and one of the 50 best sites in Serbia for 2013. The following year, Bazar magazine awarded her the "Person of Style" award. In November 2018, as part of the Wannabe Digital Awards event, she was named Lifestyle Blogger of the Year.

After all the great recognitions, it can be said without a doubt that this blogger influences those who follow her blog. She is a professional in her work, and most importantly, readers trust her and keep coming back to her. The ability to fit and supplement text with a photo, and vice versa, is the key to the success of this blogger.

When we talk about emotional intelligence blogs, Jelena Pantić's blog – https://www.jelenapantic.com/ is one of the most influential in this area.

The key to her success is in her ability to explain professional terms clearly and understandably. Lightly and unobtrusively, she points out to the readers how much is in their power, and what they can do to live their lives easier and more beautifully.

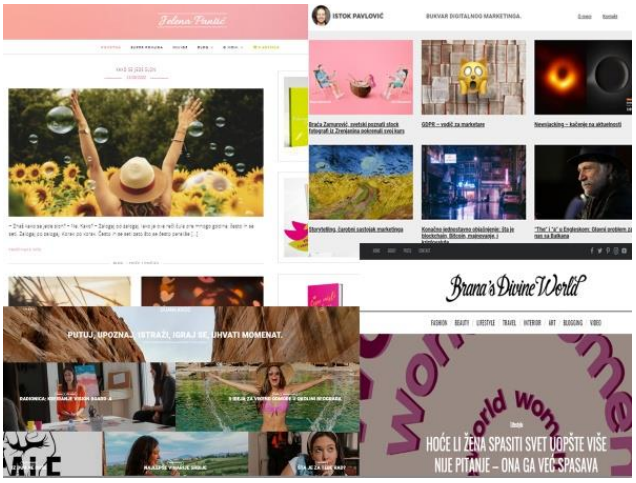

Figure 1. Some of the most influential blogs in Serbia

Jelena is a psychologist, which is another great advantage. It is completely impossible to read the advice of someone who is an expert in the given field and to remain indifferent. Each of her texts has a certain impact on the readers, whether it is a short self-examination or even a deep reflection on the topic and analysis.

At one point, Tamara Kalinic replaced her career as a pharmacist with the job of a fashion blogger. Her passion for fashion overcame her many years of schooling and Tamara decided to dedicate herself completely to what she loves the most.

The Glam and glitter – https://theglamandglitter.com/ is a place where Tamara regularly publishes her texts, photos, fashion tips and suggestions. She is very successful in that, which has been officially confirmed – the Times ranked her among the 100 most influential influencers in 2019. Since she writes in English, her blog is read all over the world.

Dijana Kocic, adventurer and world traveler, is author of travel blog – https://dijanakocic.com/. It leaves a strong impression on readers by giving advice on how to make beautiful pictures on the trip, where to eat delicious local food or drink a fresh smoothie. It influences the reader's thinking on how to move and motivate him towards the realization of his travel dreams.

III. THE MOST INFLUENTIAL E-MAGAZINES IN THE WORLD AND SERBIA

The first e-magazines appeared in the seventies of the XX century, but due to their unavailability to a large number of users, they were not widely used. In the last ten years, an increasing number of magazines have switched from paper to electronic format. [4]

The term electronic journal means all journals that are available in electronic form, today it is generally understood that they are available through the World Wide Web.

E-magazines usually come in two forms, such as:

1. electronic versions of existing printed magazines – the most common form of e-magazine. Since 1997, an increasing number of publishers have published and offered electronic editions of their printed editions on the market. The content of electronic journals may be identical to the printed version or may contain some online material

2. exclusively electronic publications – magazines "born" in electronic form are still underrepresented compared to other forms of e-magazines. There are only a few hundred titles, and the number of relevant titles among them is much smaller.

A review of the 10 most read and influential electronic magazines in the world: [5]

1. Forbes – https://www.forbes.com/

Listed as one of the best magazines in the United States, Forbes contains original articles on topics related to certain industries, finance, marketing and investing. It also publishes reports on communications, technology, law, science and politics.

2. Vogue – https://www.vogue.com/

When it comes to the list of magazines in Australia with great popularity, it is impossible not to mention Australian Vogue. This magazine helps readers discover new Australian fashion trends. Vogue is released digitally via Google Play and Zinio. There is also the possibility of access on the iPad.

There is a reason why Vogue is one of the largest and most influential magazines in the world. Vogue keeps its brand strong by making its magazine available online. They have a strong online presence while also maintaining a printed version.

Although known for their beauty and fashion content, Vogue has continued its research on political and social issues. These researches are actually the reason why they are still relevant today. Vogue is not limited to one topic, but is evolving with modern society. It follows topics that are current in society, and in that way it ensures success.

From the example of this online magazine, it can be concluded that if we are up to date with what is happening around us, it will certainly help us keep our magazine relevant to our readers and thus achieve huge success in the market.

3. Business Insider – https://www.businessinsider.com/

Based in New York, Business Insider was published in February 2009. This magazine, which is among the 10 best magazines in New York, contains details and analysis of business news. News on various topics on its website may be also found.

4. Business Week – Bloomberg – https://www.bloomberg.com/businessweek

This weekly business magazine is ranked among the 10 best English magazines in the United States. Business Week also offers unique stories, a global perspective and timely insights for its users.

5. Cosmopolitan Magazine India – https://www.cosmopolitan.in/

Cosmopolitan is undoubtedly one of the best monthly magazines in India, especially for women interested in the latest life trends. This magazine contains the perfect combination of bold, open, glamorous and intimate content.

6. MSN – https://www.msn.com/en-xl/

Next on the list of the world's best magazines is MSN.com. For its users it offers content about sports, news, videos, games, weather, celebrity gossip, shopping, and other.

7. The Washington Post – https://www.washingtonpost.com/

The Washington Post is considered one of the best magazines in the world because of its compelling content. Outstanding reporting and ease of navigation are the reason for its great popularity among millions of people around the world.

8. World Magazine – https://world.wng.org/print

World magazine publishes various editions from the United States and other countries. This Christian news magazine, which is published every two weeks, also includes commentaries, cultural analyzes, films, music and book reviews.

9. The Economist – https://www.economist.com/

The Economist covers subjects related to the business world and economics. Listed as one of the world's most popular journals, it also offers information on the world economy, including authoritative insights and opinions on news from the worlds of politics, finance, business, technology and science.

10. Discover Magazine - https://www.discovermagazine.com/magazine

It is one of the most influential electronic journals in the field of science. This magazine reveals amazing achievements in science, medicine, technology and the world in which we live. Photos combined with understandable stories on complex topics connect everyday people with various ideas and the greatest minds in science.

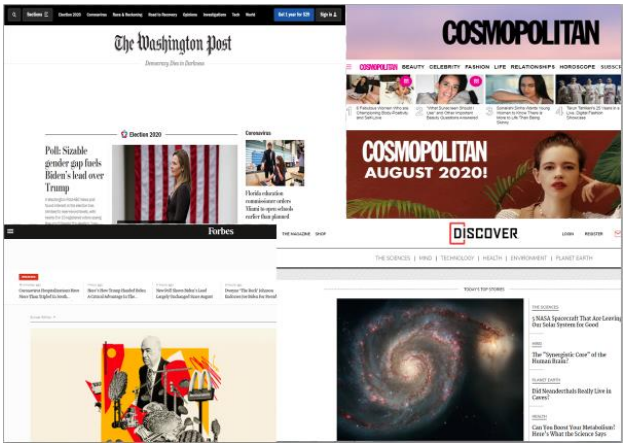

Figure 2. Some of the most influential e-magazines

The wide range of interests offered by this journal is one of its advantages to be in the top 10 in the field of science. Discover brings us: latest news, theories in the development of science; striking stories and discoveries in health, medicine; environmental issues and their importance for everyday life; information on the best technology and its impact on the future; articles by Nobel laureates.

Ease of finding texts on the desired topic is also one of the advantages. This magazine allows us to keep up to date with everything that is currently happening in the world, in any area, but it is possible to read articles related to previous years. If we have not followed something, we can find it very easily, because their articles are organized chronologically.

IV. THE MOST INFLUENTIAL VIDEO EDITIONS

Internet video is such an important part of the Internet that there are countless video sites worth visiting. [6]

Preview of the top 10 options for watching videos online is: [7]

1. YouTube – https://www.youtube.com/

YouTube is an American website for sharing and exchanging video files.

YouTube is one of the most influential and visited networks. It provides sharing videos, and users of this network can post their own videos, rate, view, comment and share videos by other authors.

The most watched videos on YouTube are entertaining and the content of the most watched YouTubers is based on life stories, dramas, reactions, tutorials, etc.

One of the most influential channels in the Balkans is Yasserstain, which has close to 300,000 subscribers. A person under the age of 25 has millions of views. He mostly deals with recording sketches and videos, but also promoting good behavior, the importance between friends and family through funny but instructive clips. The founder of this channel is Milan Inić and the complete team also includes Leni, Petar, Singer and Dex.

2. Vimeo – https://vimeo.com/

The website, which was the first on the Internet to support high-definition videos, and although it includes a selection of user-generated prices, its emphasis is more on high-quality content.

The site has a search function that is easy to view and that organizes videos by categories and channels.

3. Metacafe – https://www.metacafe.com/

Metacafe is a video site specializing in short video content. Content includes everything from the highlights of the world's best surfers, quick and detailed product reviews and tips on how to complete the difficult level of your favorite video game.

One of the advantages of Metacafe is its simplicity. Its browsing interface is quite simple, with a menu bar leading us to the latest, popular and trendy videos. Those who want to explore more deeply can click on the drop-down menu on the left which contains a more extensive list of video categories.

4. Dailymotion – https://www.dailymotion.com/us

Dailyimotion is another video site like YouTube. It was put into operation in March 2005, just a month later than its more famous rival.

Today, Dailymotion is probably YouTube's favorite competitor. Millions of videos have been uploaded by professional publishers and amateurs. The videos on the home page are organized by categories, and current topics and trendy videos have a prominent place.

Dailymotion allows you to open an account. The more videos you watch, the more personalized your site's recommendations become.

5. Veoh – https://www.veoh.com/

Originating from Israeli startup Qlipso, Veoh is a YouTube alternative that describes itself as an internet TV company. The site boasts millions of videos, most of which are professionally produced.

Veoh contains a wide range of TV content, including entire episodes and excerpts from shows. In addition to TV spots, Veoh also has music content from a wide range of genres. It also has a movie section that includes some feature features as well as memorable clips from a large number of movies.

6. The Internet Archive – https://archive.org/details/movies

The Internet Archive is a web-based library of all kinds of free content, including books, music, software and movies.

One of the strengths of the Internet Archive's video content is a large collection of historical content. Although it has newer content, some of its best videos are older, TV series and movies that are usually hard to find on other websites.

Like many other websites, users can also upload videos to the Internet Archive.

7. Crackle – https://www.crackle.com/out-of-region.html

Owned by Sony Pictures Entertainment, Crackle is an online streaming website featuring original webcasts as well as Hollywood movies and TV series from various networks. It also has a good selection of TV shows and movies from the past.

8. Twitch – https://www.twitch.tv/

Twitch is the best web platform for live streaming. The website is owned by Amazon.

The main focus of Twitch is streaming live video games. There are also some non-toy videos. Most importantly, Twitch has broadcast several live music videos from festivals and concerts. Today, Twitch is the official streaming partner for the Ultra Music Festival in Miami.

9. The Open Video Project – https://open-video.org/

It targets the research community, including those working with multimedia retrieval and digital libraries.

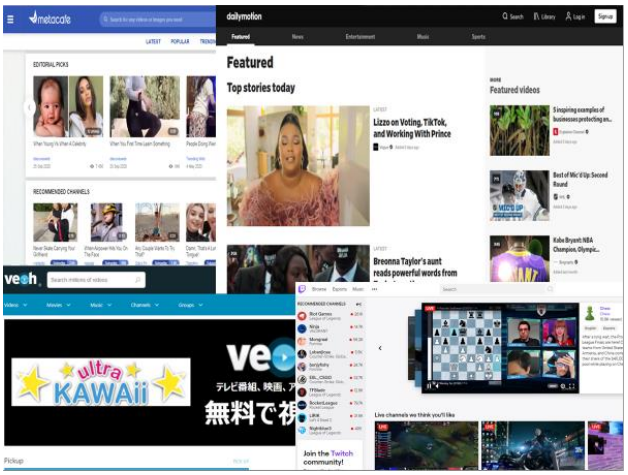

Figure 3. Some od the most influential video editions

With that in mind, most of the videos on this video site are educational in nature. There are many videos from the archives, as well as a collection of classic TV commercials and educational films from the 1950s. If you want to explore historical video content, you have the opportunity with The Open Video Project.

10. 9GAG – https://9gag.com/video

9GAG is a collection of all the funny photos, GIFs, game videos, animations and more.

Most of the content is fun and frivolous. It is the kind of thing that is hard not to click on and then spend hours browsing.

V. CONCLUSION

Today's world would be almost unthinkable without the use of the Internet. Generations that grew along with the development of internet technology do not know about the other world. For them, the use of the Internet and communication through it is everyday life. The Internet is a global medium with unlimited learning resources and great opportunities for individual and group interaction.

This paper presents and analyzes only a small number of the most influential online media in our country and in the world, which have significantly attracted the author's attention with their content, design and navigation.

ACKNOWLEDGMENT

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IT Projects Success Factors

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Abstract – In theory and practice IT projects are recognized as difficult undertakings that are more likely to fail than projects implemented in other industries, concerning the difficulty and risk of their implementation. The search for critical success factors of projects has been conducted for several decades and is the subject of numerous researches on this topic. In this paper, an overview of research on the success of IT projects is given, with the aim of identifying the factors that have the greatest impact on the projects success. Taking into account the selected factors, the outcomes and success of future IT projects can be influenced.

I. INTRODUCTION

There is a wide range of definitions of the term *success* given that success occurs in all spheres of life and given that each individual can experience it differently. In [1] success is simply defined as "the ultimate goal of an endeavor". Similarly, there is a big difference in the perception of the meaning of success in the minds of people who evaluate projects. In [2] authors recall that the discipline of project management itself is relatively new, which is why it is justified that creating a comprehensive definition of success in project management and understanding it takes time.

For many years, the failures of IT projects have received great attention. Although no industry is immune to project failure, the information technology industry has proven to be quite vulnerable to risk and failure. In order to avoid them, many organizations try to learn from past experiences. As each retrospective on the realization of the project is a unique story, their review can reveal the most common mistakes and point out the best practices in project management. However, if failure teaches us more than success, the question arises as to why most IT professionals agree with a numerous researchers who believe that project failure has become the norm in IT project management. Numerous researches on this issue testify to the fact that failure happens much more often than it should.

II. RELATED WORK

In most organizations IT projects are characterized from undisciplined to chaotic, most of which are out of control. The fact that failure is a much more frequent in IT project management is confirmed by numerous researches, which have been conducted for many years. Research conducted at the beginning of the 21st century indicates that the failure rate of IT projects is quite high. When it comes to IT projects [3] indicates that more than 50% of companies in America experience some form of failure. In [4] it is pointed out that 75% of ERP system implementation and development projects are considered unsuccessful, and many end up with very bad consequences. Although the authors [5] of one of the researches conducted in 2007 conclude that the situation in practice is not as bad as before, the results of their research do not show great improvements. They point out that 67% of projects end up with costs and deadlines that are close to projected. However, "roughly predicted" does not represent a significant improvement over the results of research conducted in previous years. Such doubts can be confirmed by the research of other researchers [6, 7] who point out that a few years later the situation has not changed significantly compared to the beginning of the 21st century and that there is still a high failure rate of IT projects.

During investigation of the IT projects success, special attention was paid to projects in the field of software engineering. The results of a survey conducted in 1994 by The Standish Group have attracted a great deal of attention from experts and researchers. The results were published in the Chaos Report [8] with the intention of talking about actual practice in software engineering. According to the report, it is estimated that only 16% of projects are completed successfully, while 53% are not completed successfully due to cost and budget overruns. The results indicate that 31% of projects are canceled before they are completed at all. In addition, it is estimated that software projects end with 222% delays, 189% budget overruns, and deliveries that meet only 61% of the functionality specified by customers. These results have been reviewed in detail by a number of researchers, who then explored them further. One of the leading researches in the field of information technologies [9] indicates that the success rate of projects has increased since the first publication of the Chaos Report. Researchers attribute this to the application of the "recipe for success" formed by The Standish Group, noting that project success increased from

16% in 1994 to 28% of successful projects in 2000. An example of similar results for projects of that time can be seen in a study [10] which shows that 20% of software projects fail, while 46% of projects exceed budgets, deadlines and end up with significantly less functionality. The general acceptance of the Chaos Report results is confirmed by [11] noting that "the impact of the figures and their widespread use indicate that thousands of authors agree with the findings provided by The Standish Group". Similarly [12] pointed out that the reason for the widespread acceptance of these results lies in the "lazy research" of other researchers. However, both studies provide an example of critical observations on the results of the Chaos Report. They point out that The Standish Group completely refuses to disclose the data, which raises doubts about its validity. In addition, they suggest that research conducted in a similar period yields different results than the results in the Chaos Report. For example [13] indicated that the percentage of budget overruns is 34%. A few years later [14] and [15] conduct their research and calculate that the excess is 33%. The results shown differ significantly from the 189% overdraft reported by Chaos Report. While this does not challenge the results of the Chaos Report, it does create additional doubt.

However, looking at all their research, it can be said that The Standish Group provides an overview of 25 years of cumulative research on project success and failure data, looking at over 50,000 completed projects. Traditionally, Chaos Report observes the success of a project based on only three measures of success: on-time, on-budget and performance. In the latest available version from 2018 [16], the project success is observed on the basis of six different measures of success: achievement on time, achievement within the budget, achievement in terms of performance, achievement of set goals, customer satisfaction, return on investment. This report indicates that 36% of projects are completed successfully, 45% are completed with a challenge in some of the parameters, while 19% of projects are completed unsuccessfully. Compared to the first Chaos Report in 1994, a higher success rate can be observed. The 2018 Chaos Report introduces another definition of a successful project called pure success. Pure success is a combination of high customer satisfaction, with a high degree of return on investment for the organization. The results associated with this type of success indicate that 14% of projects are completed successfully, 67% are not successful in some parameter, while 19% are unsuccessful.

A special issue that some researchers [17-19] have been dealing with for a long period of years refers to the question of the difference between project success and project management success. They point out that the success of the project is measured in relation to the overall goals of the project, while the success in project management is measured in relation to costs, time and quality, i.e. in relation to the so-called effect. Such considerations are supported by the Chaos Report [16] which indicates that the three measures (time, cost and performance) actually relate to project management success, rather than project success, as they do not indicate customer satisfaction or return on investment. In addition, researchers believe that achieving success in a project does not mean that success in project management has been achieved at the same time. In other words, a project can be successful despite failed project management if it manages to achieve multiple goals. On the other hand, the assessment that project management has been implemented successfully does not necessarily mean that the project meets all the criteria that make it successful. However, considering the existence of a large number of factor models and criteria for project success and project management success, it is difficult to make a clear distinction between these two concepts.

In theory and practice IT projects are recognized as difficult undertakings that are more likely to fail than projects implemented in other industries, concerning the difficulty and risk of their implementation. In search of an explanation, researchers [20, 21] state that the difficulty of realization and failure of IT projects can be explained by its characteristics:

- Unrealistic expectations and overambitious goals;
- Visualization difficulties, which lead to the fact that the presentation of IT projects is sometimes not understandable to stakeholders, which further affects the late detection of problems;
- Excessive perception of flexibility, which leads to time and budget overruns and frequent changes in client requirements;
- Hidden complexity, which includes difficulties that arise at the beginning of the project and is associated with the reliability and efficiency of the system;
- Uncertainty, which causes difficulties in determining the requirements and problems in the application of the developed system;
- Tendency to software failure due to assumptions that are not considered during development and difficulties in predicting the effects of small changes in software;
- The goal of changing existing business processes that requires IT professionals to understand business processes and processes related to IT systems in order to be able to automate them and make them faster.

On the other hand, [22] cites lack of input from clients, incomplete requirements and specifications, changes in requirements and specifications, and unclear project objectives as the most significant reasons for the failure of IT projects. The lack of uniform definitions in this area has influenced researchers in this field to observe and interpret project management practices in different ways. Consequently, it is clear why researchers dealing with the issue of success generally have unique understandings of success, as well as unique classifications of factors that influence success. An additional reason for the disagreement of the researchers is explained in [23], pointing out that what makes a failure in one project can be a factor of success in another. All this depends on the project management practice itself, which is such that it enables the evaluation of the success of the project to depend on the person who evaluates it [17, 24-26]. For example, project managers will apply different success evaluation criteria to the project team or end users. For this reason, a special chapter is devoted to an overview of the factors and criteria for project success.

III. FACTORS AND CRITERIA OF PROJECT SUCCESS

The search for critical success factors of projects has been conducted for several decades and is the subject of numerous researches on this topic. Beginning with the first research in the 1960s and 1970s [27-29], the authors addressed the issue of project success and failure and confirmed that there are specific factors that influence project success. In the initial research of factors, different researchers [30-33] come to the conclusion that the success of the project can be observed through two components:

- *Project Success Criteria*. Success criteria are measures that are applied to assess the success of a project, such as the time and costs required for implementation or the quality achieved.
- *Project Success Factors*. Success factors are elements of a project that, under the influence, can improve project success. It is believed that they can influence the project by making it more difficult or easier to achieve.

The project management triangle model (time, cost and scope), or the triple constraint model [34] is the first model of project management success criteria, which was later confirmed to represent only one part of the overall project success [17]. By applying the triple constraint model, success can be measured using a variety of formulas that are considered unambiguous and easy to estimate. Although this model of success criteria may seem accurate in some cases and appropriate for rapid assessments, there are a large number of cases where this model has proven to be simply insufficient. For this reason, the next step led to the creation of numerous variations and additions to this model. Researchers extend the triple constraint model by additionally looking at the issue of customer satisfaction [35-37], the benefits for the organization that owns the project [35, 36, 38], or the long-term impacts on the project environment [39]. From the aspect of IT project management, special attention is paid to identifying criteria for measuring the success of IT projects. Researchers often refer to the models of success criteria they have provided [31, 36, 40-42]. However, [43] suggest that almost every project success assessment model includes a triple constraint model. The criteria that can be found in the triple constraint model are still considered mandatory for assessing project performance in most organizations. As an explanation, they point out that the comparability of projects is considered a very difficult undertaking, and the criterion of triple constraint can be understood as solid facts that can be easily measured and calculated. For that reason, many companies still use them to compare projects.

On the other hand, the categorization of success factors is the ultimate goal of numerous studies on this topic. [44] provides one of the first classifications of success factors into strategic and tactical factors. Strategically, they were related to the mission of the project, supporting senior management and creating a project schedule, while tactically they were related to consulting with clients, selecting team members and their training. Over the years, the authors [24, 45-47] have been dealing with the identification of factors and their classification. From the aspect of IT project management, research is particularly concerned with identifying factors that influence the IT projects success. The research conducted by a group of researchers [48] is one of the most extensive studies on this issue focused on the field of IT project management. It includes project managers with extensive experience located in three different environments: Hong Kong, Finland and the United States. The results identify 53 risk factors for the realization of the IT project. Through the process of ranking and merging, the list has been reduced to 17 factors. In addition, there are other studies that indicate the success factors of IT projects [9, 49], while some research deals with specific domains of IT projects: information system implementation projects [50-53], web-based projects [54], information systems projects in health [55-57] and others.

The issue of project success is at the core of the project management area, which explains the reason

for the large amount of research conducted on this issue. Research on this topic dates back to the 1960s, and the continuity of interest has not declined to this day. At a time when projects have begun to be accepted as a way for a company to achieve its goals, Pinto, Slevin and Prescott are publishing their research papers [58-61], which are widely known today. Although these researchers were not the first to address the topic of success factors, their contribution was timely and relevant to the field. They begin to address this issue thoroughly at a time when the success of the project has been vaguely defined, and compatibility between success factors and tools for their assessment did not exist. They provide a comprehensive approach to defining success, identifying the factors that support success and assessing the severity of these factors throughout the project life cycle in different industries. They have also developed a tool that allows project managers to assess the status of their projects and compare them with a database of over 400 projects.

In a study conducted in 1986 [58], Slevin and Pinto defined ten critical success factors for a project.

• *Project mission*. It represents an initial clarification of the goals and general direction of the project. It can be explained by questions such as: is the mission clear, do I understand why the project is being considered, do I consider it feasible, is the project necessary, are the goals specified and feasible.

• *Senior management support*. It refers to the desire of senior management to provide the necessary resources and authority/power needed for the success of the project. Without their support, the project may seem unnecessary, pointless, and irrelevant to other members of the organization. It refers to whether senior management recognizes the importance of the project, whether it provides support, especially during the crisis, as well as whether it believes that the project will be able to succeed.

• *Creating a project plan/schedule*. It represents the creation of a detailed specification of the individual steps required for project realization. In order for the project to start and succeed, it is necessary to have schedules, as well as to allocate the necessary people, money, time and other resources. In addition, the optimal way to measure project progress must be determined.

• *Consultations with clients*. Clients mean anyone who will use the result of the project. Since the project is made for the needs of clients, frequent consultations with them are necessary for the project to run smoothly. It includes communication, consultation and active listening of all involved. It refers to whether the project team and the project manager understand the client, whether meetings are regularly organized and other issues.

• *Team members*. The people involved in the project are a very important variable in the project realization. The question is always whether the necessary people are included in the project team. Therefore, attention should be focused on the selection and training of key people, in order to enable only those who will contribute to the project to be included in the project. It also refers to whether individuals meet the technical requirements in terms of knowledge and skills, as well as whether team members are certain about their role in the project and whether the description of the position they have is clearly written, delivered and completely understandable to team members. In addition, it relates to understanding how team members' performance is measured, and many other aspects.

• *Technical tasks*. It refers to the availability of the necessary technology and the experience needed to achieve specific technical steps. In addition, it can be related to whether the technology is used in an adequate way, whether the technical tasks are managed properly, whether the right people are assigned to the right technical jobs, and the like.

• *Acceptance by the client*. It represents the act of selling the final product to customers. It can be related to the existence of adequate project documentation, contacting and checking customer satisfaction with product functionalities, and other aspects.

• *Monitoring and feedback*. It refers to the timely provision of comprehensive information needed for control at each stage of the implementation process. The essence can be related to the existence of regular meetings to check the progress of the project and regular comparison of what was achieved with the planned. It also refers to the revision and sharing of key information on progress and corrections.

• *Communication*. It is essential that communication exists among the members of the project team, with other members of the organization and with clients. It refers to the provision of all adequate networks and the necessary data for the key factors of the project realization. It can be associated with holding regular meetings to exchange information about the project, changes, progress, problems.

• *Troubleshooting*. It refers to the ability to resolve unexpected crises and deviations from the plan. It connects with brainstorming meetings, consulting with other team members or external consultants and all activities that enable problem identification and resolution.

In their study [59] Pinto and Slevin addressed the critical success factors of the project, presenting the

results of empirical testing of factors previously developed and published [58]. In addition to the ten internal factors, four external factors are included (characteristics of the team leader, power and policy, environmental events, urgency) and their significance and weight are determined. It was identified that all factors were significantly related to the success of the project. Combinations of these factors explained 60% of the project's success. In the same study the authors state that success factors can be observed based on the project life cycle. For each of the four phases of the life cycle (design, planning, execution and closure), the most significant factors influencing that phase are presented. The research [61] was conducted with the intention to reduce the identified success factors to two components: (1) initial project planning and development; and (2) tactical operationalization of initially established plans and objectives. Of the ten factors, project mission, senior management support, project planning, and client consultation were identified as the planning category, while the rest represented the tactical category.

Pinto and Slevin dedicate one of their researches [58] to defining success and the way of measuring it. The authors point out that there is a large amount of research that originally indicated that the success of a project can be measured on the basis of time, budget and performance criteria. However, the authors state that over time, another criterion of project success appears in the literature, which refers to client satisfaction. As a result of the research, the authors provide a model of project success, which divides success into two topics – project and clients; which are then presented as internal and external success criteria (Figure 1). Internal criteria measure success through the well-known measures of time, cost and performance. Time and costs refer to whether the project was implemented as planned in terms of time and costs. Performance refers to whether the project result provides a functional solution to the problem, whether the selected project is the best solution of all the alternatives offered for the observed problem, and whether the project result provides an improvement in the way clients performed their activities. On the other hand, external criteria view the project success from the aspect of use, satisfaction and effectiveness. Use refers to the questions of whether the project will be used by the client, whether the clients will benefit from the project, as well as the question of whether the initial non-technical problems will be minimized when the project is accepted by the clients. Satisfaction refers to satisfaction with the overall progress of a project. Effectiveness refers to whether a project will provide direct benefits to clients, directly lead to an improvement in the client's decision-making process, and have a positive impact on those who use it. The authors especially emphasize that the significance of these criteria changes as time passes. External criteria are more important at the very end of the project and after its completion, while during the project internal criteria are more important. [62]

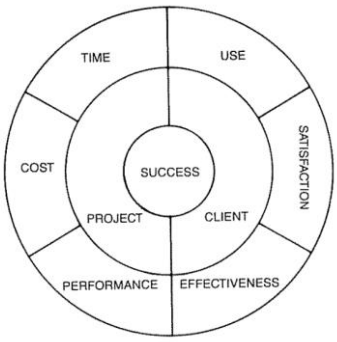

Figure 1. Model of project success criteria [58]

Research conducted by Pinto, Slevin and Prescott is cited directly within the Body of Knowledge published in 2000 by the UK Project Management Association [63]. It defines their factors as "measurable factors that, when present in the project environment, contribute most to the success of the project". This research provided a solid basis for later research by other authors.

IV. CONCLUSION

As previously shown, many studies have addressed the topic of project success and the creation of a list of success factors. Some research focuses on specific industries, such as the IT industry or specific types of projects. In this paper, special attention is paid to the research conducted by Pinto, Slevin and Prescott. Their research deals with the success of projects by studying the factors and criteria of projects regardless of the industry in which they are executed. Compared to the frequently cited research dealing with this issue in the field of IT project management, a large degree of overlap has been identified. Factors and criteria defined by Pinto, Slevin and Prescott can be considered applicable in the field of information technology.

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