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TECHNICAL FACULTY
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INTRODUCTION

This Proceedings comprises papers from the International conference on Information technology and development of education that is held on line on November 25th 2022. The International conference on Information technology and development of education has had a goal to contribute to the development of education in Serbia and in the region, as well as, to gather experts in natural and technical sciences' teaching fields. The expected scientific-skilled analysis of the accomplishment in the field of the contemporary information and communication technologies, as well as analysis of state, needs and tendencies in education all around the world and in our country have been realized. The authors and the participants of the Conference have dealt with the following thematic areas: - Theoretical and methodological questions of contemporary pedagogy - Personalization and learning styles - Social networks and their influence on education - Children security and safety on the Internet - Curriculum of contemporary teaching - Methodical questions of natural and technical sciences subject teaching - Lifelong learning and teachers' professional training - E-learning - Education management - Development and influence of IT on teaching - Information communication infrastructure in teaching process All submitted papers have been reviewed.

The papers presented on the Conference and published in this Proceedings can be useful for teacher while learning and teaching in the fields of IT, informatics, technics and other teaching subjects and activities. 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. Contribution to science and teaching development in this region and wider has been achieved in this way.

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.

Chairman of the Organizing Committee
Ph.D Dragana Glušac

IN MEMORIAM PROFESSOR DIJANA KARUOVIĆ
1978-2022.

We especially want to pay tribute to our late colleague professor Dijana Karuović PhD, as one of the founders of the ITRO conference.

To all of us who knew her, professor Dijana Karuović will be a symbol of professional attitude towards work, dedication and loyalty to the institution to which she belonged. Behind HER remain her wonderful children, her many scientific works, her goodness and her love.

We are grateful to have known her.

Also, we will always remember our dear colleague professor Ivan Tasić, PhD, who passed away in 2019.

Our team thus suffered an irreparable loss, and their names will forever remain on the pages of the conference proceedings.

Professor Dijana Karuović and professor Ivan Tasić

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INVITED

LECTURE

Skill and Competence Development at The World Robot Olympiad (WRO) Competition

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Abstract - The World Robot Olympiad (WRO) was organized in Serbia for the first time in 2019. The essence of the competition is that students solve different tasks with the help of LEGO robots. The tasks are usually structured around moving the robot itself, and moving/lifting elements. Competition preparation and the competition itself are perfectly suited to effectively develop students' STEM (Science, technology, engineering, and mathematics) competencies. In this study, the first steps in the organization of the WRO competition in Serbia are presented, along with its effects, as well as the difficulties and opportunities that this competition carries.

Keywords: World Robot Olympiad, STEM, effects

I. INTRODUCTION

Pupils must be provided with knowledge and competences applicable in daily life, so that they can meet the expectations of society once they leave school. Thus, it is essential that they become adaptive, collaborative, creative, and problem-solving persons (Kovács et al., 2022).

The superior international achievements of Science, technology, engineering, mathematics STEM-focused nations reflect the mathematical literacy assessed in PISA 2012, with the focus on "meeting life needs ... through using and engaging with mathematics, making informed judgements, and understanding the usefulness of mathematics in relation to the demands of life" (Thompson et al., p. 11).

Science, technology, engineering, and mathematics (STEM) education is receiving increasing attention, and robotics education is becoming popular worldwide. STEM education can inspire children's natural enthusiasm for exploring the unknown and give them opportunities to put their knowledge into practice (Schreiner et al., 2005). Robots are considered an essential element of STEM education because they can convey complex mathematical and scientific thinking (Kopcha et al., 2017).

The integration of robotics and STEM education and continual improvement of robotics education become increasingly a focus of research and are conducive to cultivating students' ability to innovate and their scientific literacy. Barnes and other scholars created an extracurricular activity program, the Children's Robot Theater, for rural elementary school children and conducted two iterations of the program within two years (Barnes et al., 2020).

Mathematical literacy is essential to STEM education, where a facility is dealing with uncertainty and data is central to making evidence-based decisions involving ethical, economic, and environmental dimensions (Office of the Chief Scientist, 2013).

Our mission is to help young people develop their creativity and problem-solving skills in a fun and engaging way. We do this by organizing robotics competitions in four different categories for students aged 8-19 years. World Robot Olympiad™ Association is an independent non-profit organization. All revenue from sponsorships and fees is invested in support of our mission, which is to promote robotics in STEM education worldwide. The WRO® tournaments are organized in over 85 countries worldwide (https://wro-association.org/).

World Robot Olympiad Association™ is an independent non-profit organization. All revenue from sponsorships and fees is invested in support of our mission, which is to promote robotics in STEM education worldwide. The WRO® operates on, is measured on and strives towards the following Values:

DIVERSITY

WRO is accessible to young people from around the world, regardless of background

TEAMWORK

Our teams succeed by embracing collaboration and build friendships, integrity and character in the process

PASSION

Learning occurs naturally when participants are in flow and having fun when engaged in our activities

INNOVATION

Our programs are innovative and hands-on, based around trending topics and technologies

EMPOWERMENT

We inspire and prepare young people to be digital pioneers, innovators and engineers (https://wro-association.org/).

World Robot Olympiad™ was founded in 2004. The mission statement of our founders was: "To bring together young people all over the world to develop their creativity, design and problem-solving skills through challenging and educational robot competitions and activities." It was decided that the annual WRO international final would be hosted by a different country each year. In 2004, the event was hosted by Singapore and 12 countries participated. In 2019, fifteen years later, teams from 73 countries travelled to Győr in Hungary for the international final (https://wro-association.org/)!

The WRO offers the following different competence categories, as well as different rules and characteristics (https://wro-association.org/):

RoboMission

Age: Elementary: 8-12 | Junior: 11-15 | Senior: 14-19

Team size: 2-3 people guided by a coach

Hardware: LEGO® based

Software: Free choice

Maximum size: Max. 25 x 25 x 25 cm

Characteristics: Build and program a robot that solves challenges on a field.

The WRO® RoboMission is a challenge-based competition. Students must design, construct and program an autonomous robot that can solve specific challenges on a field. Because the field is set up randomly each round, the robot needs to be able to make its own decisions during the run.

All parts of the robot, including controller, motors and sensors must be from LEGO® (MINDSTORMS® NXT or EV3, SPIKE PRIME or Robot Inventor).

RoboSports

Age: 11-19
Team size: 2-3 people guided by a coach
Hardware: LEGO® based
Software: Free choice
Maximum size: Max. 20 x 20 x 20 cm
Characteristics: Teams design 2 robots that compete with robots of another team.

With the WRO® RoboSports category two teams have two autonomous robots on the field playing a sports game. The robot needs to be built from LEGO® materials, including controller, motors and sensors (MINDSTORMS® NXT or EV3, SPIKE PRIME or Robot Inventor). In addition, teams use a camera of their choice.
The game changes every 3 or 4 years and the current game is Double Tennis. Each year little changes are introduced to motivate the students to keep on developing their robots.

Future Innovators

Age: Elementary: 8-12 | Junior: 11-15 | Senior: 14-19
Team size: 2-3 people guided by a coach
Hardware: Free choice*
Software: Free choice
Maximum size: Must fit in 2x2x2m booth
Characteristics: Develop a robot project that helps solve real world problems.

Future Innovators category is a project-based competition. Students create their own innovative intelligent robotics solution relating to the current theme of the season. There is no restriction on the use of materials. This includes free choice of controllers, motors, sensors, etc.

Teams will present their project and their robot model to a group of judges on the competition day. The judges will not only grade the robot solution but will also look at aspects of innovation and entrepreneurship.

Future Engineers

Age: 14-19
Team size: 2-3 students guided by a coach
Hardware: Free choice
Software: Free choice
Maximum size: Max. 30 x 20 x 30cm

Characteristics: Advanced robotics following current research trends.

The WRO® Future Engineers is an exciting category for older students. This new format, bring the current research challenge into schools and teach students an engineering workflow by solving real-world-problems. Teams can use any robot, controller and materials that are in line with the regulations.
The game changes every 3 or 4 years and the current game is all about autonomous driving. The challenge is to build a robot with a steering drive that can drive around a track autonomously. Each year little changes are introduced to motivate the students to keep on developing their robots.

II. WORLD ROBOT OLYMPIAD (WRO) IN SERBIA

The national organizer in Serbia of the WRO is the Hungarian Language Teacher Training Faculty in Subotica, of the University of Novi Sad & the EDUTUS Nonprofit Közhasznú Zrt.

The competition was organized in Serbia for the first time in 2019 with the participation of 22 teams in the regular category (later RoboMission). In the first year, 22 teams participated in the national competition and Serbia had the opportunity to delegate the winners from the elementary, junior and senior categories to the world finals to be held in Győr (Hungary).

The 2020 competition was canceled in its entirety due to the coronavirus pandemic.

In 2021, this competition was more popular than ever in Serbia, with 57 teams participating in an online setting. From this competition, the winners were also delegated from the elementary, junior and senior categories to the world finals, which were also organized online.

In 2022, 41 teams took part in the national finals and the winners were once again delegated from the elementary, junior and senior categories to the International finals to be held in Dortmund. In addition, the second-placed teams participated in the Friendship Invitational competition held in Balatonfüred (Hungary). This year, teams applied for the RoboMission category for the first time, which received huge media response and significantly contributed to increasing the visibility of the event.

The help of the Edutus University in Hungary was a huge help in taking the first steps, accelerating the catching up of the Serbian community with knowledge (training), tools and shared experiences. This year, the international finals were organized in Hungary (Győr), which was one of the most popular events yet, and the best, most successful finals organized so far (since 2004).

When analyzing the popularity of the categories, it is important to highlight that the WeDo (category under 10 years old) category reached great popularity in Serbia. This can probably be attributed to the contact system of the organizing institution (Hungarian Language Teacher Training Faculty).

It is important to note that in the case of the competition in Serbia, a great achievement is that the teams do not face any financial barriers, as the sets (LEGO EV3 Mindstorms Education and LEGO WeDo 2.0), the WRO brick sets and game fields are available to them free of charge if they choose to participate in the competition. This level was achieved with the help of the Hungarian National Council and the Edutus University. Thanks to this, there are more than 50 sets available to the Hungarian Language Teacher Training Faculty in Subotica.

III. COMPETENCE DEVELOPMENT WITH THE WRO COMPETITION

The integration of robotics with STEM education had great potential and could promote STEM education in an integrated manner. In addition, the combination of STEM education and educational robotics technology provides opportunities for the development of skills and capabilities required in the workplace (Plaza et al., 2019).

Participating in the WRO can improve students' engineering abilities and global awareness, promote STEM-related career planning, help students develop initiatives in adaptive learning in schools, and eventually achieve their best performance as much as they can. Second, although the coaches were generally positive towards students' teamwork skills during the WRO, they believed that there is more space for students to improve and grow in this area in future WROs. Another area needing more attention would be improving students' concentration and cohesion during the entire robot project, instead of patches of concentration at some stages. In addition to the coaches' focuses on communication between students and team members during the competition and how students could challenge themselves to use their initiatives, manage

pressure, work as a team, and reflect on competition outcomes, coaches had some concerns with students' emotional control and ability to make further improvement in an internationally competitive environment. (Zhang et al., 2022).

One of the biggest advantages of the WRO competitions is that students can try their hands at robotics, engineering fields, and learn about programming. This experience can greatly help them in making the right decisions when choosing a future career.

In addition to IT and engineering competencies, this competition also creates an opportunity to develop so-called soft skills, which nowadays play a distinct role in the labor market.

Soft skills are essentially people skills – the non –technical, intangible, personality-specific skills that determine one`s strengths as a leader, listener, negotiator and conflict mediator. "Hard" skills, on the other hand, are more along the lines of what might appear on one`s resume – your education, experience and level of expertise. Soft skills is a term which refers to personality traits, social graces, facility with language, personal habits, friendliness, and optimism that mark people to varying degrees (Alex, 2009).

Among the competence-enhancing effects of the WRO competition, the following soft skills need to be highlighted:

Teamwork skills: This skill is of prime importance during the preparation and the competition itself. Students work in teams of 2 or 3 and a coach leads the professional work. Usually, each student specializes in one area: some of them program, some build, while some think about strategy and organization. However, the most important thing is that the students work together, accept it if one of the team members performs less well or makes a mistake.

Communication skills: also a key soft skill, it appears continuously during the competition, it is one of the main pillars of the LEGO Education program, and appears most intensively in the form of public speaking. During the competition, the team members, the coach and the judges also communicate with each other. This skill appears even more prominently in the Future Innovators competition, as it requires the completed project to be presented orally as well. It is particularly interesting that the language of communication at the international competitions is English, so the ability to communicate in a foreign language is also developed.

Creativity, problem solving, decision-making: these thinking skills are also developed during a WRO season. Creativity plays an important role, as there are countless solutions to a given problem. These solutions include the construction of the robot and the various operating mechanisms (structure, movement, grabbing and lifting objects), as well as writing the program and the entire strategy that a team follows. Of course, problem solving also appears here, as pre-defined tasks must be solved. The surprise rule also requires a great deal of creativity and a high level of problem-solving skills. Having the right decision-making skills can give a team a significant advantage. During the race, they must decide whether to follow the strategy they have developed over the months of preparation or try to solve the surprise rule as well. In addition, the teams have the opportunity to stop the robot even before the 2-minute running time, if they assess that the robot's movement endangers an element that has been moved/collected points.

Frustration tolerance is also an important competence, since during the preparation period the right solution is only born after many unsuccessful attempts. Many times the robot has to be rebuilt completely and the entire program and strategy rethought. Frustration tolerance is an outstanding competence in a society characterized by digital devices.

Adequate time management is also one of the most significant competencies of the 21st century. The teams have to make decisions both during the preparation and the competition period, the consequences of which they must bear together. These decisions relate to making the best use of the available time and focusing on the tasks that are worth more points, as well as timing the preparation tasks depending on the available time.

Adequate stress management and performance can also be developed in competitive situations with the help of WRO competitions. Making the right decisions under stress is also a competence that is extremely important in today's competitive market.

Of course, in addition to the highlighted competencies, many others can also develop, such as mathematical and digital competencies, and the students' vocabulary expands as well.

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SCIENTIFIC

PAPERS

Abilities to Organize Learning as Factors of Success of Distance Learning

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Abstract - This paper presents some factors that influence the success in mastering the course via the system of distance education. The factors that would be considered in this paper are possession the ability to harmonize life obligations with requests related to distance education, as well as the motivation for this kind of education. The research in this paper includes both empirical and theoretic character. The results confirmed the significant influence of analyzed factors on the implementation of distance education, and work represents a clear guideline for the need to work on increasing each of these factors individually, all in order to facilitate the successful implementation of distance education method.

I. INTRODUCTION

Educational activity is one of the most complex human activities with responsibilities involving human personality, development and training. At the time of the global pandemic caused by the Covid 19 virus, the traditional role of education in the acquisition of individual knowledge and the development of his abilities took on new features. Information technologies are becoming a key factor in the overall human and social existence, conditioning the readiness of the entire educational system for rapid transformation and adaptation to these requirements and changes. We are witnesses that countries around the world have transformed their educational policies and organized distance learning in various forms, depending on the resources at their disposal. In the learning process realized through the distance education (in the rest of the text DE) teacher has no direct contact with the students and has to find some way to motivate them for work. Therefore, the professor is required to animate and arouse interest among students for higher activity and participation in working through a DE course.

II. THEORETICAL BACKGROUND

A. Distance education

Because it is justified to conclude that we are living in a 'knowledge-based society' (Katalinic, 2010; Tekic, Katalinic & Cosic, 2009), student motivation is an essential element that is necessary for quality knowledge gaining.

The most important benefit of using DE is to provide more learning options than the normal face-to-face classes such as using discussion boards, instant messaging or email. To make DE successful the students has a short time to become familiar with the new way of teaching and learning at a distance. Thus, the success rate of distance learning depends on the ability of students to organize learning and obligations they have apart from learning, as well as adapt personal habits to the new way of working (Woodgate, Macleod, Scott & Haywood, 2015). Therefore, we need to adapt the system of DE, to motivate students and to meet their needs, not only in terms of content but also in terms of preferred learning styles. According to this, following should be taken into consideration:

- Students should be closer with technologies and prepared for solving technical problems they will come upon;
- Enable and train them to use new ways of communication;
- Learn more about the knowledge and experience that students possess; it is also important to know knowledge and interests of teachers;
- Have a sense of the different styles of communication (different speech areas) and cultural background;
- Students must have an active role in DE and self-taking responsibility for their own learning.

B. Personal life habits and abilities to organize learning

The primary role and task of the student is to learn. Under the best of circumstances, this task requires proper motivation, planning, ability to analyze and learn received information. In DE, the learning process is much more complex than the traditional learning.

For this reason, when it comes to adjusting personal habits, DE primarily refers to the student's ability to:

- Be able to set aside a certain time for a course by DE;
- Plan and coordinate all of its obligations related to work through the DE with other responsibilities;
- Plan learning and obligations connected with the course;
- Overcome lack of interaction "face to face" without a problem.

If a student manages to respond to these demands, it can be considered that the degree of his motivation for this type of education is very high. (Prskalo, Badrić, Sporiš & Ružić, 2013).

III. RESEARCH METHODOLOGY

A. Sample of research

The sample size achieved in this study is 360 participants. The sample is a representative focus group consisting of students from several colleges from Vojvodina (Serbia), 19 - 22 years of age, during period from 2019 to 2021 years. The most important criterion for forming of the sample was that participants follow the complete or a part of their courses through DE. In addition, sample was made with concern to describe well the population and statistical mass by age, gender, type of department.

B. Statistical analysis of data

For the processing of data descriptive and comparative statistical procedures were used. Respondents were classified on the basis of (Table 1):

- year of study (1- first, 2-second, 3-third, 4-four year of study)
- gender (1-male, 2-female)

TABLE 1. DESCRIPTIVE STATISTICS

	first	second	third	four	sum
male	72	64	58	57	251
female	34	26	22	27	109

IV. FINDINGS

The following chart (Figure 1) shows the values obtained as answers to questions related to personal life habits.

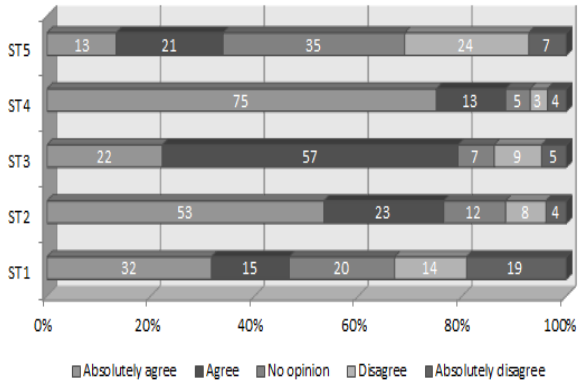

Figure 1. Results of personal life habits

Results of answers given to statements related to motivation are shown in Figure 2.

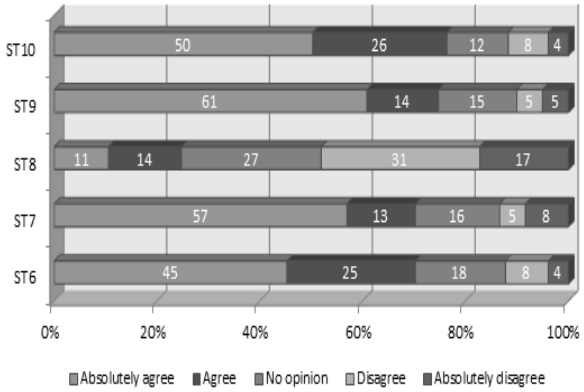

Figure 2. Result of motivation

Students - 47% - think that they are able to harmonize the obligations related to the DE course with all their other life liabilities, while other respondents answered as follows: 'I disagree' and 'I absolutely disagree' (33%), 'No opinion' (20%) (Figure 2. as ST6). Most students (53%) is able to allocate more than 10 hours per week to work with DE course, 23% - 8 hours, 12% - 6 hours, 8% - 4 hours and 4% of respondents 2 hours per week (Figure 2. as ST7). While 22% of students considered extremely capable for assessing their needs for learning and understanding of materials, 57% believe they are capable and 7% are undecided. The number of students who are at variance with the given statement is 14% (9% of disagree and 5% of absolutely disagree) (Figure 2. as ST8).

The vast majority of students have not a problem to seek for help (88%), from their either colleagues or professors, by e-mail or discussion forum. A smaller number of students have a problem (3% disagreed, and 4% absolutely disagrees), while 5% had no opinion (Figure 2. as ST9). To implement successfully the course through the DE, it is very important that the

students have not a problem with teaching taking place without direct contact with professors ("face to face"). It seems that the students during their previous education learn to follow courses in direct contact with the teacher. For as much as 34% it is a problem, 35% have no opinion on the matter, while for 31% it is not a problem (Figure 2. as ST10).

The research results show that students are organized, motivated and self-disciplined (70%). Some students have doubts in theirs organizational skills (12%), while there are those who have no opinion (18% - Figure 3. as ST11). Given that, a large number of students (75%) have clearly defined goals (Figure 3. as ST14), they are motivated to achieve them (70% - Figure 3. as ST12), while 76% are proud of their success and wish to highlight it (Figure 3. as ST15).

V. CONCLUSION

Based on these results, it is concluded that the students are organized, motivated and self-disciplined, and accurate in assessing their needs. The obtained results show that the students are able to predict and set aside sufficient time for distance education course, so they are able to plan their study and course - related obligations. The fact that they are unable to interact directly with the teacher does not disturb them in working with the material presented in distance education course. All this factors influences on student interest for work and therefore increases their motivation to work with this education system.

Students feel sufficiently free to ask without hesitation for all the necessary assistance that they need during the DE course and thus enable them to communicate with instructors. The fact that instructors periodically inform students about their progress makes that for students contact "face to face" is not critically important. At the traditional class student follows not only what teacher presents, but also the appearance and manner of teacher's presentation. In learning through DL course, students do not have the opportunity to establish this interaction with the instructor, so the instructor's obligation is to help those students with that problem to overcome it. "Time was spent interacting with the students as they were expected to complete exercises aimed at ensuring an understanding of conceptual material covered" (Richardson, 2003, p. 28).

At the same time, the lower level of the course abandoning can be achieved if instructors find ways to improve the relevance of the course. According to (Jun, 2005; Meneger-Beeley, 2004; Packham et al., 2004; Park & Choi, 2009), personal learning characteristics such as organization skills and self-discipline, have significant influence on the decision to abandon course, while others claims those characteristics have only minor or indirect effect (Kember et al., 1994; Willging & Johnson, 2004).

Otherwise, students who are able to spend the time necessary to work with DE course, have positive experiences related to DE courses. The very fact that students in this survey can properly allocate all of their obligations shows that they have a high degree of organization and self-discipline that requires learning through the DE course. Students feel that the contents of the course is adapted to length of school hours and that the material obtained for the course is adequate and that it contains all the essential information for its successfully mastering. The materials must be supported with a variety of examples and tasks so the students can add new information to theirs existing knowledge - these results are similar to the results (Menager-Beeley, 2004).

The results show that students are highly motivated, organized and self-disciplined for learning through the DE course. Possession of good learning strategies and setting realistic goals leads to achieving the goals (Pardanjac et all, 2014). Good learning strategies and the desire for success have provided good grades on tests and positive experience with the procedures of testing and evaluation. The feedback that students receive from their instructors, both during the course and during chatting and commenting on forums, have positive impact on their motivation for learning through the system of DE.

The results of research show that students are motivated to work through the DE, which confirmed the main hypothesis, and show that today's educational process, cannot be imagined without the use of computers and technologies.

The obtained results show that more of 60% students are able to schedule and harmonize their personal life habits, according to DE requests, in order to achieve success in learning.

Either some students has lack of experience in working with DE system, based on their personal life habits, their ability to organize learning, as well as the possession and use of information technology, we can draw a general conclusion that the students are willing and ready to accept and practice learning through DE system.

Results of research provides a set of indicators that are useful as a participation measure of above mentioned factors in implementation and development of DE, and provides help to DE creators to identify best practices. Afterwards, they have ability to set aside time for learning through the DE. That ability can be increased by forming of adequate schooling habits during the previous levels of education. Valuable for DE process is that students have developed habits regarding the planning and coordination of the obligations related to work with DE method with other life commitments.

Students are able to work without the presence of teachers, but teachers must be trained and ready to provide fast and adequate feedback, and to be available for any concerns that students face in DE. Such things can be resolved through the organization of courses and seminars for teachers where they will be able to raise their level of training for work with DE. Significantly, for the implementation of DL is that the course is properly designed, to lead students through the process of acquiring knowledge, to ensure accuracy in the assessment of what should be learned and provide the ability for understanding of the presented material. Organization and self-discipline are the qualities of students necessary for the successful functioning of the DE. Besides, of the earlier acquired habits, an interest for learning can influence on those two factors. Because of that, the contents must be well designed and prepared.

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General Wallis Integral Formula in the Definition of Precise Hyperspherical Caps

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Abstract - Wallis's integral is often used in the field of the special functions. Here is presented one of its generalized forms, although it is supposed that there exist also some other forms of the generalization of the hypergeometrical forms or some other forms. In the center of the investigation certainly was the integral of the form ∫ sin^k (z) dz..

I. INTRODUCTION

As it is known in mathematics, the integral of the expression $\int_0^{\pi/2}\sin^k(z)dz$ or $\int_0^{\pi/2}\cos^k(z)dz$, is called the integral of Wallis (1616-1703). There are some solutions for this integral, and among them is the most known and most general [1 - 3]:

$$\int_0^{\pi/2}\sin^k(z)dz=\frac{1}{2}B\left(\frac{k}{2},\frac{1}{2}\right) \tag{1}$$

Where $B(a,b)$ is Euler's beta function. The same value (1) is referred as well for the second expression with the cosines function. This value exists within many domains of mathematics and mathematical physics. The interesting matter is that is not any expression where the integral of the form (1) gets a more general form, even not only to verge on the interval value $[0,\pi/2]$?

II. THE INTEGRAL OF THE EXPRESSION SIN^K(Z)DZ ON THE BASIS OF THE HYPERGEOMETRICAL PROGRESSION

Definition 2.1. Well, here is stressed the value of the integral $\int_0^{h}\sin^k(z)dz$ where is $h\in\Re^+$. A more complex form of this integral is known and defined as [4]:

$$\int z\sin^k(a\,z)\,dz=\frac{1}{2a^2}\left\{\sin^{k+1}(a\,z)\left[\frac{2a\,z\cos(a\,z)}{k+1}\right.\right.$$

$$\left.\times{}_2F_1\left(1,\frac{k+2}{2};\frac{k+3}{2};\sin^2(a\,z)\right)-2^{-k-1}\sqrt{\pi}\,\Gamma(k+1)\,{}_3\tilde{F}_2\right. \tag{2}$$

$$\left.\left.\times\left(1,\frac{k+2}{2},\frac{k+2}{2};\frac{k+3}{2},\frac{k+4}{2};\sin^2(a\,z)\right)\sin(a\,z)\right]\right\}+C$$

When excluding a member of z and putting the parameter $a=1$, the previous expression can be reduced to a simpler form [2]

$$\int\sin^k(z)\,dz=\frac{\sin^{k+1}(z)}{k+1}\,{}_2F_1\left(\frac{k+1}{2},\frac{1}{2};\frac{k+3}{2};\sin^2(z)\right)+C \tag{3}$$

The function of the indefinite integral can be presented in the form of the hypergeometric progression. For $k\in N_0$ generally, this hypergeometric progression is equal [5, 6]

$${}_2F_1(a,b;c;z)=\sum_{n=0}^{\infty}\frac{(a)_n(b)_n\cdot z^n}{(c)_n\,n!}\ /; \tag{4}$$

$$|z|<1\vee|z|=1\wedge\mathrm{Re}(c-a-b)>0\,.$$

Where the expressions are written down on the basis of the gamma function, $(x)_n=\frac{\Gamma(x+n)}{\Gamma(x)}=x(x+1)\cdots(x+n+1)$ in the form of the Pochhammer's symbols. Now the integral is being to be added up to the expression

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$$\int \sin^k(z)dz = \frac{\sin^{k+1}(z)}{k+1}\sum_{u=0}^{\infty}\frac{\left(\frac{k+1}{2}\right)_u\cdot\left(\frac{1}{2}\right)_u}{\left(\frac{k+3}{2}\right)_u\cdot u!}\sin^{2u}(z) \quad (5)$$

Here is $\frac{\left(\frac{k+1}{2}\right)_u\cdot\left(\frac{1}{2}\right)_u}{\left(\frac{k+3}{2}\right)_u} = \frac{(k+1)\,\Gamma\left(u+\frac{1}{2}\right)}{\sqrt{\pi}\,(2u+k+1)}$. The expression (5) may be after it is sorted out, and be written down in the form of the trigonometric progression.

$$\int \sin^k(z)dz = \frac{\sin^{k+1}(z)}{\sqrt{\pi}}\cdot\sum_{u=0}^{\infty}\frac{\Gamma\left(u+\frac{1}{2}\right)\cdot\sin^{2u}(z)}{u!\,(2u+k+1)} + C \quad (6)$$

Definition 2.2. Taking into account that there is the relation $\frac{\Gamma(u+1/2)}{\sqrt{\pi}\,\Gamma(u+1)} = \frac{1}{u\,B(u,1/2)}$, follows the similar expression to the previous one as

$$\int \sin^k(z)\,dz = \sum_{u=0}^{\infty}\frac{\sin^{2u+k+1}(z)}{u\,(2u+k+1)\cdot B(u,1/2)} + C \quad (7)$$

After this generalization, follow some special cases as, for example, are:

A. The example 2.1.

When the integral is limited by the interval $[0,\pi/6]$, it follows that is:

$$\int_0^{\pi/6}\sin^k(z)dz = \sum_{u=0}^{\infty}\frac{\sin^{2u+k+1}(z)}{u\,(2u+k+1)\cdot B(u,1/2)}\Bigg|_0^{\pi/6}$$

$$= \sum_{u=0}^{\infty}\frac{1}{u\,(2u+k+1)\cdot 2^{2u+k+1}\,B(u,1/2)} \quad (8)$$

B. The example 2.2.

When the integral is limited by the interval $[0,\pi/4]$, it follows that is:

$$\int_0^{\pi/4}\sin^k(z)dz = \sum_{u=0}^{\infty}\frac{1}{u\,(2u+k+1)\cdot\sqrt{2^{2u+k+1}}\,B(u,1/2)} \quad (9)$$

C. The example 2.3.

When the integral is limited by the interval $[0,\pi/2]$, it follows that is:

$$\int_0^{\pi/2}\sin^k(z)dz = \sum_{u=0}^{\infty}\frac{1}{u\,(2u+k+1)\,B(u,1/2)} \quad (10)$$

Well, this is Wallis integral case, so that it follows on the basis of (1) and (10) that is while the next expression could be called by its generalized form

$$\int_0^{h}\sin^k(z)dz = \sum_{u=0}^{\infty}\frac{\sin^{2u+k+1}(z)}{u\,(2u+k+1)\cdot B(u,1/2)}\Bigg|_0^{z=h} \quad (11)$$

III. THE INTEGRAL OF THE EXPRESSION $\sin^K(z)dz$ ON THE BASIS OF THE BINOMINAL FORMULA

The connection of the beta binominal pattern i.e. model, is equal [2].

$$\frac{1}{B(x,y)} = y\binom{x+y-1}{x-1} = x\binom{x+y-1}{y-1} \quad (12)$$

The similar expression is known as well as:

$$\frac{1}{y\,B(y,x-y+1)} = \binom{x}{y} = \frac{x!}{y!\,(x-y)!} \quad (13)$$

By substitution i.e. by replacement in (12), with $y = 1/2$ it follows that it is. The primary, i.e. prime formula for further transformation has the form [2] $\Gamma(x+1/2)! = \sqrt{\pi}\binom{x-1/2}{x}x$. Out of the formula follows that is $\frac{\Gamma(x+1/2)}{\Gamma(1/2)\,\Gamma(x+1)} = \binom{x-1/2}{x}$ which presents the reciprocal value of the expression with the beta function

$$\frac{1}{x\,B(x,1/2)} = \binom{x-1/2}{x} \quad \text{or}$$

$$\frac{1}{x\,B(x,1/2)} = \binom{x-1/2}{-1/2} \quad (14)$$

Definition 3.1. So, there is $\binom{x-1/2}{x}=\binom{x-1/2}{-1/2}=\frac{\Gamma(x+1/2)}{\sqrt{\pi}\,\Gamma(x+1)}$. Because the right expression is in the composition of the integral $\int \sin^k(z)dz$, substitute by the binominal form the integral (7), so that

$$\int \sin^k(z)dz=\sum_{u=0}^{\infty}\binom{u-1/2}{u}\cdot\frac{\sin^{2u+k+1}(z)}{2u+k+1}+C \qquad (15)$$

It can be written down as or as

$$\int \sin^k(z)dz=\sum_{u=0}^{\infty}\binom{u-1/2}{-1/2}\cdot\frac{\sin^{2u+k+1}(z)}{2u+k+1}+C \qquad (16)$$

So the first expression (16) can be restructured in the trigonometric progression

$$\int \sin^k(z)\,dz=\binom{-1/2}{0}\frac{\sin^{k+1}(z)}{k+1}+\binom{1/2}{1}\frac{\sin^{k+3}(z)}{k+3}+\binom{3/2}{2}\frac{\sin^{k+5}(z)}{k+5}+\ldots+C \qquad (17)$$

In the similar way follows as well the restructuring of the alternative expression (17), so it is that:

$$\int_0^{\pi/2}\sin^k(z)dz=\frac{1}{k+1}\binom{-1/2}{-1/2}+\frac{1}{k+3}\binom{1/2}{-1/2}+\frac{1}{k+5}\binom{3/2}{-1/2}\ \ldots \qquad (18)$$

IV. THE APPLICATION OF THE GENERALIZED INTEGRAL

The generalization of the Wallis's integral is significant because the integral $\int \sin^k(z)\,dz$ is no more limited only in the domain $[0,\pi/2]$. The application of the generalized integral (7) or (18) is possible with the calculation of the volume of the hyperspherical cap [7].

A. *The example 4.1.*

There is the case when the expression for the hyperspherical cap (fig. 1, left) of k dimension, converges to the hemi-hyperspherical (fig. 1, right) expression. Namely:

$$V_k^{cap}=\frac{\sqrt{\pi^{k-1}}\,R^k}{\Gamma\left(\frac{k+1}{2}\right)}\int_0^{\frac{\pi}{2}}\sin^k(\theta)\,d\theta=\frac{\sqrt{\pi^{k-1}}\,R^k}{\Gamma\left(\frac{k+1}{2}\right)}\cdot\sum_{u=0}^{\infty}\frac{B^{-1}(u,1/2)}{u\,(2u+k+1)} \qquad (19)$$

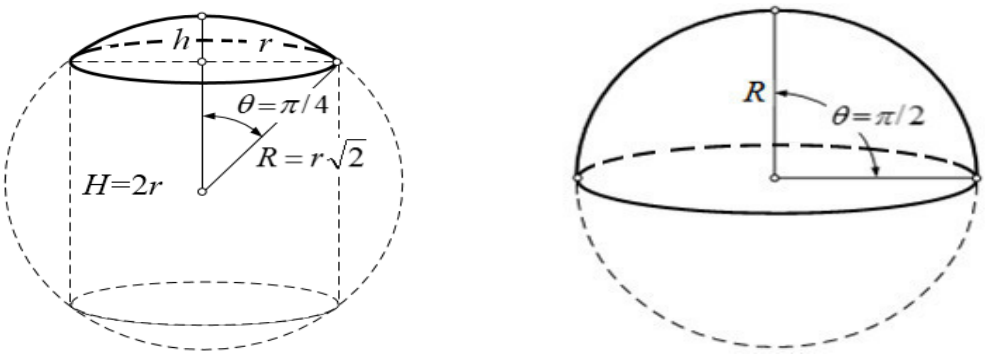

Figure 1. The spherical cap of Archimedes type (left), the extreme spherical cap or hemisphere (right)

Which matches up, i.e. fits to the volume of the hyper-hemisphere, of R, radius, which in this case is equal to the half of the hypersphere volume [8]

$$V_k^{cap}=\frac{1}{2}VS_k(R)=\frac{1}{2}\frac{\sqrt{\pi^k}\,R^k}{\Gamma\left(\frac{k}{2}+1\right)} \qquad (20)$$

From the previous it follows that hyper-hemisphere can be expressed as well in the form of gamma or beta function, as

$$\frac{\sqrt{\pi^{k-1}}R^k}{\Gamma\left(\frac{k+1}{2}\right)}\cdot\frac{1}{2}B\left(\frac{k+1}{2},\frac{1}{2}\right)=\frac{1}{2}\frac{\sqrt{\pi^{k}}R^k}{\Gamma\left(\frac{k}{2}+1\right)} \qquad (21)$$

The convergence of the progression (19) is slow-rising, so its calculation is as well by the computer methods aggravated. It would be interesting to restructure many other hypersphere segments generated on the basis of hyperspherical [6, 9, 10, 11, 12], hypercylindrical [13], and hypercube functions [14].

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Computing Summer School

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The results of the project „Computing Summer School" are shown in this paper. The main idea of the project was to modernize computing courses at Technical College of Applied Sciences in Zrenjanin. Contemporary engineers should be able to work with modern software packages which provide easier and faster problem solving. Thus, we incorporated a few new software packages and trainings for students on how to work with this software as part of our project tasks. We also taught them to program in the most advanced and popular programming languages that were not part of our regular courses. This way students got all the necessary competences required for the profession of a contemporary engineer.

I. INTRODUCTION

The project „Computing Summer School" [1], [2], was cofinanced by the Provincial Secretary for Higher Education and Scientific Research. It was created at the Technical College of Applied Sciences in Zrenjanin in 2022. It was realized during summer 2022. as a series of lessons and trainings and it lasted for two weeks. The main idea of the project was to bring some improvements into education, with the primary focus on the Sector of Computing at our college. During the Computing Summer School at Technical College of Applied Sciences in Zrenjanin, students followed few courses:

- C++ programmig,
- R programming,
- IgorPro software usage,
- Application of microcontrolers for automatic data aquisition and their presentation via web application.

More information about the project as well as instructions and project materials are available in the project's Google Classroom [2] (classroom code: 5hol7st, classroom name: LETNJA SKOLA COMPJUTINGA) and at the college website [1].

II. COURSES AND TRAININGS

A. C++programming language

C++ language [3], [4], [5], [6] is one of the most powerful programming languages with the widest possible field of application. It is an extension of the C programming language and can be used when developing operating systems, browsers, games, and so on. C++ is a cross-platform language and can be used to make high-performance applications. Its dominant use are surely car industry and video-gaming industry. C++ supports different ways of programming like procedural, object-oriented, functional. It can also manipulate low-level memory. This makes C++ both very potent and flexible. It is implemented as a compiled language and vendors also provide C++ compilers. International Organization for Standardization (ISO) made C++ a standardized language.

During Summer School students followed basic and partly medium level course, which lasted for 20 hours during 2 weeks. During the training students also did a lot of practical examples which gave them better understanding of given topics and also made them feel more secure in the new programming field.

Knowledge of this programing language is the additional skill which highly raises position of the engineer in the labor market.

B. R programming language

R programming [7], [8], [9] is used for statistical computing by both researchers and academics and its popularity has risen over time. It is an implementation of the S programming language and can be available on various platforms like Windows, macOS and UNIX. R consists of many libraries called packages which are available through an extensive R archive network called CRAN. These packages can be used for various techniques like descriptive statistics, statistical analysis and data visualization techniques. Besides Python, R is one of the mostly used programming language in the area of Data Science which is a multidisciplinary field that consists of statistics, computer science, machine learning and domain expertise or knowledge. Data Science is very important in today's industry because data analysis can produce valuable data insights which can help

companies improve their businesses by making good business decisions in the future.

R programming workshop was realized through 3h of extensive theory and hands-on activities where students were able to learn basics of R and RStudio and also how to install them on their computers. Through basic examples provided in the classes, they could also understand basic operations and data structures in R, how to write R code in a script as well as in console and many more.

This workshop gave the students necessary experience and knowledge to be more competitive while in a search for a job.

C. *IgorPro Software*

IgorPro [10] is a professional software used for data analysis. It is a Wave Metrics product. In the physics community, Igor Pro is used at least as much as Origin and for the same purposes. Besides the great functionality of IgorPro software, one of its positive sides is the possibility of writing your code for analysis. Macros are easily integrated with this software and can be privately made or producted by experimental setup manufacturers. Namely, for big 3D data packages, companies producing instruments are writing macros and sharing them with their users. IgorPro allows data treatment, data visualization, and curve fitting with various types of functions. Visualization can be done in different forms and all elements can be chosen and changed.

A workshop for developing skills with IgorPro was a benefit for talented students and marginal social categories since Igor Pro can also be used for some limited time as a free demo version. For everyone aiming to continue their schooling in natural sciences or engineering, the ability to work well in Igor Pro is a great advantage.

D. *Applied use of Microcontrolers*

The specific application of a microcontroller for automatic data collection and sending them via a web application is one part of this project. The most important features related to microcontrollers, sensors, Cloud Computing, Realtime Databases, JSON (JavaScript Object Notation), Web services, API (Application Programming Interface) and Web applications are theoretically presented. The system presented to the students is based on the article [11], which has been extended. The source programming code for the microcontroller written in C++ language can be seen at [12]. The listeners were also shown the Realtime Database where the measured data is stored which can be seen at [13] and [14]. The results were displayed using the React web application available at [15], so that participants could also access it with their smartphones. This way, it is possible to monitor the results of measurements live, and also see the results of measurements over time, and the interface is of a graphic type. The source code of the web application is available at [16] for those students interested in this aspect of the system. The web application is written using HTML, CSS and JavaScript languages which are not covered in this course. A complete system and procedure is shown here that allows the microcontroller to connect to the Internet, thus gaining the potential to be part of a larger IoT system.

III. RESULTS OF THE SURVEY

A survey about prior knowledge (before the Summer School of Computing) was done by students. Most of them knew what C++ and R were used for and that they differed from Excel in terms of use. Prior knowledge was lacking about the two data processing software, with slightly more students being informed that Origin existed, while the biggest unknown was the IgorPro software.

At the end of the summer school, students also gave their opinion about the quality of teaching and professors. The category "Engagement of teachers" received the most positive comments, which most of the students rated as "Exceeds all expectations". The correctness of the lecturer's behavior, the stimulating atmosphere, the well-designed program and the quality of the activities were evaluated with "Excellent" and "Exceeds all expectations". The expertise of the lecturer and the choice of content were rated as "Excellent" and "Exceeds all expectations". In personal comments, it was stated that both the school and individual parts of the program could have lasted longer and been even more detailed. Such quality evaluations by students who attended summer computing school are more than commendable.

IV. CONCLUSIONS

As science and information technology moves forward, education must also keep pace with them. Future engineers should know how to use advanced software tools and programming languages in order to be able to face challenges as they arise in their work.

As part of the project's ("Computing Summer School") activities, students at Technical College of Applied Sciences in Zrenjanin, learned to work with contemporary software packages and advanced programming languages that provided them extra knowledge for fast and accurate problem solving. Also, students find this way of presenting practical knowledge very useful.

We plan to organize similar courses in the coming years, by also taking into account all the students' suggestions from the survey.

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IoT Project Management

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Abstract - Internet of Things (IoT) or Industrial Internet is a modern-day catchword, which over the past few years has tremendously impacted numerous aspects of almost-all the advanced technology fields. IoT framework envisions transforming the everyday objects into intelligent systems, while working under a common infrastructure and by connecting the global network of devices and machines over the internet. Based on many underlying interdisciplinary ecosystems, like sensor network, embedded systems, big data platforms, cloud computing and service-oriented architecture; IoT projects are non-traditional in many ways. Such projects involve research and development phase, more technical work, are lengthy, require advanced skill sets and lacks well-defined business models. A recent alarming rate of IoT project failures provide incentive to look for project management philosophies, which would emphasize on more flexibility, agility, teamwork and a developing a strong technical framework. This study work provides overview of IoT concepts and through a systematic review of scholarly research papers, blogs, review articles, and other literature available online, it addresses the current managerial challenges for such projects. Finally, to solve this issue a focused survey was conducted and collected data was analyzed. Based on the responses from IoT professional's various suggestions are made, which can be used to improve management of such projects.

I. INTRODUCTION

With the underlying concept of sensor embedded physical objects, Internet of Things (IoT) have become a common house hold thing, where use cases such as Wi-Fi connected smart gadgets, which one can control from anywhere with a smartphone have increased over the years. Coming out of its nascent phase, IoT projects have created many job opportunities and project managers are already working on such undertakings. With potential economic impact to increase from $3.9 trillion to $11.1 trillion a year by 2025, as predicted by McKinsey Global Institute researchers, one can expect a lot of new IoT projects and initiatives. The future projects such as Google's Project Wing, and Amazon's Prime Air, which would include drones, needs project managers engaged from starting in the research and development phase and going through deployment, and testing and then the future maintenance stages. In this never-ending cycle a manager needs to communicate with PMO office, internal and external stakeholders and customers and at the same time keeping up with the new technology.

Historically, project management methodologies are framed around system development life cycle, where waterfall like one dimensional model included defining, designing, developing, testing and then deploying the end product. But, then, the agile philosophies have nearly ended that, introducing the concept of concurrently performing many steps of traditional project phases. And now, we have IoT projects, where one can expect longer project timelines, no place for silos, many issues with staff morale, comprehensive testing that goes beyond traditional projects, strict rules around compliance, security and policy planning, once again demanding that we revisit the current project management philosophies and re-structure or scale to manage such advanced projects.

There is a problem with how IoT projects are managed now. Despite tremendous forward momentum in this field, a survey says that about 75 percent of IoT projects are failing [1]. This problem has negatively affected several industries, which are feeling less confident to invest in the IoT space and see it as a risky endeavor. The main question that arises is "How can we scale the current project management processes, tools and techniques to successfully complete IoT Projects?"

The survey said that a possible cause of this problem is "human factor", be it their lack of communication, technical or managerial skills or the overall culture. Lack of universally accepted and recognized technical and managerial "jargon" is causing problems in interoperability [2]. IoT projects have longer project timelines, such as: the testing cycle will be longer in IoT projects and the teams would need to be co-located and fully involved during the whole product cycle [3]. IoT itself will affect project management, like new project management software will be required. Because of the involvement of many systems at a time, huge risks are involved at various phases of a

product development, which may be related to compliance, security and would probably need better policy planning [3]. Projects will need to be run differently than simple and traditional IT, manufacturing or construction projects. Five phases, namely: collect, transport, store, analyze and archive of an IoT project should be streamlined with the current Project Management Institute (PMI) project phases, i.e., with Initiation, Planning, Execution, Monitoring and Control, and Closing [4]. Project manager should be involved in the research and development phase of an IoT project. If we don't address all of these issues now, we will see some key players backing off in contributing to major changes in IoT infrastructure that are required to make it a reality. Perhaps research that investigates how to better project management, specifically for such interdisciplinary projects, could remedy this situation.

II. LITERATURE REVIEW

For successful deployment of IoT-based products and services, the top five technologies that are essential are radio frequency identification (RFID), wireless sensor networks (WSN), middleware, cloud computing and IoT application software [5]. A literature review by In Lee et al. [5] focuses on technical and managerial challenges in putting these five components together and then proposes a net present value option to justify the investment in such project. Also, this work emphasizes the need of carrying on more studies that deals with economic, social, behavioral and project management aspects of IoT projects [5]. In addition, this article introduces to conceptual model of IoT applications, where challenges in implementing IoT projects for enterprises, especially from information sharing and collaboration, monitoring and control, and big data and business analytics aspects are highlighted.

A similar study by Somayya Madakam et al. [6] walks one through the timeline of origin of IoT concepts, their initial usage and how slowly these technologies are seeping into our daily lives. Whereas the idea is to make our lives easy, simpler and more comfortable, it's becoming more challenging to keep everything intact (in sync), like: Sensing, Access, Network, Middleware and the Application layers of IoT infrastructure [6]. Even though, this review lists many useful applications of IoT into myriad of domains including healthcare, education, manufacturing, transportation, education, governance, and other upcoming industries, its core message lies around pointing to few deep-rooted flaws in the IoT governance, management, and implementation and development stages. The author lists key observations they gathered form several other authors, publications, researchers, and industry practitioners and summarize those by asking for "universalization" of jargon, processes and practices for IoT projects. This study asks for a standard of definitions around the world, a universally recognized architectural level, and technology interoperability standard protocols for global governance to have a better future in the IoT world.

Apart from providing an overview of Internet of Things, its various architectures, current and upcoming technologies and their socio-economic impacts, this study is a good compilation of basic concepts for newbies in this field [6]. Like, it talks about the prerequisites for implementation of IoT projects, their components and an example of a "European FP7 Research" project to help benchmark and develop a business case. This can help an enterprise in understanding the concept, search for the right tools and coming up with a solid business case, and a project management plan. This paper has plethora of ideas about the technical and management areas, which need to be worked on from both enterprise and project aspect. Each layer of IoT infrastructure would need a management plan, be it to cope with the issues or to take care of risks [6]. So, it's important to understand the IoT architecture. This review provides more insight into the IoT world and how stakeholders at large are receiving this technology disruption. In a recent podcast interview, Wanda Curlee of www.wandacurlee.com said that the Internet of Things is an ever-growing network of physical objects, where communication occurs between these objects and other Internet-enabled devices and systems. And, Internet of Things (IoT) projects have the potential to change project management, and not because project management software will be dependent on IoT devices, but because project managers will need to better equip themselves to better handle on research and development aspect of such projects.

Like Internet has touched millions of lives, with the projected installment of IoT endpoints to be more than 82 billion in 2025, it will also be indispensable part of everyday life- style. Whereas this forecast sounds very optimistic, a CISCO survey last year showed a different story, where it was seen that about 60 percent projects fail at Proof-of-Concept stage, and if completed only two third are considered successful [7]. This survey consisted of more than 1,800 business and global IT leaders from across the world, and information on main challenges organizations are facing while adapting to IoT projects was gathered. Apart from resistance to change, poor quality of data to make

decisions, lack of internal expertise, hurdles in project/product integrations and long completion times and budget overruns were the key reasons why IoT projects are failing [7].

To avoid these initial pitfalls, top management, business owners and the project managers have to plan diligently, carefully, and by benchmarking or using the lessons learned to fill the gaps in knowledge, for which they can seek help from external IoT experts. Also, for integrating such projects with the existing systems, thorough policies and technical implementation reviews, better communication channels among the teams and enterprise environmental factors should be considered. And, with this information, management can come up with realistic timelines, cost estimations, contingency reserves estimations, integration strategies, data privacy and management and a deployment plan. So, by combining data and good management skills, better results can be achieved for IoT projects. While talking to experts' form Intel and Capgemini at the 2016 SAP Executive Summit on IoT, Margaret Anne McPhee, North America National Vice President of S/4HANA Services at SAP, said that when coming to IoT projects, one should "Think big but start small." During this panel discussion on how to handle the challenges and bank on the opportunities provided by IoT projects, it was suggested that a sound business case, probably a pilot project and more customer and marketing engagement in the initiation phase of a project should be used to upfront establish Key Performance Indicators (KPI's) for data and personas for better use cases [8].

The complexity of such undertakings poses both: challenges as well as grand opportunities for the project managers, especially for IT project managers, for whom this experience can be intimidating as well as rewarding. To equip and strategize well, project managers should fully grasp the big picture, get a strong technical lead on-board, and phase a project into small achievable, viable phases/cycles, such as research and development phase or proof of concept phase. Also, they should select industry approved IoT reference architecture, which would require unique project infrastructure and a team with unique skill sets. Apart from this, a collocated, collaborative team should be built and should be constantly inspired to work on such cutting-edge projects [9].

The large and complex IoT projects will need more engaged Project Managers, who apart from handling work-flow would be needed to control some programs. Like, for Amazon drone delivery project, a manager would be involved from research and development phase and going through the whole process of drones communicating with air traffic controller, corporate office and then the end customers. With the assistance of CEO or any executive officials, and portfolio managers, project managers will be able to subdivide projects into small phases and provide Return on Investment (ROI) estimations. Whereas there is already number of mangers working on IoT projects, this field will eventually provide more jobs for skilled technical and IoT mindset folks [10].

IoT will disrupt the project management in several ways, as the data from sensors will help companies save money, reduce downtime, lower down the waste, increase productivity and help determining the workforce needs. Also, these long-term projects will need more focus on maintenance, security and monitoring and hence requiring the project managers to expect lengthier and onsite based commitments [11]. For IoT projects the mantra is not just to focus on the business but also the technology, and to pay serious attention to the security and privacy threats, to always have an exit strategy or a plan B, plan better risk management; including the vendor risk, making it easy to replace or update the IoT components and finally to have buy-in from across the organization [12]. If these things are kept in mind, a project manager can effectively lead an IoT project.

With lot of IoT projects coming up, the possibilities seem to be endless, but it is yet to be seen if such projects will impact the current management methodologies, measurement standards and planning strategies. Whereas this technical advancement will make a project manager's life easier, there will be certain areas where they need to be more agile, precise, and knowledgeable and need to use more rigorous parameters [13].

While the technology world is continuously creating opportunities, it has also faced challenges from time to time. Over the last decade new approaches such as: Scaled Agile Framework (SAFe), Disciplined Agile Delivery (DAD), Scrum, Kanban, Extreme Programming, and other various Agile philosophies have been implemented to accommodate the big data, cloud computing and Service Oriented Architecture (SOA) based products development [14,15]. Even though, these approaches have been tested for traditional projects, will these improve chances of IoT projects complete successfully, is still an unanswered question. Similarly, for IOT projects, do we need entirely new management practices or we can scale the current ones to find the best

possible framework that can be universalized, has yet to be explored. Not only that, the impact of IoT on Project Management and the execution has not been studied due to lack of data, use cases, resources, focused research and efforts in this direction.

To summarize, here are few key points gathered from the above literature review: (1) what and how IoT projects are different from traditional or software projects? (2) What are the main challenges faced in the IoT projects, ranging from being interdisciplinary to complexity in managing and planning such projects? (3) What approaches are currently being used to manage IoT projects in various domains and why management area will be affected the most. Concluding, project manager's role and responsibilities will be changing with the new technical upheaval, as their role will broaden from advocate to specialist, and so will be the need to have new management philosophies.

III. METHODOLOGY

Whether it's a tech or non-tech, what comes under the purview of Internet of Things is so vast that it covers nearly every domain and company, be it into agriculture, space exploration, retail, and health or even education sector. The Study Design for seeking solution to the above said problem involved reaching out to IoT professionals, via LinkedIn or any other social networking website, and especially focus was on to reach out to the top ten well-established as well as startup companies that are poised to make a mark in the IoT world. These companies are: General Electric, Schneider Electric, ARM, Robert Bosch, The Channel, Riot Micro, zGlue, ETA Compute, Bebop Sensors and TrackNet.

Online or web-based tools such as survey monkey was be used to define and disseminate the surveys for collecting data. From survey results, the data was collected, analyzed, and then discussed among the peers for their suggestions. The main results are presented in the next section, where quantitative analysis of data gathered is used to point out the pain points in handling IoT projects.

IV. RESULTS

IoT projects introduces combination of software and hardware components, which creates dependencies and is disrupting traditional product manufacturing mindset. Whereas Waterfall is known for delivering a predictable product and Agile is at the heart of small teams or startups working to get quick turnovers, what would work for IoT projects still remains under question? The survey takers were asked how often they follow various, such as Waterfall, Agile, Hybrid or RAD project management frameworks for IoT projects. The results point to most survey takers embracing the agile and a hybrid of waterfall and agile features in IoT projects.

Next, when asked, what were the main challenges while developing a project charter on an IoT project, for the following options, no clear link with overall organizational strategy The project statement of work is not clearly defined, any concerns about goals being realistic and attainable, no clear picture of the risks and assumptions related to the project or any concerns about realistically measuring the project success (ROI). Getting a better ROI stood out.

Next, when survey takers were asked to rank the challenges that they may have faced while team building on an IoT project, such as: would they consider an IoT team management a challenge, do they agree that interdisciplinary teams are hard to manage, lack of team collocation poses challenges or if roles and responsibilities are not well defined for such projects and are such projects are more conflict prone and where a team-work skill set is an asset on an IoT project. For this, IoT being an interdisciplinary field and lack of team colocation stood out.

Based on their experiences, survey takers were asked how they see various stakeholders engaged on an IoT project. And the results were following: Steering Committee/Leadership (Supportive), Program Manager (Leading), Project Sponsor (Supportive), Project Development Team (Neutral), Business/Product Analysts (Neutral), End Customer or Client (Leading), Local Communities (Unaware, Neutral), and Regulators (Resistant). So, we can say that on IoT projects regulations pose a great resistance and leadership and project sponsors are very supportive. Also, we need to make local communities to be more aware of such initiatives.

When asked about the project management tools/software which can make them well equipped to manage IoT projects, among MS Project, Jira, VersionOne, Asana, and SmartSheet, Jira tool stood out. So, one can say that Jira, which is currently used for managing agile projects would be preferable choice for IoT projects as well.

Next, survey takers were asked to rank process groups are likely to increase the following few factors in IoT projects, and the factors along with the groups are: Cost (Execution), Schedule (Planning), Scope Creep (Execution), Conflicts (Planning), Quality Control (Execution), Risks

(Execution), and Vendor Management (Initiation). So, for the Execution Phase one can see Cost, Scope Creep, Quality Control and Risks are the factors that will be highly affected. Similarly, during the Planning Phase Schedule and Conflicts will be more seen, and in Initiation Phase Vendor Management will pose more challenges. Another question about checking which factors in their views are likely to contribute to managing IoT projects, among the following: A separate research and development phase, A Proof-of-Concept or Prototype before actual project begins, Project managers with interdisciplinary technical knowledge, Using hybrid of Waterfall and Agile methodologies, and, universally defined business and technical jargon. As seen from the responses, all of the above factors were selected were overwhelmingly selected and would add value to IoT project management.

V. CONCLUSION

The fourth industrial revolution, which consists of the big data and the Internet of Things as its main ingredients, has already impacted wide range of industries. The companies affected are already trying to adapt to upcoming changes, by either changing their internal processes or by following the standard protocols. Even though IoT is such an important topic and has touched our daily lives in so many ways, there is still a scarcity of studies on the managerial aspects of the IoT projects, and this is adding to the current challenges of adoption to IoT world. This study lay out the fundamental building blocks of IoT projects and then based on exhaustive literature review; pin points the challenges in successfully completing IoT projects for enterprises and also provide reasons for failure of such projects. To summarize, a unique nature of such projects, where there are long product life cycles, complex nature of business models, lack of skill sets, no past projects to benchmark and ever-growing technology requires drastic changes in the philosophies, by which we currently carry-on traditional projects.

Based on a mix of quantitative research, this study work identified the most important challenges being faced in management of IoT products development and then suggests solutions to tackle those. To reemphasize, a need to have separate research and development phase, where Proof-of-Concept/Prototype can be developed before the actual project begins can add to business value. Also, the stakeholder, especially the Project Managers need to be from or have interdisciplinary technical knowledge. Coming to management frameworks, a hybrid of Waterfall and Agile methodologies would work best for IoT projects and a well-defined universally accepted business and technical jargon would defiantly add to successfully complete the IoT projects. Furthermore, with these findings form this work will help the IoT business owners, stakeholders, managers and developers in developing, designing, and carrying on the IoT projects in more systematic and in a universally accepted framework. And, need of hour is to bridge the gap between traditional project management philosophes and IoT initiatives, where more peer reviewed work is needed focused on IoT management.

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Impact of Society 5.0 on Educational Institutions and Educational Workers

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Abstract - With the Fourth Industrial Revolution, technological progress shone brightly. Every segment of human life is based on a wider use of technology than was previously the case. Society 5.0 is changing the approach to technological progress, influencing people's awareness that technologies should be used for the benefit of the entire population. Educational institutions and educational workers now have the task of instilling in future postgraduates the philosophy of Society 5.0 by which they should be guided.

I. INTRODUCTION

Industry 4.0 is based on automated production, an abundance of technological innovations that have replaced human work and connecting the physical with the virtual space. With her appearance, there was a lot of turbulence that affected many sectors, and the education sector is one of them. Modern technologies have transformed the way of approaching and solving existing problems and have given man the opportunity to remove obstacles in front of him in a faster and more efficient way.

Educational institutions and educators have undergone a large series of changes that occurred with Industry 4.0, and now they must shape their knowledge according to the concept of Society 5.0. This means that they should continue with the application of modern technologies in education, but with a changed approach. Foundations should be laid for young people at an early age, as a landmark for the formation of the Society, which will be directed towards the well-being of all humanity.

Education has always been an important segment of every state. It represents the basis of development and progress of future generations. Preparing young people to think in a different way and applytechnology for the sake of creating a world that will be a better place for all people to live, forms the basis of Society 5.0.

II. SOCIETY 5.0 - TERM AND CHARACTERISTICS

Society 5.0 is a concept unveiled by the Government of Japan in 2016. To improve living conditions, this country came up with the idea of directing the unfathomable possibilities of modern technology to the formation of the well-being of all mankind. She shared her idea with other countries, representing the goal, which is the formation of Society 5.0, which will live a better, safer, and more beautiful life.

The technologies that characterized Industry 4.0 resulted in better product quality, higher and faster productivity, more efficient and effective business processes, improved working conditions and safer decisions. The power discovered in this revolution is now being used to create a more advanced society. That is, the discovered technological power is now directed towards man and his needs, to ensure the well-being of life.

Society 5.0 is a new perspective of thinking, which is oriented towards man and his individual needs. The bottom line is that the potential of modern technology, which turned out to be enormous in the previous industrial revolution, is being used to solve the problems humanity is facing.

The core of Society 5.0 is man, who places himself at the center of innovation, technological transformation, and industrial automation [1], with the aim that all available capacities of the 21st century are used to his advantage. The focus is no longer on improving production processes, but on human life.

Society 5.0 has the task of balancing economic progress and social problems with the help of a system that integrates virtual and physical space [2, 3]. It is considered that the goal of Society 5.0 is the establishment of a common social infrastructure, which is based on advanced technologies [4].

It is believed that the realization of Society 5.0 comes thanks to innovations, which are driven by Big Data [5]. Collecting and processing a large amount of data has never been easier and more transparent. This enables a better insight into the possibilities and solutions to the problems that are in front of man. In addition, there is an opinion that Big Data [6], data science and artificial

intelligence are the most important points of support of Society 5.0 [7].

III. INDUSTRY 4.0 AND SOCIETY 5.0 - SIMILARITIES AND DIFFERENCES

The main subject of Society 5.0 is man, who manages modern technology for the benefit of all mankind, as opposed to his role in Industry 4.0, where he was subordinated to that technology [8]. Automated production, which suddenly started to develop, led to the fact that man was in the background. In Society 5.0, the human factor changes the course of movement with technological innovations, directing them to their needs.

In generally, the concepts of Industry 4.0 and Society 5.0 are very similar. The main difference is in their direction: the Fourth Industrial Revolution is based on improving production, creating smart factories and cities, while Society 5.0 emphasizes the importance of people's well-being [9]. In addition, Industry 4.0 relies heavily on artificial intelligence, while Society 5.0 emphasizes the pairing of machines with the power of the human mind [10]. Therefore, the solution to creating better conditions for life can be seen in the crossing and symbiosis of human and artificial intelligence at the base, connected with digital, blockchain and other technologies.

Many authors share the opinion that Society 5.0 was created because of the implementation of the Fourth Industrial Revolution [11, 12, 13]. However, this connection is still firmly connected, because precisely thanks to the characteristics and technologies of Industry 4.0 (artificial intelligence, cloud computing, Big Data, adaptive robotics, augmented reality, nanotechnology, 3D printing, additive manufacturing and the Internet of Things), it is possible to realize advanced society [14]. Therefore, it can be said that Society 5.0 uses all the resources, which are characteristic of the Fourth Industrial Revolution, and directs them to the well-being of life on Earth.

The concept of Society 5.0 strives to make maximum use of the technologies on which Industry 4.0 is based, for the sake of solving social problems [15]. Accordingly, the upcoming era indicates the necessity and need for technology to be part of the social good [16]. Finally, one can add the statement of one author [4], that technology should not be seen as a threat, but as a support for humanity. According to him, there is no room for fear of management and application of technology, but it should be positioned in such a way as to make maximum use of its potential. Serpanos [17] expanded on this, saying that the technologies that dominated Industry 4.0 will be based on improving the quality of life, social responsibility, and sustainability. The aspiration lies in creating a sustainable society, and ensuring the safety and well-being of the individual, with the help of the active participation of cyber-physical systems [18], in the domains of production, mobility, health care, agriculture, energy, sustainability, disaster prevention, and education. In this way, Japan promotes a smart society, which will take advantage of all available technological innovations and form a better place to live.

The main role in the management of new technologies and innovations will be played by state governments, the industrial environment, and academics [19]. To achieve a sustainable and inclusive society, it is very important that people are in focus when making political decisions [20]. Society 5.0 predicts the penetration of digital technologies into all spheres of human life. Their role must be aimed at the welfare of society, otherwise economic and social degradation may occur [21].

IV. EDUCATION IN SOCIETY 5.0

Many authors [22, 2, 23], who dealt with the concept of Society 5.0, emphasized the importance of education, as an important segment in its application. Hence the idea that educational institutions must prepare for the introduction and implementation of this social revolution.

The digital transformation that is characteristic of the Fourth Industrial Revolution has shaken all social activities. Among other things, the changes affected the education sector, which inevitably must adapt to the changes. Digital technologies, through the possibilities they can provide, will be an inseparable part of educational institutions.

The role of educators in schools is also changing in accordance with the changes that have affected the whole world. The success of their transformation will reflect on young people, who are expected to readily accept the changes those previous industrial revolutions have brought to their attention.

Generations of children born in recent years, as well as those yet to come, will grow up in the digital world. Digitization has begun in a big way, and young people must train and prepare to meet the business world. Education in this domain plays a key role in every country. Education must adapt to changes; educational institutions must introduce the possibility of electronic education, acquire, and apply modern technologies that will enrich the

teaching content, and educators must complete their knowledge with the skills of handling and applying that technology.

A. Educational institutions in the Society 5.0

In accordance with the changes, available technologies and the philosophy of Society 5.0, schools [24] are advised to analyze their curriculum as soon as possible, and prepare for the transformation, if they have not already done so. Their adaptation in the turbulence that occurred is a necessary step in all countries.

Schools and colleges should take the initiative to adapt, to remain competitive in the market compared to others and achieve good results. For this reason, many schools have included modern technologies in their curriculum and provided students with training on how to apply them. Such an approach led to an improvement in the quality of teaching, but also to many challenges they had to face.

It is essential for younger generations to acquire knowledge about available technologies and their possibilities, to be able to apply them and use them for the benefit of all. The goal is for young people to adapt as efficiently as possible in the world of business, but also to improve the quality of their own lives.

Management of educational institutions in Society 5.0 requires changes. Starting from elementary, through secondary schools and colleges, all educational units must work on the quality of the services they provide.

Society 5.0 advocates the well-being and better quality of life of all people. This also applies in part to education. In addition to preparing young people for a life with many technological innovations in it, it is necessary to ensure that every child has the possibility of quality education and access to technologies, regardless of the financial situation of the family they come from.

B. Impact of Society 5.0 on educators

The role of educators in Society 5.0 is changing and expanding. In addition to the basic task of imparting knowledge, teachers must motivate and inspire students, introduce them to modern technology, and be their mentors [25].

In summary, it can be said that the task of educators in Society 5.0 is to provide students with human, digital and technological literacy [26]. Accordingly, this circle of knowledge was expanded, and it was added that educators of the 21st century must master the skills of leadership, entrepreneurship, and global citizenship [2]. Certainly, people who work in schools need new knowledge. To be able to teach and guide the younger ones, they themselves must master the art of managing and applying the many technological innovations that are becoming our present today.

Educators in Society 5.0 are forced to use technology to ensure an effective teaching process [27]. Lifelong education is one of the essential items that accompany Society 5.0. It is an indispensable feature of a successful career. The condition for the human staff to be able to follow technological advances and remain competitive on the labor market is to learn and improve throughout their working life. At this moment, this primarily refers to educators, who will be prevented from advancing further without upgrading their knowledge.

Through lifelong learning, educators can build on what they have learned and refine their skills, which is extremely important for current changes. This program can reduce the opportunity gap, since its most common patterns are lack of skills, inadequate education [28], but also insufficient information, since many people have not had many opportunities to apply modern technology.

C. Electronic education as an important approach to education in Society 5.0

With the technological approach, a multitude of advantages have been recognized that are available to students and educators. Greater flexibility, efficiency and effectiveness of teaching processes is enabled. The material taught to students can now be presented in a better and clearer way, which will ensure a better understanding of the essence.

Modern technology, among other things, makes it possible to follow classes without being physically present in class. This was especially evident during the COVID 19 pandemic. Distance learning enabled a smooth process of teaching, which would otherwise have been completely suspended.

In addition, the issue of students living in remote and inaccessible areas, who due to weather conditions, spatial distance, or financial possibilities, are often not able to attend classes, i.e., lectures, was resolved. Technology in Society 5.0 enables the erasure of regional, age, gender, and language boundaries [29], which brings the whole world closer together and unites it in the fight for a better future.

Also, one of the advantages of modern technology is that the necessary information can be obtained in a faster and simpler way. This

greatly shortens the search time and allows that time to be used in a better way. The collection and processing of data has been improved many times over by the technological approach and provides the opportunity for educators to handle data related to students and teaching in a more systematized, transparent, and transparent way. In accordance with the above, Fadzi and others [30] said that it is necessary to synchronize the education sector with modern technologies, that is, to include electronic education as mandatory, to prepare postgraduates for the revolutionary changes that have occurred and are yet to follow. According to him, the traditional method of education is no longer functional, that is, it does not give satisfactory results, because it is outdated. Similarly, Darmaji et al. [25] recommend multisimulative learning, which represents the application of various teaching materials and types of learning, which modern technology enables. Teaching in Society 5.0 implies the application of information technologies, the Internet of Things, virtual reality, artificial intelligence, and others [2]. By using and connecting the mentioned technologies, the foundations for currently unimaginable future technologies and progress are created [31]. Educational institutions must strive for the maximum use of the mentioned technologies, to create competitive young people in Society 5.0 [32].

D. Challenges facing education in Society 5.0

In addition to the above, it is very important to mention that according to some studies [33], not everyone has the same access to the Internet and modern technologies, which today represent a requirement for creating competitive graduates. This problem includes educational institutions, educators, and students. The technological equipment of schools will affect the quality of teaching, and the inability to access the Internet can in some cases completely prevent students from following the teaching content.

The mentioned problem can be more pronounced when speaking at the state level, and it can certainly mean a certain number of people within them. Bartolović [34], pointed out that in such cases, there is a visible drop in student success, which later manifests itself in an increased unemployment rate, and a decline in the rate of the economy.

V. CONCLUSION

Educational institutions and educators must keep pace with Industry 4.0, to form Society 5.0. This implies the application of modern technology and deepening awareness of its possibilities, in the service of creating a better quality of human life.

Society 5.0 is a concept that directs technological achievements to help man to form a global community that will live in prosperity. Modern technologies can replace humans when performing difficult, monotonous, and static jobs, data processing is drastically facilitated and accelerated, the memory space for their storage is greatly expanded; enabled use of virtual space; digitized and modernized teaching processes and more.

Educational institutions and educators represent a bridge between modern technology and its possibilities, and young people, whose help is expected in the formation of Society 5.0. The role of education is to prepare young people and guide them in the direction of society, which will strive for a better and more carefree life.

Accordingly, education must change. Schools must include modern technology in their curriculum and prepare young people for its diversity and comprehensiveness in the upcoming period. The role of educators to introduce young people to the concept of Society 5.0 is very important. In addition to changing their way of working, and adapting within the resulting changes, they must prepare young people to use the technological opportunities in front of them in the right way.

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Microorganisms Detection Using Circular Gabor Filter

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Abstract - This paper introduces a new algorithm for filtering and detecting microorganisms in composite images. The proposed procedure is based on circular Gabor filter. Microorganisms were robustly and efficiently detected in images, and the circular Gabor filter demonstrated substantial resistance to noise and image degradation.

I. INTRODUCTION

Recently, the application of digital image processing and object detection in microbiology is a very important task, because microscopic image analysis is a principal step in microbiological research. This paper introduces a robust texture detection procedure for microorganisms detection from composite and complex images.

Texture analysis are one of the main tasks in algorithms for shape and object detection in complex images and these are the most researched fields in digital image processing [1]-[25]. Of all texture detection methods, Gabor filters refer to those that achieve the most prominent results [1]-[8]. Filtering an image with a Gabor filter is a common method for detecting the spatially localized spectral components of an image. Gabor filters are robust and are very resistant to noise and interference, and they provide good filtering results for low-quality images.

In this paper, a particular type of circular Gabor filter is presented for processing circular image segments, for example the microorganisms in the image. This paper represents an introduction to a new research on cell detection methods.

The paper is organized as follows: after the introduction follows the related work section. Next is the section with brief circular Gabor filter description, which is followed by the experiments and results section. Finally, the conclusions are given, followed by the future works and acknowledgements.

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II. RELATED WORK

In contrast to the classic Gabor filter, the circular Gabor filter is less mentioned and represented in the scientific literature. Only a minor number of scientific papers have been published on the theme of circular Gabor filters, in spite of the fact that they have very good characteristics in terms of simplicity, robustness and resistance to various kinds of artifacts and noise to low-quality input images.

Tadic et al. [1]-[6] published several researches on fuzzified Gabor filters in recent years. They have proved, that the Gabor filters are highly effective in various application such as license plate detection, texture analysis and text detection. Zhang et al. [8] employed a circular Gabor filter to detect and extract textures and shapes with invariant orientations. They have utilized a symmetrical circular filter in the shape of a regular circle. The authors stated that the constructed filter with appropriately selected parameters achieved satisfactory results in filtering symmetrical circular shapes. Zhu et al. [10] introduced a procedure for measuring the likeness of shapes. This procedure is based on filtering with a circular Gabor filter and the technique of measuring the Hausdorff distance. The introduced algorithm was proven to be resistant to noise and rotation. Yin et al. [11] suggested circular Gabor wavelets for the classification of textures that are invariant to rotational variations. The developed method was tested on a large database of images and proved to be highly efficient. Xu et al. [12] utilized a bank of circular Gabor filters to enhance the edges of cells in images during antiviral experiments. The final segmentation was obtained by clustering with very

high reliability. Meng et al. [13] introduced a biometrical algorithm for identifying the retina utilizing an augmented circular Gabor filter based on wavelets.

III. CIRCULAR GABOR FILTER

The impulse response of the 2D Gabor filter is a 2D sinusoid modulated with a Gauss function with an orientation of 0°, where f is the spatial frequency, and Φ is the orientation of the Gabor filter, and it can be expressed as [1]-[7]:

$$g(x, y, f, \Phi, \sigma) = Ae^{-\left(\frac{(x-x_0)^2}{2\sigma_x^2}+\frac{(y-y_0)^2}{2\sigma_y^2}\right)}e^{j(2\pi f(x\cos\Phi+y\sin\Phi)+\varphi)} \quad (1)$$

where the first exponential function denotes a 2D Gauss function that is named an envelope and the second exponential function denotes a complex sinusoid called a carrier with the initial phase φ. Parameter A is the amplitude of the Gabor function, (x_0,y_0) is the center of the filter, and σ_x and σ_y are the standard deviations of the Gauss curve along the spatial coordinates.

The filter determined in this manner has proven to be remarkably robust in detecting various textures, primarily due to its ease of optimizing parameters such as changes in orientation angles, frequency, and bandwidth, which can be tuned with the values of the standard deviation. Still, describing the filter in this manner, i.e., as a non-circular shape [2], is not appropriate for detecting circular shapes and deformations of circular objects. For the detection of circular and deformed circular shapes to be successful, it is necessary to use a circular Gabor filter.

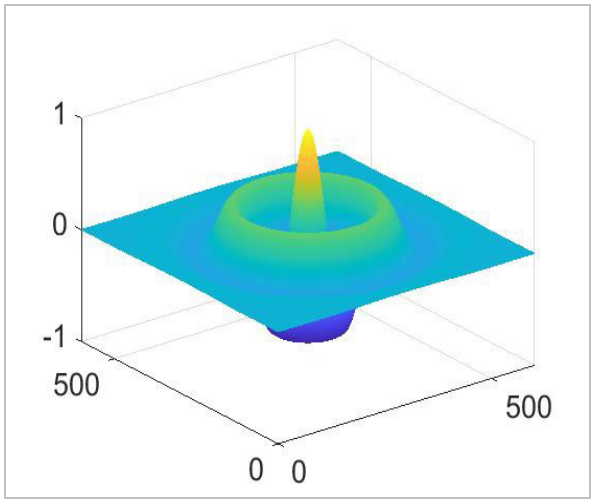
A circular Gabor filter can be expressed as [1]:

$$G(x, y, F, \sigma) = Ae^{-\left(\frac{(x-x_0)^2}{2\sigma_x^2}+\frac{(y-y_0)^2}{2\sigma_y^2}\right)}e^{\left(2\pi jF\left(\sqrt{x^2+y^2}\right)\right)} \quad (2)$$

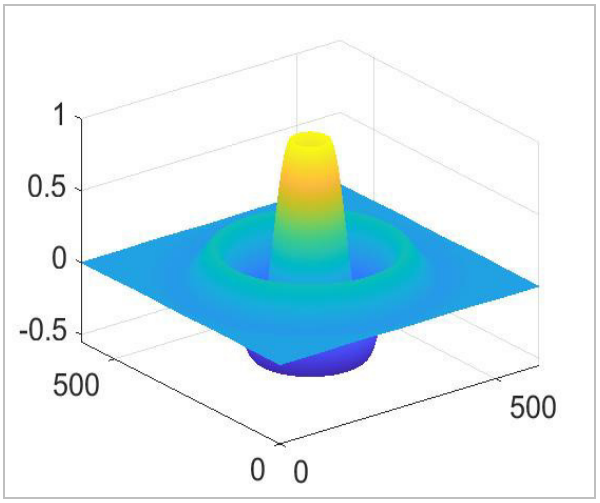
where F is named the central frequency and in this research is calculated experimentally as [3]:

$$F = \frac{1}{\lambda} \quad (3)$$

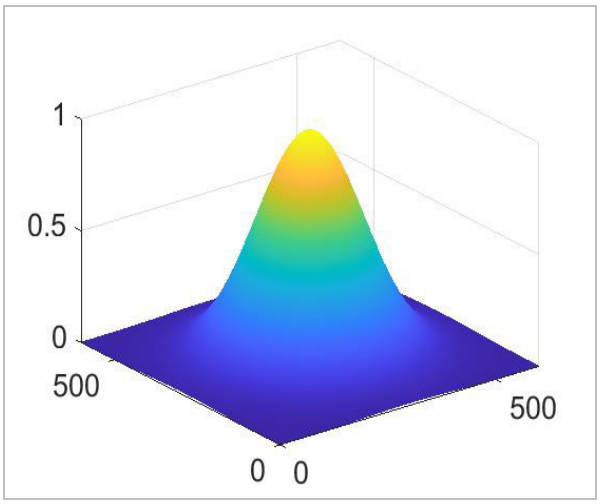
where λ denotes the wavelength of the circular Gabor filter in pixels, i.e., the size of the filter.



(a)

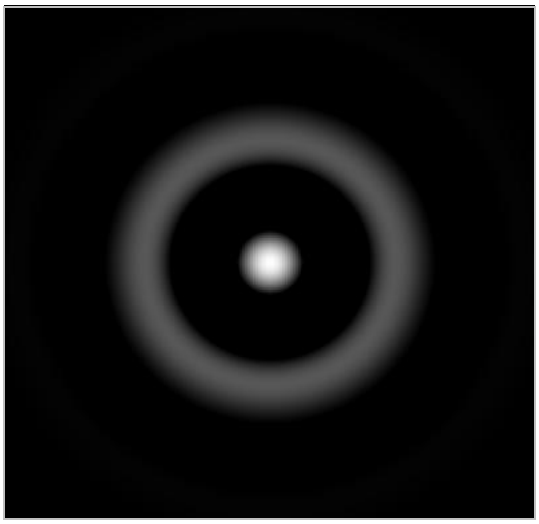


(b)

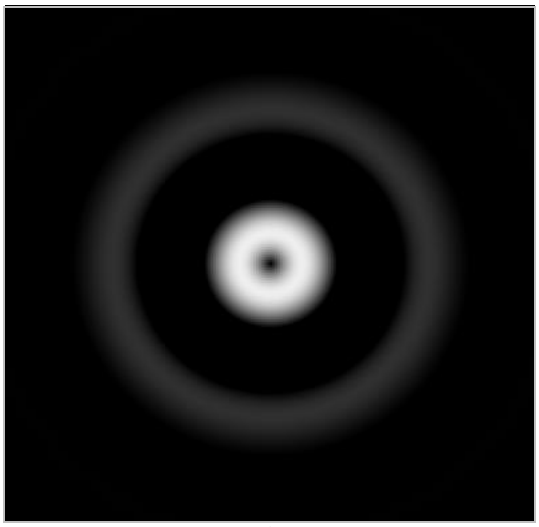


(c)

Figure 1. Example of a spatial circular Gabor filter. (a) Cosine component. (b) Sine component. (c) Amplitudinal characteristics.



(a)



(b)

(c)

Figure 2. Example of impulse responses of the circular Gabor filter. (a) Cosine component. (b) Sine component. (c) Amplitudinal characteristics.

The circular Gabor filter can be expressed as:

$$G(x,y,F,\sigma) = Re\left(G(x,y,F,\sigma)\right) + jIm\left(G(x,y,F,\sigma)\right) \tag{4}$$

where the real and imaginary parts of the filter are defined as:

$$Re\left(G(x,y,F,\sigma)\right) = Ae^{-\left(\frac{(x-x_0)^2}{2\sigma_x^2}+\frac{(y-y_0)^2}{2\sigma_y^2}\right)}\cos\left[2\pi F\left(\sqrt{x^2+y^2}\right)\right] \tag{5}$$

$$Im\left(G(x,y,F,\sigma)\right) = Ae^{-\left(\frac{(x-x_0)^2}{2\sigma_x^2}+\frac{(y-y_0)^2}{2\sigma_y^2}\right)}\sin\left[2\pi F\left(\sqrt{x^2+y^2}\right)\right] \tag{6}$$

The impulse response of the circular Gabor filter on the input image is obtained by convolution [1]-[7]. If *I(x,y)* denotes the image, and *G(x,y)* denotes the response of the circular Gabor filter at point *(x,y)* on the plane of the image, then *Y(.)* can be expressed [9] as:

$$Y(x,y,F,\sigma) = \Sigma_p\Sigma_q I(p,q)G(x-p,y-q,F,\sigma) \tag{7}$$

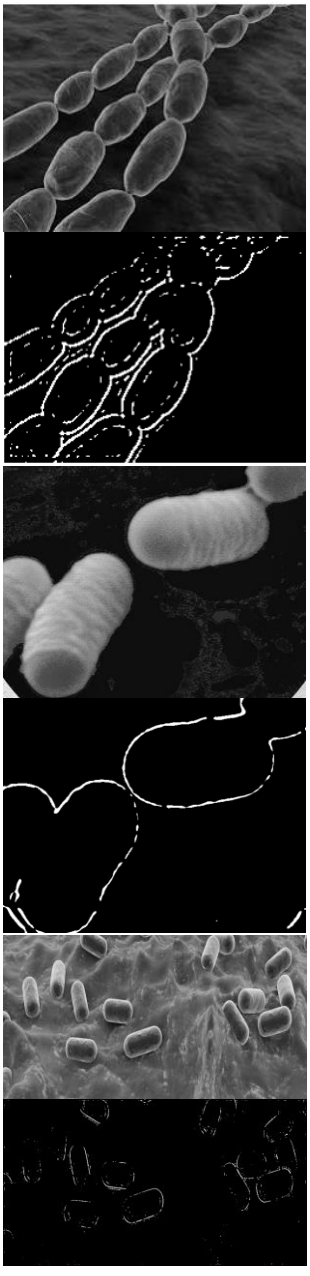
In Fig. 1, the cosine component of the circular Gabor filter has a clearly expressed shape in the form of a circle, which can be used in the detection of circular shapes. Therefore, in the following experiments, filtering is performed using only the cosine component of the circular Gabor filter [1]. It has been confirmed in experiments that the sine component, especially the amplitude of the filter, yields much weaker results in filtering circular shapes, and thus these components are not considered in this research [1], [8]. Further, the Fig. 2 shows the frequency responses of the circular Gabor filter. Also, it is evident here too that the cosine component of the filter gives the strongest response for circle shape detection and extraction [1], [8].

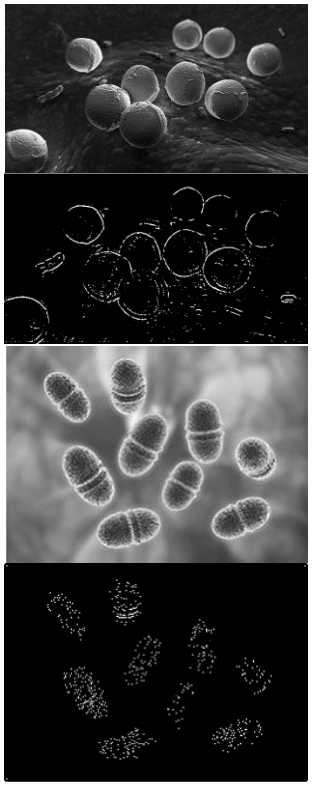
IV. EXPERIMENTS AND RESULTS

The effectiveness of this new procedure was tested on test images specifically selected for this purpose. The results of the experiments are presented in Fig. 3. The left column shows the original input images in Fig. 3(a), while the right column in Fig. 3(b) shows the results of the filtering with the circular Gabor filter. All the images are of unknown origin and they are presenting various microorganisms.

The first example shows a sequence of mutant Streptococci bacteria. The shape of the bacteria is similar to the ellipse. As it can be seen, the circular Gabor filter detected and highlighted successfully

the shape od the bacteria-chain in the image. The second example displays a Lactobacillus Curvatus microorganism. The shape of this bacteria is similar to ellipse too, but it is not so elongated as the bacteria in the previous example. As it can be noticed in the filtering result, the circular Gabor filter has filtered and detected the contours of the microorganisms in an appropriate and visible way. The third example presents the image of a Streptococcus bacteria. As it can be seen, the shape of these bacteria is like ellipse again. Also, the nuance of the bacteria and the background is very similar, and this can cause problems during the image segmentation since the textures desired bacteria shapes can be merged with the background.





(a) (b)

Figure 3. Results of the experiments. (a) Original images. (b) Responses of the circular Gabor filter.

However, regardless of the fact that the shapes are not of a regular circular shape, and the textures of bacteria are not the clearest, the circular Gabor filter has detected satisfactory the bacteria in the image. The next example shows one of the Streptococcus bacteria strain. As it can be noticed, the shape of these bacteria is similar to the circle, and the image is highly noised. The filtration via circular Gabor filter resulted with a successful detection of the microorganisms in the image. The final example in Fig. 2 presents a Streptococcus Pneumoniae bacteria. The shape of this bacteria is similar to the ellipse again. Despite the fact that the shape of the microorganism is not a circle, the circular Gabor filter has detected the textures related to the bacteria and the positions of the bacteria are reliably noticeable in the filtering result.

V. CONCLUSIONS

This paper presents a procedure for robust detection of microorganisms in composite microscopic images. Detection is achieved through filtering by applying a circular Gabor filter. It has been experimentally proven that, by using the cosine component of the circular Gabor filter, an efficient extraction of the segments of interest can be achieved. It became evident on the

test images that the circular Gabor filter can more robustly filter and detect the objects in complex microbiological images of various origins.

FUTURE WORKS

This work is a beginning of a new research on cell detection procedures, hence in the future, an advanced method for the parameters selection of the circular Gabor filter will be developed to attain reliable detection of specific circle-shaped objects in microbiological images. Special emphasis will be placed on developing automated methods for selecting particular microorganisms from complex pictorial structures and images.

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Clean Code Principles Used in PHP Application

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Abstract - Aiming to create a readable and understandable software code is very important in companies where programmers are grouped into teams and coordinate together with a goal of creating a software product. Team members communicate and share their software codes between each other in aim to finish their tasks effectively and on time. If team members can't read and learn what the code does, project will come to a hold-up, taking the precious time to complete tasks. This paper focuses on clean code principles and the impact they have on the readability and understandability of the PHP web application code. Conclusion is pointed towards comparison between a "dirty" and "clean" code, and a table which shows types of repair.

I. INTRODUCTION

Programming as a profession in most cases requires teamwork. Team members coordinate their work, develop and test software, which leads to achieving a mutual goal. That goal is customer satisfaction. As most of the team members are programmers, there will be situations where it will come to a certain stop in software development. Those certain breaks or hold-ups could be because of some error, software functionalities can't pass testing etc. To solve these hold-ups faster, various fixes are necessary. Those fixes can be software code corrections or adding more members to team. Accent is on software code correction, since the code itself is needed for both types of fixes. If the code is not readable, not understandable or if it's chaotic, member of the team will have hard time understanding it, which then results in hold-up in development process. New team members will have difficulties because they will have to spend more time studying the code. Error removal will be harder if it's hard to find the part of the code which causes it. In order to avoid these situations, during programming, programmers apply clean code principles.

PHP is very popular programming language. PHP was introduced in 1995. It is a open-source scripting language which can be used for creating console applications and graphical interfaces, although it is primarily used for creating dynamic web pages on the internet. There are a lot of different views on clean code principles and conventions for PHP language, which is why it is hard to precisely define rules which programmers could use as a guide.

This paper presents an overview of basic clean code principles and an example of a PHP web application and a implementation of clean code principles on the same example. Using this example a solution is presented for solving errors which are commonly present.

II. THEORETICAL BACKGROUND

"Clean code refers to the quality of software, usually pertaining to the readability and understandability of source code. We wouldn't be where we are today without continually improving the quality od software using refactoring." [1]

"One main reason for refactoring is maintainability. It is much easier to fix bugs in code when people can actually understand it, and locate things in a timely manner." [1]

"An experienced programmer can easily spot unreadable source code. People also develop separate opinions on whether or not code is efficient, simple, or well structured. However, most programmers can probably agree on whether a piece of code is clean or not." [1]

"Agility in software development means being able to adapt to ever-changing requirements. A major factor in agility is keeping the codebase easy to read and to extend." [2]

"This kind of code is commonly called clean code. Clean code is simple, elegant, and does not repeat itself. Writing clean code means that the cost of adding, changing, and removing features is kept to a minimum." [2]

According to Wojtek Lukaszuk [3], key rules in regard to clean code are:

"General rules:

- Follow standard conventions
- KISS(Keep It Simple Stupid)
- Boy scout rule
- Search for the root of the problem.

Design rules:

- Keep configurable data at high levels
- Prefer polymorphism to if/else or switch/case
- Separate multi-threading code

- Prevent over-configurability
- Use dependency injection
- Follow Law of Demeter. A class should know only it's direct dependencies.

Understandability tips:

- Be consistent. If you do something a certain way, do all similar things in the same way
- Use explanatory variables
- Encapsulate boundary conditions. Boundary conditions are hard to keep track of. Put the processing for them in one place
- Prefer dedicated value objects to primitive type
- Avoid logical dependency. Don't write methods which work correctly depending on something else in the same class
- Avoid negative conditionals.

Name rules:

- Choose descriptive and unambiguous names
- Make meaningful distinction
- Use pronounceable names
- Use searchable names
- Replace magic numbers with named constants
- Avoid encodings. Don't append prefices or type information.

Function rules:

- Small
- Do one thing
- Use descriptive names
- Prefer fewer arguments
- Have no side effects
- Don't use flag arguments. Split the method into several independent methods that can be called from the client without the flag.

Comment rules:

- Always try to explain yourself in code
- Don't be redundant
- Don't add obvious noise
- Don't use closing brace comments
- Don't comment out code. Just remove it
- Use as explanation of intent
- Use as clarification of code
- Use as warning of consequences.

Source code structure:

- Separate concepts vertically
- Related code should appear vertically dense
- Declare variables close to their usage
- Dependent functions should be close
- Similar functions should be close
- Place functions in the downward direction
- Keep lines short
- Don't use horizontal alignment
- Use white space to associate related things and disassociate weakly related
- Don't break indentation.

Objects and data structures:

- Hide internal structure
- Prefer data structures
- Avoid hybrid structures (half object and half data)
- Should be small
- Do one thing
- Small number of instance variables
- Base class should know nothing about their derivatives
- Better to have many functions than to pass some code into a function to slelct a behavior
- Prefer non-static methods to static methods.

Tests:

- One assert per test
- Readable
- Fast
- Independent
- Repeatable.

Code smells:

- Rigidity. The software is difficult to change. A small change causes a cascade of subsequent changes
- Fragility. The software breaks in many places due to a single change
- Immobility. You cannot re-use parts of the code in other projects because of involved risks and high effort
- Needless complexity
- Needless repetition
- Opacity. The code is hard to understand." [3]

III. EXISTING TOOLS FOR CODE CLEANUP

With the upgrade of development frameworks and with addition of new features, programmer's work is significantly easier.

Programmers can run the tool for code cleanup after writing the code and correct the irregularities

and syntax errors. Development tools that posses code cleanup options:

- Microsoft Visual Studio 2019 [11]
- Eclipse by IBM [12]
- Microsoft Visual Studio Code (if extension is downloaded). [13]

Alongside development frameworks which posses a feature for code cleanup, there are separate software tools for code cleanup.

Some of them, according to [14] are:

- Decoravit
- HTML Cleaner
- JS Beautifier
- CSS Comb.

IV. PHP-BASED SOFTWARE EXAMPLE

In this paper, example PHP-based software is presented as a web application for online military volunteer recruitment. This is not official software for recruitment for Serbian Army, but it presents a final exam work [15] at bachelor studies.

Users of this software could be potential candidates and secretaries working in recruitment centers. Potential candidates register by creating an account. They could read the information provided on the web site and apply for military service, filling up the form and providing needed data. Secretaries then check the data provided from administrative section, get in contact with the potential candidates, confirm their decisions to serve in the military and then further direct them towards next stage of recruitment. Figure 1 presents a welcome page to software administrator, while figure 2 presents the applicant homepage.

Figure 1: Administrator homepage

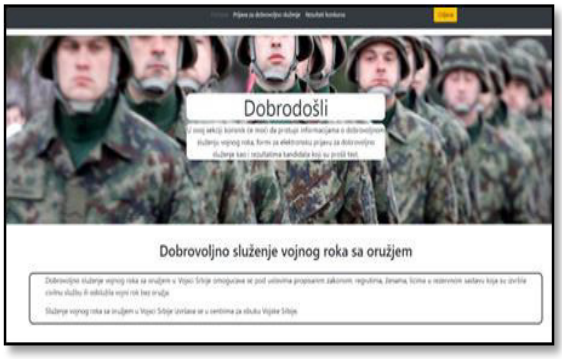

Figure 2: The applicant homepage

V. EXPERIMENT RESULTS

A. *Methodological frame*

The goal of the experiment is to show possibilities of clean code principles implementation for PHP language, applied with an example of a software.

The subject of the experiment is the characteristics of understandability, namely readability of the source code after the implementation of clean code principles.

B. *Experiment sample*

In previous section it is stated that the example is a web application for army recruitment. Languages used for creating this web application are HTML, CSS and PHP.

Accent is on the PHP language, which means that only code written in PHP language is used as an example.

C. *Results*

Outcome of this research is related to making PHP code clean and presenting possibilities of locating and refactoring the code, i.e. changing the source code without affecting the application functionality.

In this section, we present part of results with the example of the code from file *JedinicaClass.php.* The codeis briefly analyzed, then the cleaned up version is listed as an example.

Cleaning code is presented with some partial results:

- On the beginning of the code, unnecessary commenting was spotted *<!-- PHP script -->,* as well as on the end of file *<!-- End of PHP scipt -->*. It is unnecessary because it is clear that

this is a PHP script, therefore these comments should be removed.

- Variable *$id* is unused and therefore should be removed. After that, a large section of "dead" code was spotted. "Dead" code is a code which is commented and unused, therefore it should be removed. "Dead" code was starting with */* *Example of FILTER and INNER JOIN* and was taking 12 lines of code.
- *$lista3* does not have a meaningful name, therefore it should be changed to something that will help us understand it's purpose

```php
<?php
    class Jedinica{
        // Navođenje atributa
        public $konekcija;
        public $listaJedinica;
        public $listaVratiJedinicu;
        public $listaBrojnost;
        public $nazivJedinice;
        public $rodVojske;
        public $staresina;
        public $lokacija;
        public $brojnost;

        // Konstruktor konekcije
        public function __construct($Konekcija){
            $this->konekcija= $Konekcija;
        }

        // Funkcija za dodavanje vrednosti atributima
          public function DodajJedinicu($nazivJedinice, $rodVojske, $staresina,
$lokacija, $brojnost){
            $this->nazivJedinice= $nazivJedinice;
            $this->rodVojske= $rodVojske;
            $this->staresina= $staresina;
            $this->lokacija= $lokacija;
            $this->brojnost= $brojnost;
        }

        // Funkcija za upis jedinice u bazu podataka
        public function UpisUBazuJedinica(){
             $query= "INSERT INTO JEDINICA (NazivJedinice, RodVojske, Staresina,
Lokacija, Brojnost) VALUES
                ('$this->nazivJedinice', '$this->rodVojske', '$this->staresina',
'$this->lokacija', '$this->brojnost')";

            $this->konekcija->otvorena_konekcija->query($query);
        }

        // Funkcija za prikaz jedinica iz baze podataka
        public function CitanjeIzBazeJedinica()
```

```
        {
            $query= "SELECT * FROM JEDINICA";

                    $this->listaJedinica=  $this->konekcija->otvorena_konekcija-
>query($query);
            return $this->listaJedinica;
        }

        // Funkcija za vraćanje određene jedinice pomoću id
        public function VratiJedinicu($TargetId){
                $query=  "SELECT  NazivJedinice  FROM  JEDINICA  WHERE  IdJedinice=
'$TargetId'";

                $this->listaVratiJedinicu=  $this->konekcija->otvorena_konekcija-
>query($query);
            return $this->listaVratiJedinicu;
        }

        // Funkcija za vraćanje cifre o brojnosti jedinice
        public function VratiBrojnost($TargetId){
                  $query=  "SELECT  Brojnost  FROM  JEDINICA  WHERE  IdJedinice=
'$TargetId'";
                    $this->listaBrojnost=  $this->konekcija->otvorena_konekcija-
>query($query);
            while($row= $this->listaBrojnost->fetch_assoc()) {
                $A= $row["Brojnost"];
            }
            return $A;
        }
    }
?>
```

Figure 2 Listing of clean code in JedinicaClass.php file

TABLE I. Principles and types of repair implemented in file JedinicaClass.php

Principle	Type of repair
Don't use closing brace comments	Removed unnecessary comments on the beginning and at the end
Use meaningful and pronounceable names	Variable *$lista3* name is changed into *$listaVratiJedinicu*
Don't use comment out code, just remove it	"Dead" code is removed
Use comments as explanation of intent Use comments as clarification of code Don't be redundant Always try to explain yourself in code	Added comments which describe the code
Keep lines short	Lines of code are shortened
Don't add unnecessary context	Variable *$id* is removed

VI. CONCLUSION

The difference between conventions and clean code is that conventions are strongly defined patterns for variable, method and class naming, while clean code principles are different ways of code writing, so that it could be readable.

Clean code does include the implementation of conventions, but it is mainly directed at structural quality of the software and use of design patterns.

Clean code principles are not strongly defined because every person has a different view of readability. There are no specific clean code principles just for PHP language, because these principles are set to be universal.

In this paper, some of clean code principles were applied on the sample of PHP language

written code. Cleaning code brings benefits of better code readability and understandability.

Applying clean code principles efficiently improve readability and understandability of the source code, which could improve coordination in one team. In addition, the source code size is reduced, which could benefit in measures of application performance.

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Clustering Serbian Text Documents

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Abstract: The idea of the paper, which will be explained below, was to write a program in the Python programming language, which would perform clustering of text documents in the Serbian language. Texts entered by the user himself would be used for clustering, regardless of whether the Latin or Cyrillic alphabet is used. Also, the user would be the one to determine the number of clusters. Hard Clustering was applied to the work, which ensures that each "item" is assigned to only one cluster.

Key words: clustering, data, K-means, Stemmer

I. INTRODUCTION

Every human being is characterized by the ability to unite similar objects into appropriate groups, which is called classification. The grouping was created at the same time as the planet Earth, so the first people, for example, distinguished plants by whether they are poisonous or not, they also distinguished animals and similarly. On the other hand, classification is also needed for language development, for word recognition and grouping, regardless of the language area. When we talk about clustering, it is used in many areas including machine learning, computer graphics, image analysis, data compression, in marketing to segment consumers based on their purchases, in medicine to identify groups of patients with the same disease or drug reaction and many other areas. The simplest explanation for the functioning of clustering is that it groups sets of objects in such a way that the objects within the cluster are similar to each other, and that they are different from the objects of other clusters.

II. CLUSTERING

Clustering or cluster analysis is a machine learning technique, which groups the unlabelled dataset. It can be defined as "A way of grouping the data points into different clusters, consisting of similar data points. The objects with the possible similarities remain in a group that has less or no similarities with another group." [1] Clustering works by finding some identical patterns in an unmarked data set, such as shape, size, color, behavior, and similarly, and dividing them according to the presence or absence of those similar patterns. Once the grouping is done, each cluster, gets its own ID. As a simplified example of the operation of the grouping algorithm, we can cite the division of fruits into several groups, according to the corresponding properties, which is illustrated in Figure 1.

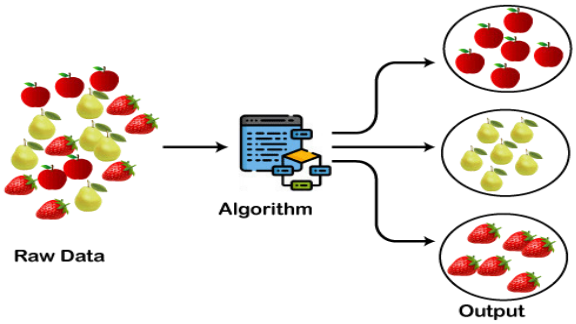


Figure 1. Illustration of how the clustering algorithm works [1]

III. CLUSTERING TEXT DOCUMENTS

Textual data generated in recent years is on the rise. Text document clustering groups similar documents that to form a coherent cluster, while documents that are different have separated apart into different clusters. [2] The way text clustering works involves using an algorithm that presents a text document numerically as a vector, because it allows us to compare text by measuring the distance of the features of those vectors. As for the use of text clustering, it has great application, such as in the case of generating taxonomies, identifying fake news, filtering spam, but also for language translation. The two basic steps in clustering are the selection of the appropriate distance measure and the selection of the clustering algorithm, which will be discussed below.

IV. K-MEANS ALGORITHM

This type of algorithm is used when the goal of clustering is to ensure that each data point belongs to only one group. The algorithm works by trying to make the data within the cluster as similar as possible, while keeping the other clusters as different as possible. The way in which this algorithm distributes data points into appropriate clusters is based on the arithmetic mean of all data points within the cluster, which needs to be minimal. The steps in the work of this cluster can be divided into the following:

- Determining and specifying the number of clusters,
- Defining the center of a cluster by first mixing a set of data, and then randomly selecting a number of data points that are same as number of clusters and setting them up as cluster centers,
- The first two steps are repeated until the center of the cluster moves,
- When a cluster center is specified, each data point is assigned to the nearest cluster.

V. PYTHON LIBRARIES

As already mentioned, the Python programming language was used for the realization of this paper, in which, as in any other language, libraries are the basis of programming, because they contain the specification of things and objects, as well as a large number of tools and functions that facilitate work of developers. For the purposes of this paper, two libraries Scikit-learn and NLTK were used. The Scikit-learn library is inevitable when it comes to classification, regression and clustering, and NLTK is essential for working with human language data. The way libraries work will be explained below.

VI. STEMMER

Stemmer is the process of creating morphological variants of the root / basic word. It is possible to compose sentences and documents using NLTK stemmers. Stemmer sees the whole sentence as a word, so he returns it as it is, so we have to embed each word in the sentence and return the compound sentence. It is possible to use a tokenizer to separate a sentence into a word. The NLTK tokenizer splits a sentence into a word by allowing functions to be created and sentences passed to the function, and provides a base sentence. For documents, we can write our own function that can stop documents. One way to stop a document is to:

1. First, we take the document as input,
2. We read the document line by line,
3. Tokenize the line,
4. We stop the words,
5. We present the keywords (print on the screen or write to a file),
6. Repeat steps 2 through 5 until the end of the document.

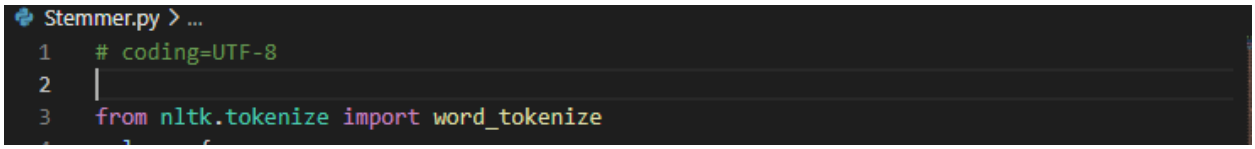


Figure 2. Use of NLTK tokenizer

Stop Words: A stop word is a commonly used word (such as “the”, “a”, “an”, “in”) that a search engine has been programmed to ignore, both when indexing entries for searching and when retrieving them as the result of a search query. We would not want these words to take up space in our database, or taking up valuable processing time. For this, we can remove them easily, by storing a list of words that you consider to stop words. NLTK(Natural Language Toolkit) in python has a list of stopwords stored in 16 different languages. [3]

VII. TRANSFORMATION OF SPECIAL SERBIAN SIGNS

The first action that will be taken is the transformation of special Serbian characters such as č, ć, š, ž, đ into cx, cy, sx, zx and dx. When the user receives the answer, the characters, by transformation, return to normal, namely, a readable form. This is done with the intention of facilitating text manipulation, as well as text exchange between the user and the service provider,

namely, the server. The program code is also written to change all uppercase letters to lowercase and to add a space before and after the punctuation mark, to ensure separation of tokens. After this is completed the tokenization is as follows.

```
389    def stem_str(str):
390        str = str.lower()
391        str = str.replace("š", "sx")
392        str = str.replace("č", "cx")
393        str = str.replace("ć", "cy")
394        str = str.replace("đ", "dx")
395        str = str.replace("ž", "zx")
396        str = str.replace("Š", "sx")
397        str = str.replace("Č", "cx")
398        str = str.replace("Ć", "cy")
399        str = str.replace("Đ", "dx")
400        str = str.replace("Ž", "zx")
401        str = str.replace("“","\"")
402        str = str.replace("\"","")
403        str = str.replace("”","\"")
404        str = str.replace("'","\"")
405        str = str.replace("’","\"")
406        str = str.replace("€","eur")
407        str = str.replace("„","\"")
408        lam = word_tokenize(str)
```

```
367    def stem_arr(str):
368        str = str.lower()
369        str = str.replace("š", "sx")
370        str = str.replace("č", "cx")
371        str = str.replace("ć", "cy")
372        str = str.replace("đ", "dx")
373        str = str.replace("ž", "zx")
374        lam = word_tokenize(str)
```

Figure 3 and 4. Character transformation

In order to obtain an appropriate basis for the Serbian language, it is necessary to apply a combined approach to stemming, where most words can be obtained using suffixes obtained by the "tearing algorithm". However, some irregular verbs and some other types of words with an incorrect base must be found using a dictionary. The algorithm that will be used for that purpose will search the dictionary to see if the word exists in it, if word exists, it will be changed to its basic form, otherwise it will "look" in the list of suffix rules and remove or change the suffix. Also, stems should not have less than 2 characters, the reason for this is that they then become unusable, and for that reason the algorithm is looking for a suffix after the second character. If a special character appears, the algorithm will look for a suffix after the third character.

```
i = 0
for word in lam:
    for key in dictionary:
        if key == word:
            lam[i]= dictionary[key]
            break
    for key in rules:
        if(word.endswith(key) and len(word)-len(key)>2):
            lam[i] = word[:-len(key)]+rules[key]
            break
    i = i+1
return lam
```

Figure 5. Determining the minimum stem length -a

```
i = 0
for word in lam:
    for key in dictionary:
        if key == word:
            lam[i]= dictionary[key]
            break
    for key in rules:
        # Tokenize only words larger than 2 characters, apart from modal verbs
        if(word.endswith(key) and len(word)-len(key)>2):
            lam[i] = word[:-len(key)]+rules[key]
            break
    i = i+1
end_str = ""
for word in lam:
    end_str = end_str+" "+word
return end_str
```

Figure 6. Determining the minimum length of the stems and writing a new character string

VIII. MAKING RULES

Given that it was necessary to write new rules, two approaches were used. The first involved the use of Serbian grammar, with this approach improving code performance, but some shortcomings were noted, such as the fact that some words are not yet properly connected. On the other hand, manual identification of words that cannot be stopped correctly and an attempt to create rules for that word form were used. The creation of new rules in this case was done by correcting the mistakes of already existing rules developed by Vlado Kešelj and Danko Šipka. The dictionary was used only when there was no other solution, as is the case with irregular verbs.

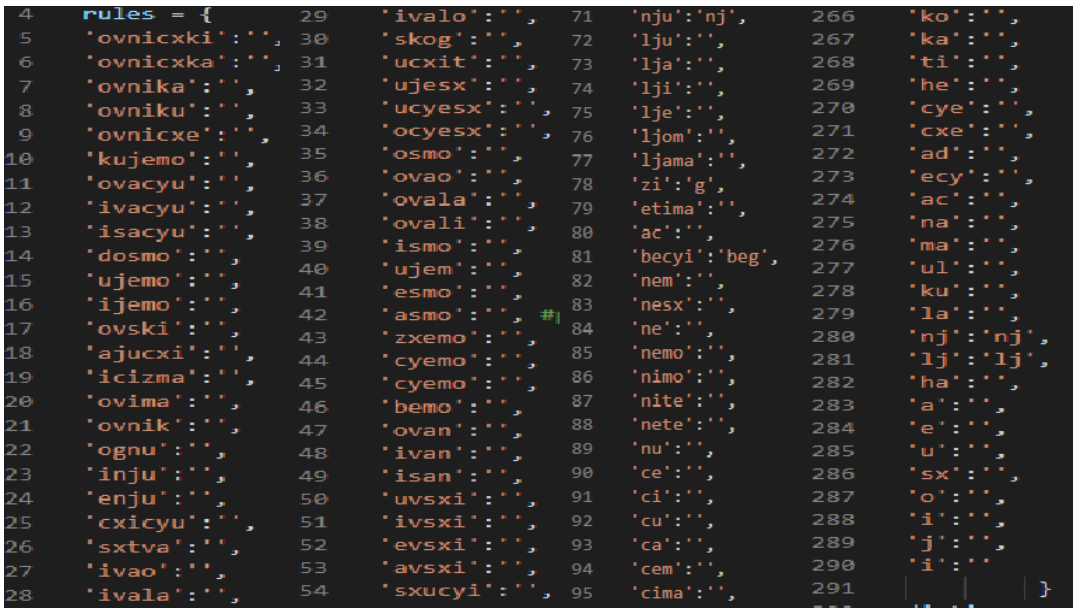
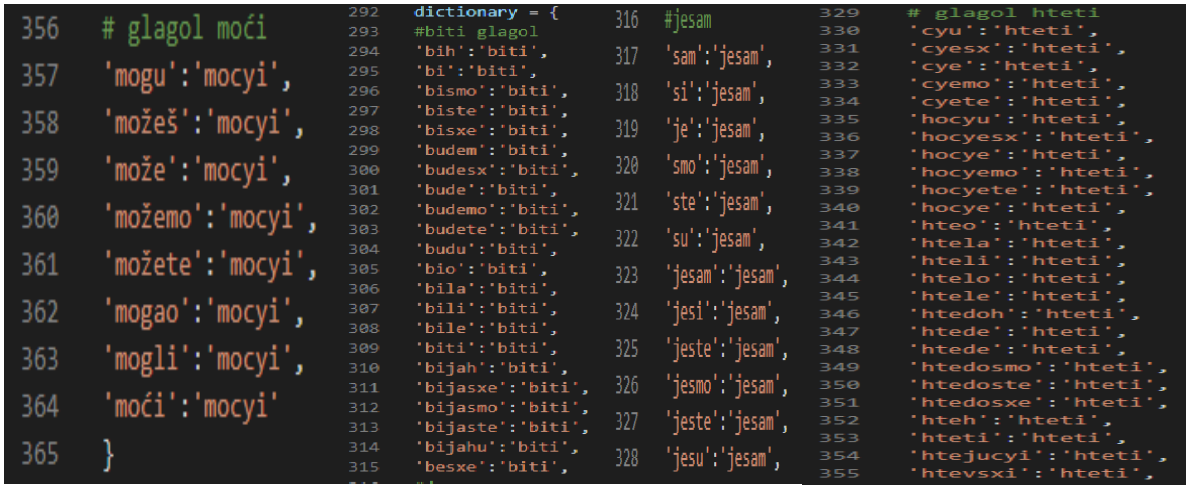


Figure 7. Example of some of the rules



Figures 8, 9 and 10. Determining the basis for irregular verbs

IX. CODE IMPLEMENTATION IN PYTHON AND RESULTS

In this example, it is determined to be classified into six clusters. At the very beginning, we import all the necessary functions and libraries, which is shown by the lines of code in Figure 11, and define a map of symbols that allows us to convert text written in Cyrillic to Latin, and thus allows their comparison.

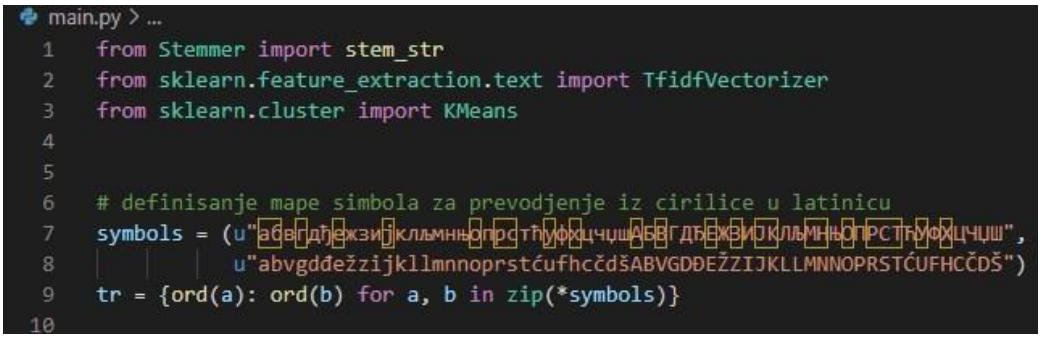


Figure 11. Defining a symbol map for converting Cyrillic to Latin

Then, we introduce an algorithm for converting text into vectors (** TF-IDF ** was used in this example), which enables comparison and classification of text documents into appropriate clusters, and also defines a series of texts used to write results, which is shown by the code in Figure 12.

```
11  # algoritam za pretvaranje teksta u vektor
12  vectorizer = TfidfVectorizer()
13
14  # niz izvornih tekstova koji se koristi za ispisivanje rezultata
15  original_text = []
```

Figure 12. Code lines

The next step involves defining a series of processed texts that are used for "training", that is, the corpus. When the string is defined, the code for opening the file containing the corpus, which will be classified, is written, and in this case, the ***primer.txt*** (eng. example.txt) file was created for that purpose, which contains the text. After opening the created file, each line of text is read, as a separate text document, and the part of the text that will be used to process and place that part at the end of the created string is extracted. Then, the method for translating the text from Cyrillic to Latin is called, and then the stemmer for the Serbian language, which was previously made, and at the end we place the obtained results in the created string, which is shown by the code in Figure 13.

Figure 13. Explained code lines

Finally, the previously defined string of texts, obtained as a result of the above lines of code, are converted into vectors using the previously defined algorithm and based on the obtained vectors, we cluster documents, for which the K-Means method is used in this example, with defining the number of desired clusters, in this case it is six clusters.

```
# definisan niz tekstova pratvaramo u vektore koristeci prethodno definisan algoritam
X = vectorizer.fit_transform(corpus)

# na osnovu kreiranih vektora klasterizujemo podatke
# metodi KMeans definisemo 6 klastera
kmeans = KMeans(n_clusters=6, random_state=0).fit(X)
```

```
n.py > ...
# niz obradjenih tekstova koji se koriste za treniranje
corpus = []

if __name__ == '__main__':

    # otvara se fajl koji sadrzi korpus koji se klasifikuje
    with open("primer.txt", encoding="utf-8") as fp:

        while True:
            line = fp.readline()
            if not line:
                break

            # iz ucitane linije izvlaci deo koji je tekst za obradu
            string = line.strip()

            original_text.append(string)

            # poziva se metoda za prevodjenje teksta sa cirilice na latinicu a potom STEMER-a za srpski jezik
            string = string.translate(tr)
            string = stem_str(string)

            corpus.append(string)
```

Figure 14. Display of code lines for use of K-Means method

As a result of clustering, we write lines of code to writethe obtained results in the created file, in this example the file ***rezultati.txt*** (eng. results.txt) was created to write the results, where, in addition to writing the text, the cluster to which the text documents written in the ***primer.txt*** (eng. example.txt) file belong is also displayed.

```
# ispisivanje rezultata u fajl
with open("rezultati.txt", mode="w+", encoding="utf-8") as fp:
    for i in range(0, len(original_text)):
        fp.write("  ".join([original_text[i], str(kmeans.labels_[i]), "\n"]
```

Figure 15. Display lines of code to write the results to a file

As an example of how the code shown above works, we also show an example of files that were used to write text documents that will be used for clustering and files with the resulting code outputs. Within the ***primer.txt*** (eng. example.txt) file, each line is viewed as a separate text document, which will then be clustered according to the written lines of code, shown in the previous figures. After executing the code, based on the entered "data", as a result, the program creates a file ***rezultati.txt*** (eng. results.txt), in which all text documents are written, together with the cluster in which they are classified.

primer.txt

```
1   Данас је уторак!
2   Da li je oblačno?
3   Kako ste?
4   provala
5   Sutra je subota!
6   Сунчано време?
7   Половима децембра;
8   Догодила се провала пре пар дана?
9   Gledamo film ili seriju?
10  Koji grad treba posetiti?
11  Београд је главни град.
12  Сутра ћемо изаћи у град?!
13  Lav Nikolajevič Tolstoj
14  Детињство (рус. Детство; 1852)
15  Дечаштво (рус. Отрочество; 1854)
16  Младост (рус. Юность; 1856)
17  Породична срећа (новела, 1859)
18  Козаци (рус. Казаки; 1863)
19  Рат и мир (рус. Война и мир; 1865–1869)
20  Ана Карењина (рус. Анна Каренина; 1875–77)
21  Смрт Ивана Илича (рус. Смерть Ивана Ильича; 1887)
22  Кројцерова соната (рус. Крейцерова соната; 1889)
23  Васкрсење (рус. Воскресение; 1899)
24  Хаџи - Мурат (рус. Хаджи-Мурат; написано 1896–1904, издано 1912)
```

Figure 16. Display of the primer.txt (eng. example.txt) file in which examples of text documents are written

rezultati.txt

```
1   Данас је уторак!    1
2   Da li je oblačno?   1
3   Kako ste?   1
4   provala 3
5   Sutra je subota!    1
6   Сунчано време?  0
7   Половима децембра;  0
8   Догодила се провала пре пар дана?   3
9   Gledamo film ili seriju?    0
10  Koji grad treba posetiti?   5
11  Београд је главни град. 5
12  Сутра ћемо изаћи у град?!   5
13  Lav Nikolajevič Tolstoj 0
14  Детињство (рус. Детство; 1852)  4
15  Дечаштво (рус. Отрочество; 1854)    4
16  Младост (рус. Юность; 1856) 4
17  Породична срећа (новела, 1859)  0
18  Козаци (рус. Казаки; 1863)  4
19  Рат и мир (рус. Война и мир; 1865–1869) 4
20  Ана Карењина (рус. Анна Каренина; 1875–77)  4
21  Смрт Ивана Илича (рус. Смерть Ивана Ильича; 1887)   0
22  Кројцерова соната (рус. Крейцерова соната; 1889)    2
23  Васкрсење (рус. Воскресение; 1899)  4
24  Хаџи - Мурат (рус. Хаджи-Мурат; написано 1896–1904, издано 1912)    4
```

Figure 16. Display of the obtained file results.txt in which the clustering results are located

X. CONCLUSION

Many methods of cluster analysis have been developed and numerous researches have shown that there is no best method, but it exclusively depends on what we want to get, that is, to 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, so that the appropriate model can be applied. Finally, what has not been mentioned so far is that it is important to know how to interpret the results of cluster analysis and thus sufficiently know the theoretical background of the research so that the results can be used to find new knowledge.

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Students' Networking with Industry Foster Successful IT Curriculum Completion

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Abstract - The goal of each IT Curriculum is to enable a successful student to get a good job and have a great career. Nevertheless, it is not always easy to keep up with progress in the fast-changing IT world. Therefore, higher education institutions introduced competitions for students in cooperation with IT companies for the overall benefit. In this way, academia keeps up in touch with the novelties and has direct input for curriculum development. IT companies collect talent at the source, and students can experience real-world challenges, meet potential employers, and win prizes. In this paper, the authors focus on academia-organized competitions for IT students, explore the world of hackathons, and present some data on the local competition organized at the Faculty of Information Technologies, FIT, in Mostar, Bosnia and Herzegovina.

I. INTRODUCTION

There is a high demand for software developers worldwide, so there is a high demand for the study programs that educate them. Nevertheless, it is not easy to find the balance between the study programs' academic demands and the skills that the ever-changing IT labor market currently prefers. Higher education institutions (HEIs) are typically striving to provide lifelong education or, more precisely, "to produce" people skilled in one area that can adapt and adopt innovations in their area of expertise. In the context of software development, that would mean educating software developers that can fulfill the current labor market's demands and remain good software developers in the future unknown labor market. The existing software developers partially create the future market, so the responsibility of HEIs is huge. Since IT is one of the fastest-growing and fastest-changing sectors, HEIs must be good at predicting the changes, or at least the directions.

In the standard regional nomenclature, IT belongs either to technical sciences or mathematics, but in the ISCED 2013 document [1], Information and Communication Technologies (ICTs) stand for themselves as the area 06. Additionally, the regional tradition pushes HEIs to include their parent area subjects into the IT curriculum, i.e., the faculty of electrical engineering will add a lot of core electrical engineering courses, whether it is or it is not clear how they contribute to the educational goals. That can result in good software developers, but to potential IT students, it does not have to be clear why they need that much electrical engineering to become software developers. On the other hand, the most sought-after soft skill these days is problem-solving. In higher education, it is common to refer to engineers as problem solvers, so it naturally follows that any engineering education will produce good problem solvers. If we relate this skill to mathematics, mathematicians must always solve problems, but too much mathematics can be even more demotivating for future students than too much engineering.

Hackathons are nowadays a very popular way to rapidly develop software solutions to given problems in a typically very short time frame. In addition, they provide their organizer a much-needed prestige if successfully organized. At the same time, they foster direct potential employees to the potential employer or potential business angel networking. As such, they have the potential to help higher education institutions successfully supplement their curriculum with students' exposure to what awaits them in the labor market.

One good local example of future employee and future employer networking is FIT-CC, an annual competition organized at the Faculty of Information Technologies (FIT), University "Džemal Bijedić" of Mostar in Bosnia and Herzegovina. FIT has existed for 25 years and is widely recognized in the IT sector for its alumni, affiliates, and students (FITAAS). FIT curricula were always a mix of engineering principles and software development best practices and have always produced highly employable graduates resulting in feedback that FIT attracts hardworking and innovative freshmen who want to earn qualifications for well-paid jobs. In the B&H IT sector, FIT has alumni, affiliates, or students in every privately owned company.

Recognizing the need to motivate students to present themselves to IT companies, FIT started a coding challenge (FITCC) 15 years ago,

connecting students and IT companies with typically 15-20 IT companies as sponsors, 200 competitors, and 400 student visitors per year. The main goal of FIT-CC is to capitalize on the trust and understanding that FITAAS have with the FIT and increase the visibility of students' innovativity and the impact it can have on B&H IT sector development. Nevertheless, even if companies see the clear benefit of accessing future employers at the source, students and unemployed affiliates need a lot to explain obvious benefits to themselves. One surprising fact is that it is typical that students recognize the benefits only after the first event they miss.

II. IT CURRICULUM – SOFTWARE DEVELOPMENT AT FIT-MOSTAR

In describing a curriculum for software developers, we start from the goals. In this case, we will show a FIT curriculum innovated in the 2021/22 academic year according to the recommendation from the EU [2]. The goals of this curriculum are to enable students to:

create and develop a software product applicable to the global market while fulfilling user requirements,

adopt fundamental knowledge in programming, data management, software modeling, and software development,

adopt and implement methods, techniques, and tools for software product development,

integrate IT knowledge and skills in solving complex real-life problems while working in an IT company, and

show creativity and innovativity while working individually or in a team, grow personally and professionally, to apply social and professional ethics to promote entrepreneurship and employability.

In the EQUANIE Euro-Inf Framework Standards and Accreditation Criteria for Informatics Programmes (New Programme Outcomes, as of 12.10.2015) [3], knowledge skills and competences fall into one of the following groups: Underlying Conceptual Basis for Informatics; Analysis; Design and Implementation; Economic, Legal, Social, Ethical and Environmental context; Informatics Practice and Other Professional Competences. In Figure 1, the authors illustrate the approach to IT curriculum development.

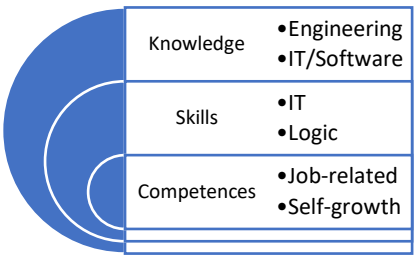

Figure 1: Elements of IT curriculum development

The approach illustrated in Figure 1 misses one crucial detail which became obligatory ages ago in IT curricula: IT students need practice through practical placement in IT companies. In order to fulfill such a requirement, HEIs need to have extremely good ties with IT companies from the area their students come from or from their location, as shown in Figure 2. Furthermore, HEIs need to have a good reputation, and it helps to have a strong alumni or affiliates association. Feedback from the companies helps HEI update the curriculum regularly and remain attractive to potential students. It follows that, to successfully implement IT curriculum, HEI's need not only to take into account the cooperation with IT companies but to foster a strong network and maintain it for the benefit of all.

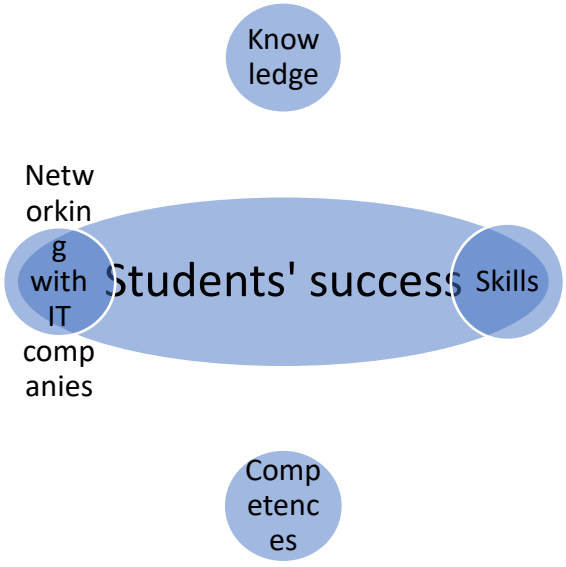

Figure 2: IT curriculum implementation

III. HACKATHONS

Hackathon is an ever more popular global instrument for rapid solution development for a broad spectrum of problems. The first hackathon [4] took place in June 1999, when OpenBSD broadcasted a worldwide call to hackers; they responded, and in a week in Calgary, Canada, they offered a solution for the integration of IPv6 and IPSEC stacks into the operating system. Since

then, hackathons have gained popularity and the term today refers to a short (typically a weekend or shorter) organized event where hackers and industry representatives gather to offer digital solutions to specific problems (or a company gathers their employers to solve something rapidly) [5]. The usual outcome is that the best solutions end up as software products. Authors Moe et al. [6] suggest a grouping of organizational and implementation activities as follows:

Definition of goal and structure, organization of physical and technical infrastructure, opening call for participation, and presentation of the hackathon to participants.

The opening ceremony, design and development / technical monitoring, and closing ceremony.

Evaluation of participants' satisfaction and evolution of developed solutions.

The most famous global hackathons are [7]:

HackMIT by Massachusetts Institute of Technology, since 2014, top sponsors: Microsoft, Facebook, IBM, a yearly event during a weekend with typically 1000 participants.

HackZurich by Jonathan Isenring, Ramsus Rothe, Setareh Gharibi, since 2014, top sponsors: Microsoft, Migros, Zurich Insurance, Huawei, randstad, optive, a yearly event during 40 hours with typically 600 participants (from 55000 applicants from 85 countries).

NASA International Space Apps Challenge by NASA, since 2012, top sponsors: Australian/Brazilian/Canadian/European Space Agency, Japan Aerospace Exploration Agency, National Space Activities Commission of Argentina, National Space Science Agency of Bahrain, Paraguayan Space Agency, and South African National Space, during 48 hours with 28000 participants from 162 countries/territories in 2021 and over 2500 projects in 28 challenges.

Mhacks by the University of Michigan, since 2013, top sponsors: Google, Walmart, bi-annual during 36 hours, organized by students.

PennApps by the University of Pennsylvania, since 2009, top sponsors: Bloomberg, Filecoin, HRT, ACV, Citadel, annual during a weekend in September.

Hack The North by University of Waterloo, since 2014, top sponsors: Hootsuite, Loblaw Digital, Cockroach Labs, Facebook, Deloitte, annual during 36 hours with typically 3000 best students worldwide.

LAHacks by the University of California, since 2013, top sponsors: Oracle, Google, Captial One.

Systematization of information on the world's most popular hackathons leads to some key characteristics that can be summarized as follows:

Each hackathon must be centered around an interesting problem that will attract a huge number of participants; the definition of the problem must be precise to be solvable in a given time.

Since prizes are not huge, a list of sponsors must be exhaustive to offer an exciting problem, attract participants, and provide future employees with future employer networking.

Even if the hackathon is a short-lasting event, the organization must be long-lasting with committed organizers.

A maximal awards fund is typically not large enough to attract participants. Still, it has to be clear that participation is direct marketing of innovativity, commitment, and any other soft skill to the sponsors, and so direct networking with the labor market.

The clear advantage of hackathons is in the rapid development of innovative solutions to given problems, even if a hackathon is organized within a company as a pandan to brainstorming. However, as shown earlier, each successful hackathon has a strong future employee-to-future employer networking component. Furthermore, since hackathons offer innovative digital solutions to any given problem, they can result in software products and start-ups that strengthen the digitalization of any society. Additionally, the organization of a successful hackathon is a matter of prestige for the organizer and serves as an added value to any educational or other institution. Nevertheless, suppose organizers fail to attract participants or sponsors or fail to provide a tailored problem, or fail to provide clear information on benefits or adequate guidance. In that case, any such hackathon is doomed to fail too.

IV. LOCAL EXAMPLE OF GOOD PRACTICE – FIT CC

FIT-CC lasts for two days at the end of lectures (the last week of May or the first week of June), and it consists of the competition in four categories, namely, coding, game development, ethical hacking and innovations and smart living, jobs fair, presentations for students and barbecue. Since the organization typically lasts for six months, it is the only promotional event that FIT organizes, and organizers aim to market the

enrolled students and the benefits of studying at FIT.

Even if FIT-CC is not a hackathon by its nature, it does have the same benefits:

The list of sponsors consists of some of the most desirable IT companies in Bosnia and Herzegovina so that competitors can show off their potential directly to their target companies. At the same time, participants can learn from the presentations and benefit from the job fair.

The solutions in game development and innovations and smart living categories have the potential to become software products. The developers have an immediate chance to provide support for starting their own business or joining an existing company and becoming product owners.

FIT benefits from a media-supported event are promoting the following: competition itself, FITAAS, networking with the country's IT companies, and implicitly the FIT curriculum itself.

V. CONCLUSIONS

Students' networking with IT companies fosters successful IT curriculum completion, at least for students involved in such networking. It is less obvious how the students who are not involved in the networking per se can benefit from it, but one of the benefits for them can arise from observing the examples of good practice and starting to participate in networking themselves. The tricky part for the HEI's is how to motivate freshmen to become more active in networking, or how to present to them all the obvious benefits. This can influence at least two important points namely students' motivation to pursue the degree, and their understanding of the possible career paths. Nevertheless, networking comes with a price, especially for the HEI's in the developing countries, who can not commit their staff to work with the IT companies on joint projects for the mutual benefit and have to devote precious resources.

As the authors discussed, the most popular global networking tools are hackathons. As the organization of a successful hackathon is time and resources consuming, any promotional event such as a competition combined with jobs fair that can attract a huge percent of unemployed students can serve the purpose of fostering networking with IT companies. The success of FIT-CC, and its addition to success in curriculum completion for FIT students is one good example of how HEI's can foster networking with IT companies for the benefit of students who can hear from their future employers what knowledge and skills they need to develop to have their desired career.

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Introducing the R Programming Language in University Teaching

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Abstract - R is a programming language for statistical calculations and data analysis with possibilities for data visualization. This research presents the programming language R basic characteristics, advantages, disadvantages, development, origin, areas of application. The central part of the paper includes a presentation of study programs that teaches the R language in the world and in neighboring countries. At the end, the content of the new study program that handles R at the Technical faculty in Zrenjanin is given.

I. INTRODUCTION

R is a programming language which is primarily intended for statistical calculations, data analysis, and graphical representation of data values, data visualization and it can be used for creating various reports [1]. This language is increasingly used nowadays, not only in its primary field for which it is written for.

Due to the growing use of this language, especially in the areas of data analysis, large databases, business systems, and big data, a new course at the master's level of study was introduced at the faculty in Zrenjanin, which teaches students this increasingly popular programming language.

The rest of the paper is divided into the following parts: section 2 provides basic information about the programming language R, section 3 shows at which foreign universities the R language is studied with its characteristics, section 4 is the main part of the paper that show features of the R language application at the Technical faculty "Mihajlo Pupin", and finally section 5 gives a brief conclusion of the paper.

II. PROGRAMMING LANGUAGE R BASIC CHARACTERISTICS

Programming language R is a free and open source programming language and an environment that is available for use by various operating systems. It is flexible for use in the field of statistics. R is such a language that it can be said to be unmatched by any other statistical program. The programming language is object-oriented and allows users to write functions and procedures that can be adapted at runtime. The automation of tasks is also supported. [2][3]

The programming language R first appeared in 1993 thanks to the authors Robert Gentleman and Ross Ihaka from the University of Auckland in New Zealand. According to the initials of their first names, this programming language was named very shortly R. The first version of R language came out in 1995, while a stable and usable version can be said to have appeared in 2000. [4][5]

R is a dynamic programming language which is not very convenient for scientists and experts to use. However, the language has become very popular at the last ten years. With millions of lines of code available through repositories on the Internet, researchers and developers have the opportunity to use a combination of static and dynamic program elements and libraries for various analyzes and tasks. [6]

R is based on a vector data structure that handles data and from which other more complex structures can be created. This language is actively developed today in many areas. One of its key strengths is the ability is that programmers can add functionality to the core feature set through the system of packages. The R system uses and programmers can load or install many packages covering a wide variety of modern statistical methods. [1]

Advantages of R language are [2]:

- R tool is available for anyone in the world for use because it is a fee software and can be run anywhere.
- It can import tools from many other software. It produces graphics in pdf, jpg, png and svg formats.
- R has more than 5000 packages which are available from repositories.

- There are active user groups where any question that is been put up is responded within a short span of time.

Disadvantages of R language are [2]:

- R memory management almost utilizes all the disk space.
- R is best suited for people with problems oriented to data.
- It cannot be used as a backend server for calculations.
- It is less secure than other programming languages.

An example of R program execution with statistical functions and calculations in the R GUI is shown in Figure 1.

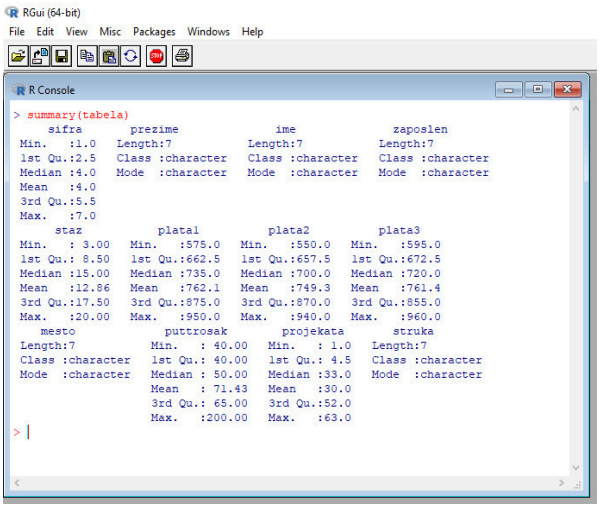

Figure 1. R programming language GUI

III. R LANGUAGE AT FOREIGN UNIVERSITIES

In this section, we will present some experiences from several universities in the world and their introduction, confrontation, and problems during the introduction of the R language in teaching.

Auker and Barthelmess discuss in [7] their experiences teaching undergraduates R in two advanced ecology classes at department of Biology, Misericordia University, Dallas, Pennsylvania and Department of Biology, St. Lawrence University, Canton, New York, USA. They stated that undergraduate ecology students are exposed to data analysis in their coursework, however, proper data management is not often taught in undergraduate ecology courses. Furthermore, authors have both recently begun to use the R programming environment in teaching. First they were examined 154 Ecology papers from 2008 to 2018. In 2008, only 14.3% indicated using R, while in 2018, the software used for analysis was indicated in 82% of all papers, of which 81% used R. Ecology course content: installing and introduction to R and R Studio, learning to plot data using R, introducing basic R script for interspecific competition models, opportunity to test different scenarios, using chi square to examine mutualisms, planning analysis for final project, building R skills with plant cover data, datasets examination of plants impacted by volcanic eruptions and analysis, measuring diversity using different indexes, calculate measurement, students work on R project.

A brief article [8] is an introduction to teaching R, based on authors experience in teaching computational biology graduate students. R is environment for teaching many aspects of computational biology, including functional genomics, statistical genetics, computational neuroscience, dynamical systems, and network biology. Eglen provide resources and suggestions for teaching R and describe difficulties faced by students during learning R. Most students at master's program have not previously seen R. Because of this students often said that R was too difficult to learn, especially on their own. In response to this problem, it was created a set of lectures and lab sessions covering both an introduction to programming in R and a refresher in statistics. Students come from different backgrounds, some with experiences of programming and others without any prior programming experience and it is difficult to know at exactly which level to aim a lecture course. This approach has provided lecture material containing concepts that may not immediately be understood by novice programmers, but will serve as a reference for them later in the year. Instead, the lectures contain advanced material that can challenge students who have programming experience. Students learn a programming language by using the language on problem sets. Lab sessions are arranged on that way that students work through introductory material on R. After becoming familiar with R, we then suggest they work on some problems in computational biology. There are difficulties with learning R, but they are fairly minor compared to the benefits in using such a powerful environment.

Stanford university [9] offers course that covers the basics of R. Reason why they teaches R is because it is widely used by data analysts, statisticians, and data scientists around the world. This course covers an introduction to R, from installation to basic statistical functions. Attenders learn to work with data sets, to write functions.

Topics include: working with data types and variables, vectors, matrices, lists, and data frames, data import, logical statements, data plotting and visualization, introduction to basic statistical functions and packages.

Stanford University [10] offers another course entitled "Introduction to R Programming". This course helps attenders to learn the practical aspects of the R programming language and to apply their theoretical knowledge in practice. R has various packages covering a wide range of topics such as econometrics, finance, and time series. R has best-in-class tools for visualization, reporting, and interactivity, which are as important to business as they are to science. R is well-suited for scientists, engineers, and business professionals. During each session, hands-on exercises will be practiced to: building data frames, applying functions, downloading public data into R, applying manipulation functions on data records, and summarizing insights from data, merging datasets, reshaping datasets, selecting random samples from data-frames, and aggregating columns by other columns, creating different data visualizations and saving them in different formats.

Students in Canada first encounter the R language in the upper years of their undergraduate studies or during their graduate studies. The way R is presented probably has consequences for the fundamental understanding of the program and the language itself. A user's understanding of the R language may be better if learning the language itself followed by conducting analyses, compared to someone learning another subject (e.g. statistics) using R for the first time. Consequently, understanding the approach to R education is critical and important. The survey found that R is used in a wide range of course disciplines outside of statistics (e.g. ecology) and just over half of Canadian universities have at least one course that uses R. It was concluded that the development of programming-literate for students is of the greatest importance and that the teachers, as well as programmers, when developing educational and teaching content, will form educational texts, etc. which will help students to understand the R language. [11]

Higher education commission in Pakistan presented, in curriculum of Statistics [12], a course that uses programming language R. Attenders use different statistical software and packages for application of survival techniques. Course contents are different statistical methods, models, risk factors etc. with use of statistical packages and R programming for analysis.

Description of the subject Basics of the R programming language [13) at the University of Zagreb in Croatia, at the Faculty of Electrical Engineering and Computing - The goal of the course is to train the student to use the R programming language, which by its nature is a cross between classical programming languages such as Python, Java or C++ and statistical tools such as SAS or SPSS. Since R has established itself today as one of the leading analytical programming languages with which, with the help of accompanying packages, complex analyzes of data sets can be carried out in a very efficient manner and reports accompanied by complex visualizations and calculations can be created. Mastering the R language requires a specific combination of programming skills, knowledge of the basics of statistics, but also a certain creativity and readiness for challenges. Learning outcomes refer to: analyzing smaller and larger data sets in a meaningful and organized way, recognizing the nature of data and approaching their processing, using an interactive programming approach to data analysis, modifying raw data into a form suitable for analysis, preparing more complex programming scripts and packages in the programming language R, application of the machine learning method in the programming environment, application of the reporting methodology. Program exercises contain analysis of data sets and reports preparation, solving electronic workbooks in the R Studio tool.

IV. R LANGUAGE AT SERBIAN UNIVERSITIES

The following information are about learning the R language at universities in Serbia

R is studied at the University of Kragujevac, at the Faculty of Technical Sciences in Čačak, in Serbia [14]. The content of the book "Introduction to Programming Language R" is: Installing R Studio, writing programs in the console, variables, data types, vectors, numbers, lists, matrices, strings, factors, tables, functions, operators, conditional structures, cycles, statistical functions, working with files and directories.

The subject "Data Science in R" is studied at the Metropolitan University in Belgrade. This course aims to provide students with a technical foundation for working with data in the R language and supporting applications and modules that are commonly used, such as R Studio. The subject is not intended to understand the theoretical foundations of the programming language, nor to understand the statistical methods used when working with large data sets. The course is designed to equip students with the basics of

programming and data visualization, in order to be able to start using the aforementioned work tools after successfully completing the course. [15]

At the Faculty of Sciences that belongs to the University of Novi Sad, the programming language R is used and studied within two subjects at Applied Mathematics three year studies with modules: Data Analytics and Statistics, Mathematics of Finance, Techno-mathematic. These subjects are: Software packages for data analysis and Statistics. The goal of the course Software packages for data analysis is to introduce students to existing software packages for statistics, data analytics, data visualization, analysis, etc. The outcome of the course is the acquisition of operational knowledge and experience in the application of various software packages for statistics on real data. The course covers a wide range of software packages and libraries, including packages in R and other available software. Students create mini-projects in different software packages and on different sets of real data. The goal of the course Statistics is to familiarize students with the basic concepts of statistics, parameter estimation and statistical tests, as well as the broad possibilities of its application in practice. Course outcome - students are expected to master the basic concepts of mathematical statistics and be able to solve practical problems economic and scientific problems using statistical software. Practical teaching consists of tasks and problems in practical teaching that follow the content of theoretical teaching. Practical examples and implementation of solutions in statistical software are done. [16]

V. R LANGUAGE AT TECHNICAL FACULTY "MIHAJLO PUPIN"

The R language has been studied at the Technical Faculty in Zrenjanin since a year ago as part of our subject entitled "Programming languages for application in business systems". This course, as an elective, can be taken by students on accredited master's studies in the field of information technologies.

The main goal of the course is to acquire knowledge necessary for the application of programming languages in business systems, familiarization with the programming language, and application of the R programming language in business systems, the fields of finance, statistics and science.

The outcomes of education and acquired knowledge that are expected after completing the course are: the ability of students to design and write programs in the R programming language, as well as for independent work, and the acquisition of practical experience for the application of programming languages in various business systems.

The theoretical content of the course includes:

- Overview and history of the programming language R.
- Basic program elements, syntax, data structures.
- Work with input and output data, data formats.
- User interface.
- Objects in the R programming language. Control and program structures, functions.
- Standards in writing programs.
- Program execution.
- Simulations, probability, optimization and execution of various scientific methods in the R programming language.
- Examples of the application of the R programming language in business systems, the fields of finance, statistics and science.

Practical teaching consists of:

- Exercises are performed in the computer laboratory and include designing and writing programs in the R programming language.
- Creation of student projects and seminar papers on specific examples from the fields of business, science, and statistics.

VI. CONCLUSION

From this study it can be concluded that the R programming language is one of the most used languages today and is one of the leading in the fields of data science, data analysis and statistics. Because of this, it has become an integral part of study programs at various universities in the world, and at the Technical faculty in Zrenjanin, it has been recently introduced into the study programs offered to students.

There are difficulties with learning R worldwide, but they are fairly minor compared to the benefits in using such a powerful environment.

At this moment, it is too early to make conclusions about the quality of our study program and its maintenance, adequacy, adaptability to students, etc. We hope that it will be well accepted, that it is an appropriate in terms of content and structure of similar programs in the world.

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Assessment Report and Functional Qualitative Analysis of the Current Condition Regarding the Qualification Standard: Teacher in Higher Education in Republic of North Macedonia

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Abstract - The role of a higher education teacher is just one of the dimensions and attributes of the academic profession. Anyone with the necessary qualifications, engaged in the academic world is expected to possess a pool of professional academic roles through the whole career, such as teacher, researcher, manager, contributor etc. We have worked on a development of a Standard of qualification: Teacher in higher education within the international Erasmus + project, where one of the activities was evaluation of the current condition with the proposed key qualifications for the teachers in higher education and their expectations in the future, using mathematical modeling techniques. This resulted in a determination of the current qualitative levels regarding different categories of teachers, in terms of the specific qualifications of the teacher, called key job tasks, provided within the Standard.

I. INTRODUCTION

The teacher qualification standard in higher education is directly related to the:

Needs of the labor market. The qualification: Teacher in higher education primarily refers to the acquisition of knowledge, skills and attitudes for the realization of teaching activities in higher education institutions. The qualifications standard includes the competencies that teachers in higher education have acquired during their formal education (undergraduate level, master's level and doctoral level), includes the experiences gained during their classes/teaching in higher education and also the competencies that the teacher in higher education should acquire and upgrade during lifelong learning process and through various forms of professional development. All of the above mentioned strongly improves the qualities of the teacher in higher education and develops competencies that make the same teacher more competitive on the labor market. It is expected that the labor market in our country will establish conditions and criteria for advancement that each of the teachers will identify with.

Continuation of education. The teacher qualification standard in higher education is inextricably connected and conditioned by the informal learning and professional development of teachers. Each of them needs to continue their education in order to maintain and develop the quality of their knowledge, skills and attitudes.

The needs of the individual and/or society. The qualification teacher in higher education is related to the need of the individual to acquire personal competencies to improve his knowledge, skills and attitudes for successful and high-quality realization of work tasks arising from the profession itself. Achieving the standards of qualifications leads to self-actualization, satisfaction of the teacher's internal motives, but also recognition and validation of the desires, affinities and achievements of teachers by the institutions in the system.

II. KEY JOB TASKS OF THE STANDARD AND METHODS USED FOR EVALUATION

Based on the implementation document of the Qualification Standard: Teachers in higher education in Republic of North Macedonia, 10 different key job tasks regarding the qualification and related competencies were evaluated in order

to determine parameters describing the current condition about their fulfillment between the teachers, each containing specific number of different areas of competences and learning outcomes in each of them:

- Has knowledge in the scientific field;
- Realizes scientific and professional research and their application in the teaching process;
- Realizes and supports teaching, learning and studying;
- Values students;
- Mentors students;
- Applies new technologies in teaching, learning and studying;
- Communicates and cooperates with all participants in the teaching process;
- Permanently and life-long improves professionally and collaboratively;
- Acts entrepreneurial, and
- Practices and creates media and critical literacy.

A. *Surveys*

Towards collecting the necessary data to be processed through the proposed model for evaluation of the current and expected condition related to the 10 key job tasks of the qualification teacher in higher education, complex survey was conducted among the teachers in higher education in Republic of North Macedonia during the period 15.2.2022 – 5.3.2022, targeting different universities, titles, types of financing of the institution and scientific field of the title acquired:

- Surveys answers: 160
- Universities targeted: 8
- Different titles targeted: 8 (Full professor, Associate professor, Assistant professor, Senior lecturer, Lecturer, Senior lector, Professor of a Higher Vocational School, Assistant doctoral student)
- Different scientific fields targeted: 6 (Natural and mathematical sciences, Technical-technological sciences, Medical Sciences and Health, Biotechnical Sciences, Social Sciences and Humanities).

For evaluating the current qualitative level of possession of each learning outcome (key job task) which are questions in group Q1, their current practicing, realization and application, following levels were used:

TABLE I. ASSESSMENT LEVELS OF THE CURRENT CONDITION OF POSSESSION OF THE KEY JOB TASKS RELATED TO THE QUALIFICATION STANDARD

Evaluation level: Type 1	**Evaluation level: Type 2**	**Number**
Almost never	Completely disagree	1
Rarely	Closer to NO	2
Often	Closer to YES	3
Almost always	Completely agree	4
Do not have an opinion		0

For evaluating the level of need for improvement regarding the key job tasks which are questions in group Q2, following levels were used:

TABLE II. ASSESSMENT LEVELS OF THE NEED FOR IMPROVEMENT OF THE KEY JOB TASKS CURRENT CONDITION

Evaluation level	**Number**
Not necessary	1
Have an insignificant need	2
Have an exceptional need and necessity	3
Have a significant need	4

For evaluating the level of readiness of the teacher to contribute as an educator, which are questions in group Q3, following levels were used:

TABLE III. ASSESSMENT LEVELS OF THE READINESS FOR CONTRIBUTION IN THE IMPROVEMENT PROCESS

Evaluation level	**Number**
Would not make any contribution	1
Would make a small contribution	2
Would make a significant contribution	3
Would make an outstanding contribution	4

B. *Mathematical modeling technicues and evaluation model*

Two optimization techniques were used to build the evaluation model:

- AHP – Analytic Hierarchy Process, and
- DEA – Data Envelopment Analysis.

AHP enables creation of listing (depend on the criteria) showing (in this application of AHP) the most present key job task among the HE teachers (with best evaluation levels), with the importance of the criteria included and bias excluded.

DEA enables generation of final QA report, pointing to the relatively efficient and inefficient titles in HE depending on the level of presence of the key job task, related to the resources invested in gaining those key job tasks.
The proposed model is shown on the figure.

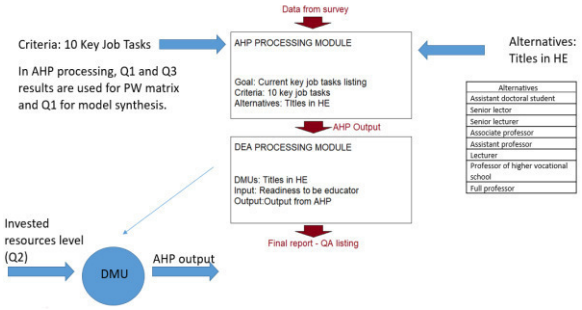

Figure 1. Evaluation AHP+DEA model

The criteria that are used in AHP are represented with the 10 key job tasks. Units that are used as alternatives in AHP, and in the same tame are Decision Making Units (DMUs) in DEA are the 8 different titles that are targeted with the model. The processing of the data via AHP is done using Super Decisions software. The processing of the data via DEA is done using OSDEA software.

III. RESULTS AND DISCUSSION

The result from the surveys Q1, Q2 and Q3 is shown as an average indexes assessed by the targeted teachers from all categories mentioned above, shown in the following table.

TABLE IV. ASSESSMENT LEVELS OF THE READINESS FOR CONTRIBUTION IN THE IMPROVEMENT PROCESS

Criterion	**Key job task**	**Average level / Current condition (Q1)**	**Need for improvement (Q2)**	**Readiness to be educator (Q3)**
1	Has knowledge in the scientific field	3,22609	2,5652	3,4222
2	Realizes scientific and professional research and their application in the teaching process	3,20838	2,6666	2,8863
3	Realizes and supports teaching, learning and studying	3,5996	2,2666	3,4418
4	Values students	3,7413	2,3333	3,2727
5	Mentors students	3,8063	2,1555	3,409
6	Applies new technologies in teaching, learning and studying	3,6776	2,6666	3,1363
7	Communicates and cooperates with all participants in the teaching process	3,7938	2,5277	3,2045
8	Permanently and life-long improves professionally and collaboratively	3,6746	2,3778	3,25
9	Acts entrepreneurial	3,3923	2,4666	2,7045
10	Practices and creates media and critical literacy	3,6083	2,5555	2,8604

Based on the results in table IV:

- Related to Q1, highest score belongs to the key job task **Mentors students**, and the lowest score belongs to the key job task **Realizes scientific and professional research and their application in the teaching process**. This means that most effort by the teachers is invested into mentoring students, working individually and in small groups, which can be evaluated as pretty good. On the other hand, teachers are aware about their weak involvement into research activities and their implementation into the teaching materials.
- Related to Q2, highest score in the context of determination what is the weakest spot that needs most improvement, **Applies new technologies in teaching, learning and studying** is detected as an issue that needs most resources involved in the future (use of computers, tablets, smartboards etc.). **Mentors students** has the lowest score, which completely matches with the results from Q1.
- Related to Q3, key job task **Realizes and supports teaching, learning and studying** has the highest score. This means that regarding the readiness to help and be included in the conduction of the teaching process, teachers evaluated themselves with a highest grade. On the other hand, lowest score refers to the key job task **Act entrepreneurial**. This means that the teachers needs education and training on how to improve their entrepreneurial skills (teamwork, leadership, communication, customer service, financial skills, analytical and problem-solving skills etc.) in order to be able to transfer them to the students via the teaching process.

When processed via AHP model, priorities of the 10 criteria are generated. Results are shown on the next figure.

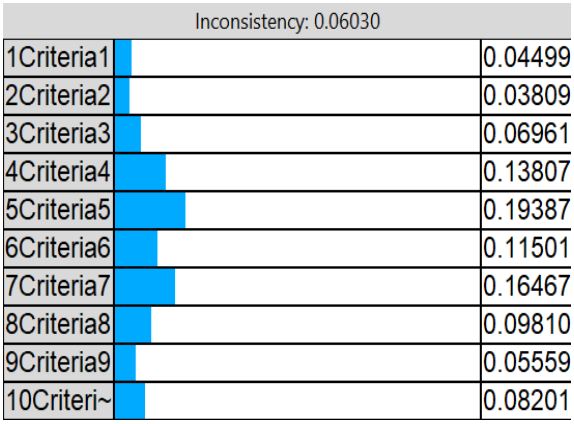

Figure 2. Priorities of the key job tasks

Based on the results, highest priority goes to Criteria 5, which is key job task **Mentors students**. According to the teachers, this is most important key job task a teacher should possess. On the other hand, lowest priority refers to Criteria 2, which is key job task **Realizes scientific and professional research and their application in the teaching process**. This means that these results about the importance of the key job tasks based on the teachers' perception are close to the level of the resources that teachers invested during their professional life into improvement their teaching capabilities (Best/Highest in mentoring their students and Worst/Lowest in expansion of their research activities towards implementation of new content and/or practical activities in their teaching). The index of incostistency is:

$$R.I. = 0.06030 \quad (1)$$

which means that the level of inconsistency of the judgements of the teachers is 6.03% and is bellow the highest possible rate of inconsistency that is 10%, so the results are acceptable and can be used for further processing. Bearing this in mind, with the complete processing of the data through the AHP model, the following results are generated:

TABLE V. AHP RESULTS

Name	Ideals	Normals
Senior Lecturer	1	0.136864
Associate Professor	0.951581	0.130237
Full Professor	0.930628	0.127369
Assistant Professor	0.92737	0.126923
Professor of HVS	0.924684	0.126556
Assistant Doctoral Student	0.904968	0.123857
Senior Lector	0.846694	0.115882
Lecturer	0.820608	0.112312

Based on the results, highest score in this environment of importance of the 10 key job tasks processed via AHP is achieved from the teachers with title Senior lecturer. Lowest score is achieved from the teachers with title Lecturer.

The processing of the data via DEA, based on the answers about resources invested in achieving the key job tasks / inverted index of the need to be educated towards achieving these key job tasks is shown in the following table (output index is the output of the AHP model):

TABLE VI. DEA MODEL

Evaluation Level	Input Resources Index	Name (DMU)	Output
3,6	1,4	3SeniorLecturer	1
NoData	NoData	6Lecturer	0.820608
NoData	NoData	2SeniorLector	0.846694
1,8	3,2	1AssistantDoctoralStudent	0.904968
1,9	3,1	7ProfessorofHVS	0.924684
2,78	2,22	5AssistantProfessor	0.927370
2,6285	2,3715	8FullProfessor	0.930628
2,1214	2,8786	4AssociateProfessor	0.951581
	DEA Model (1 input, 1 output)		

With processing the data with output oriented VRS DEA model, the results obtained are shown bellow:

TABLE VII. FINAL DEA (EVALUATION) RESULTS WITH THE MOST AND LEAST EFFICIENT TITLES OF TEACHERS

DMU Name	Objective Value	Efficient
3SeniorLecturer	1	Yes
4AssociateProfessor	0,951581	
8FullProfessor	0,930628	
5AssistantProfessor	0,92737	
7ProfessorOfHSV	0,924684	
1AssisstantDoctoralStudent	0,904968	

This QA analysis positions the title Senior Lecturer as relatively most efficient category in this moment, regarding the current investment of resources in obtaining the Key Job Tasks (10 criteria) and their current possession and importance. On the other side, title Assistant Doctoral Student needs biggest changes towards improvement of these skills. Nevertheless the results point out relatively close final scores, improvements are possible. With further DEA mathematics, precise percents of the improvement

that needs to be done related to specific key job tasks can be calculated.

IV. CONCLUSION

The proposed model is designed in accordance to the Qualification standard: Teacher in higher education in Republic of North Macedonia. With networking the key job tasks that define this standard and their assessment from the teachers, reports can be generated giving precise information about their importance and present fulfillment related to different titles and/or scientific fields. We can agree that this kind of a model would require massive surveys to be conducted towards obtaining better picture of the current condition with the teachers' skills and capabilities. The model can be used as a mechanism for qualitative evaluation periodically or promptly, depending on the needs. These results can be compared to other countries and for sure used to create strategies and make further planning of additional training and education of certain titles / groups of teachers in higher education towards improvement of their weak skills and competencies through a life-long learning process, because of the dynamic world we live in.

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Education and Training of Employees as Influencing Factors on Business Performance

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Abstract – Modern enterprises are aware that their success largely depends on the competencies possessed by their workforce. For this reason, when selecting employees, they choose those who are highly educated or to the greatest extent qualified for the position they are applying for, but also ready to further study and improve their skills. Similarly, resources are allocated for training and development of employees, in order to remain competitive on the market and achieve the best possible business results. This paper analyzes the importance of employee knowledge and training, the importance of employee training and development, which enterprises organize for their employees and their impact on the organization's business performance.

I. INTRODUCTION

Competition on the global market is intensifying every year. In order to survive in such a world, organizations must adapt to such circumstances and change faster than their competition [1]. This means that the organization must be proactive, anticipate events and readily adapt to them. Investing in education, training and development of employees is cited as the most profitable solutions for business performance improvement [2].

Employees must see their education as a chance for advancement, higher earnings, job security, more respect, while enterprises must see employee education as a means to achieve better business performance [3]. Therefore, it is of great importance for enterprises to motivate their employees to create, acquire, transform, and apply acquired knowledge, in order to most successfully cope with the competition [4, 5].

Employee training is one of the most important tools, which help to ensure the stability of the enterprise, but also to improve business performance. It represents the process by which employees' skills and abilities are improved, in order to perform their work tasks more effectively and efficiently [6]. Training can affect HR results, such as: improved job satisfaction, improved motivation, improved productivity, reduction of errors, etc. [7].
It is very important for an organization to make additional efforts and invest in employee training, if it wants to achieve its goals in the most economical way [8].

Employee education and training have become a key organizational resource for solving complex business challenges, and enterprises are ready to increase their investments in such programs, despite difficult economic conditions [9]. Education leads to changes in knowledge, and training leads to changes in the skills of employees. Education and training of employees are important, because they achieve personal development, develop their own potential, knowledge, skills, interests, personal satisfaction and ultimately improve business performance [7].

II. KNOWLEDGE AND EDUCATION OF EMPLOYEES

One of the most important business resource is knowledge. Knowledge creates money in different ways such as ensuring the production of the best products, good marketing, good design, etc. and ultimately satisfied customers [10]. Knowledge includes strategy, practice, methods, approaches, wisdom that people have acquired during their education, but also life in general [11]. For this reason, the organization's human resources management, when selecting employees, chooses those with higher education, but also invests in additional improvement of the knowledge of its employees.

The concept of education development at the level of the entire society is one of the key factors on the basis of which the competitiveness, degree of development, value of human capital of organizations, but also of a country as a whole is assessed. Therefore, defining the national education strategy is one of the prerequisites for achieving competitiveness in the knowledge-based economy [12, 13]. Given that people spend most of their lives in organizations, after formal education, which is the task of the state, the responsibility of employee development is assumed by organizations. Therefore, formal

education implies a diploma obtained during schooling. People who are dedicated to their career make sure that they have as much education as possible, both for personal satisfaction and for a better position in the workplace and a higher salary. Business success requires constant learning, improvement, acquisition of new knowledge and experiences. This is where the importance of non-formal education appears. The importance of this type of education is reflected in the fact that an individual develops and improves his competences. This is especially important in the domain of the field in which the individual is employed. Therefore, it can be said that it is the obligation of organizations to provide various courses and seminars for their employees [14].

In order to be competitive, enterprises must be learning organizations. These are organizations that facilitate learning for their members and continuously transform it in accordance with market needs and market dynamics [15]. Organizational learning is a process of continuous action towards learning, as learning is a core value for securing a competitive advantage for any organization and gives the organization the capabilities it needs to stay ahead of the competition. It can be noted that organizational learning represents the main catalyst for long-term survival in the performance of any organization [16, 17].

In order to improve employee performance, organizations must strive for additional education of their employees. The elements of employee education and skill development are [12, 18]:

- Overview of educational needs - defining the framework and goals of a an educational program to overcome the gap between the available and expected knowledge of employees, which is needed to facilitate the development of the organization;
- Determining the goals of education - defining the employee education program, as well as the criteria for evaluating their contribution to the realization of the organizational strategy;
- Creating the structure and curriculum of education - they require that the needs of the enterprise are fully aligned with the goals of the training and education program. Depending on the needs of the organization, special structures and curricula are defined, as well as ways of their implementation and realization;
- The choice of methods and techniques of education - they must be optimized and in-sync with the education curricula, because otherwise they will not ensure the achievement of the desired business goals. An appropriate educational method must result in a higher motivation of employees to improve their work [19];
- Evaluation of educational programs - verification of achieved educational goals, through application in practice.

Overall, employee training and education has to be in accordance with the organizations goals and strategic plans. Through training and learning, the organization can increase its return on investment by creating more potential value fueled by skilled employees.

III. EMPLOYEE TRAINING AND DEVELOPMENT

Training has become a generally accepted phenomenon in organizations. It can be defined as the process and method of designing training content and applying those processes and methods in order to improve the skills and knowledge of employees to perform their tasks effectively [20, 21]. Therefore, training consists of planned efforts by the organization to help employees acquire skills and abilities related to work, with the ultimate goal of doing that work in the best possible way [22]. Employee training is an activity that focuses on increasing and expanding abilities, improving the technical and conceptual skills of employees in order to have the necessary abilities to cope with complex situations and perform work in an efficient and effective manner. The central idea lies in keeping employees current, so that they can continuously perform their roles effectively in the age of rapid technological, scientific, socioeconomic, political changes and globalization. This means that employees must always be up to date with the times and development trends in their discipline, because otherwise they will become redundant or replaceable [23]. Enterprises should apply a systematic approach to training to ensure a positive training outcome. Systemic training approach consists of four stages [24, 25]:

1. Identifying the need for training - a strategic process that includes the identification of the organization’s and the industry's goals, the collection of

competences and the analysis of information, determining the gaps between the current and future conditions [26]. There are three analyzes of training needs identification: organizational analysis, task/job analysis, and personality analysis [22, 27];

2. Training design – the effects and strategies of instruction, who and how to maximize the transfer of training to the trainees. Training design includes training methods, which include a training person (instructor), e-learning, case studies, behavior modeling, role playing [22, 24, 27, 28];
3. Style of conducting the training - once the training is designed, it is moved to its implementation. It is usually first pilot tested or conducted on a trial basis to ensure the most effective implementation of the training [24,25];
4. Training evaluation - represents the final stage of training. It is a means of checking success, i.e. whether employees are effectively doing the job for which they have been trained. The evaluation of training results compares the results after the training with the goals of the manager, the trainer (instructor) who led the training and the participants themselves, with the goals that were set before the training. There are four levels of evaluation: reaction, acquired skills, behavior change, and results, i.e. application in practice [22, 25, 27].

Therefore, effective training programs help employees to progress, as well as to gain full control over their skills and competencies necessary to perform certain tasks, but also to avoid mistakes [29]. Organizations can organize the training of their employees at the workplace or the training can be organized outside the workplace. This depends on the decision of the organization itself, that is, which training method meets its training needs. Preference is usually given to employee training that is carried out at the workplace, because it is more profitable for the organization, saves time, and enables employees to learn in a practical way [6].

IV. The Effect of Improving Employee Knowledge and Skills on Business Performance

It is undeniable that the most profitable investment is in the education and training of employees, where the return of investment is expected very quickly, providing capital and profit [7]. People, as one of the most important potential of an organization, have a decisive role and importance in the production process, they are the bearers of implementing changes, creating additional value, improving business activities, and drivers of innovation and value creation. For an organization education and training represent [6, 30, 31]:

- a source of employee competence - through education and training programs, employees acquire more knowledge and skills, that is, they become more competent to perform their work tasks in the best possible way and with as few errors as possible;
- employee motivation factor - through the organization of various types of education and training, the motivation of employees to perform work tasks increases, because in this way the importance of the work of the senses is emphasized;
- a source of employee productivity - effective employee education and training programs are the basic instrument for the successful achievement of the organization's goals and objectives, which ultimately leads to greater productivity;
- a source of commitment to the organization - the organization of educational programs and training is seen by employees as the organization's commitment to them, so they reciprocate;
- improved employee performance - learning and improving skills through training is a key factor in achieving business goals and influencing organizational performance;
- increased job satisfaction - considering that through the improvement of knowledge and skills they achieve better results, employees are also more satisfied with their jobs;
- a source of employee retention - organizations that invest in improving the knowledge and skills of their employees retain employees as well as customers,

suppliers, shareholders and other interested parties.

The goals of education and training in organizations are directly related to the goals and needs of the development of employees and the organization as a whole. Training and education bring a large number of benefits to the employer.

Investing in employee development results in higher profits, higher productivity, improved effectiveness, improved efficiency and higher employee motivation. The benefits of training and education programs are numerous: increasing morale, self-confidence and motivation of employees; changing production costs, because the number of errors and waste is reduced; the feeling of security increases, which leads to a decrease in fluctuations and absenteeism; the involvement of employees in the change process increases, because by improving their competences, they are more ready for changes; salary increase, advancement opportunities, recognition; the quality of staff improves, and thus the entire organization [32]. All the advantages, that is, the effects that education and training bring can be grouped into: organizational effects, which affect individual and group/team effects, and all of them together give the final/overall effects (Figure 1). It can be concluded that the drivers behind employee education and training programs have intensified in recent years thanks to the rapid pace of knowledge creation, fierce global competition and economic uncertainty. Such global phenomena require modern organizations to rely on the quality of their human capital if they want to remain competitive. Having a high-performing staff that is technically savvy and motivated and uses the latest knowledge has become critical to market success [9].

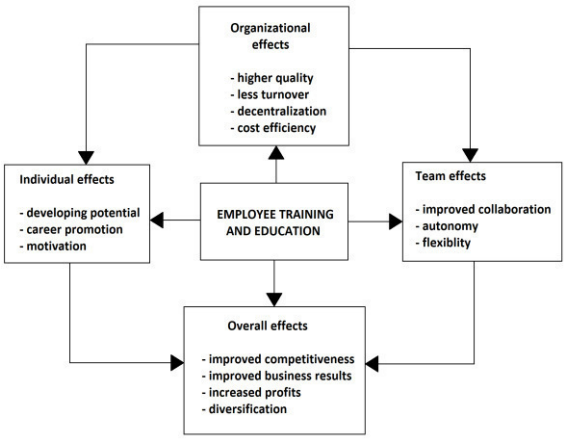

Figure 1. Positive effects of training and education of employees

V. CONCLUSION

Employees are one of the most valuable resource that an organization can possess. Therefore, investing in their development is vital for the business result. When recruiting and selecting employees, organizations go through long-term processes, and what they take care of is certainly employee education. They tend to hire those who are the most competent and have the highest level of education for that job position. However, it should not stop there. The task of every organization, but also of every individual, is to develop the competencies of employees. This is done through the organization of various types of knowledge improvement (courses, seminars) and training. The main advantage of developing the knowledge and skills of employees is the creation of a more efficient and competitive workforce, which will be able to respond to current market demands, especially when changes on the market are dynamic and constant.

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Educational Robotics in Technological Education

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Abstract - Integrating robots as a technological learning tool helps prepare students for the future.Educational robotics provides students with the opportunity tolearn how technology works, apply the skills and knowledge learned in math, physics and technology and entrepreneurship classes in a meaningful and exciting way. It provides an opportunity to find new ways of working together to promote collaboration skills, express yourself using the technological tool, solve problems and think critically and innovatively. The article examines the possibilities provided by educational robotics for the formation of STEM skills in the process of technological education. Robot kits are presented that can be used in the different stages of training. Methodical guidelines for the construction and modeling of educational works are also presented.

I. INTRODUCTION

Educational robotics is a discipline that is designed to introduce students to robotics and programming. It provides students with everything they need to easily build and program a robot capable of performing various tasks. Educational robotics is part of the field of robotics we call social robotics.Social robotics is growing in human society, developing a significant presence in our daily lives. We are gradually incorporating robots into human social life [1]. Educational robotics is included in STEM (Science, Technology, Engineering and Mathematics) education, a teaching model designed to teach science, engineering, technology, mathematics, and how practice takes precedence over theory.Educational robotics is an effective learning tool forproject-based learning where STEM, coding, computer thinking and engineering skills are all integrated in one project. Robotics provides opportunities for students to explore how technology works in real life, all with one tool through the act of making.[2].Educational use of robotics for school-aged children has been around for more than a decade. How-ever it has been observed in the last several years thatpopular interest in robotics has increased astonishingly [3].

Educational robotics is a technological innovation that serves as a tool for the realization of the mission to prepare young people for active inclusion in the labor market, social processes and communications. To acquire the skills needed in the 21st century that would help them feel like full participants in society.

II. APPLICATION OF LEARNING ROBOTS IN TECHNOLOGICAL EDUCATION

Educational robotics has its place in the content field of technological education in the construction and modeling of robots, the complexity of which depends on the age of the students.Through it, knowledge on constructing, modeling and programming learning robots is developed, as well as STEM skills such as:

- Creative thinking;
- Logical thinking;
- Spatial thinking;
- Problem solving;
- Teamwork, etc.

In technological education, learning robots can be used as:

1. Means of measurement - in this case, Lego Mindstorms or Arduino, etc. measurement system is used with processing and recording of the results in the form of tables, data databases. Concepts of accuracy, calibration of measuring scales and reading are studied.
2. Experiment facility - Lego Mindstorms 9797, 9686, 9688 and more sets are used to build demonstration and laboratory facilities for physical experiment.
3. Process modeling tool - using Lego 9797, 9686, 9688 and others, industrial, household and other devices and natural phenomena.
4. Design and research tool- Robot kits can measure, analyze, calculate results, create projects.

III. CHOICE OF LEARNING ROBOTS DEPENDING ON THE AGE OF THE STUDENTS FOR THE PURPOSES OF TECHNOLOGICAL EDUCATION

1. Grades 1-4 primary stage of education

The Makeblock mBot (Figure 1) is a wheeled robot that is easy to assemble and control and can be built by students at the articulated stage. in technology and entrepreneurship classes. It is programmed in Scratch, a computer language that is studied in introductory computer modeling classes.

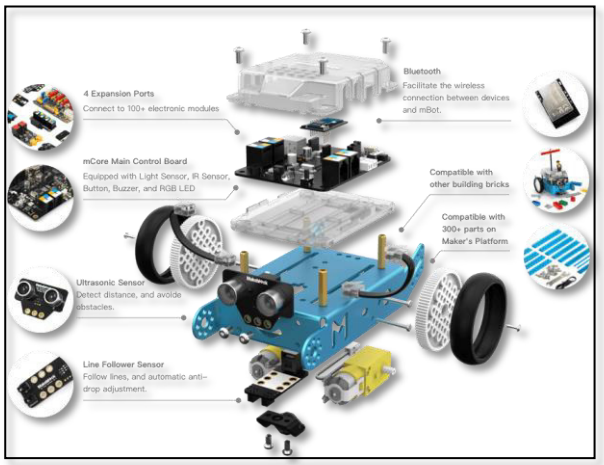

Figure 1 The Makeblock mBot robot

The mBlock Blockly gamified learning app makes learning and playing one and the same. The mBlock Blockly has designed game levels which are easy to understand and learn from, each new level adding to a child's programming knowledge.

Methodological guidelines for the construction and modeling of educational works in the primary stage (grades 1-4) include:

- Learning safe work techniques while working with kits, understanding the performance characteristics of electrical parts.
- Designing specific mini-robots. Learning children create and program interesting models such as race cars, spaceships and shuttles.
- Individual projects. At this stage, children are already developing their own models in pairs and groups. With them, they can participate in various exhibitions, competitions. At this stage, previously acquired knowledge is consolidated.

In the process of work, students learn to use special equipment, independently, according to the instructions, perform simple actions.

2. Junior high school stage 5-7 grades

LEGO EDUCATION SPIKE™ (figure 2) is a kit for building and modeling various robots that includes sensors, servo motors and over 500 LEGO Technic components [4]. Students can create various works capable of moving, shooting, crawling, etc. It is operated through a simple and intuitive programming interface. This robot is suitable for students from 1st to 7th grade.

Figure 2. Lego education spike™

By creating programmable robots, students develop design skills, cooperation and teamwork skills, and career choice skills.

EDGE OWI 535 ROBOTIC ARM (Figure 3) is suitable for students in grades 5 to 7. It can lift objects weighing up to 100 grams and has motion that students can program.WI's second-generation robotic arm kit, the Robotic Arm Edge, teaches the basic mechanics and electronics of robot arm construction and control. Using five motors with gearboxes, the Edge has five degrees of freedom: a 120° wrist motion, a 300° elbow motion, a 180° shoulder motion, a 270° base motion, and a 0-1.77" (0-4.5cm) gripping motion. When one of the gearboxes encounters excessive resistance to motion, the gearbox will make a noise that alerts you to stop the arm's motion in that direction. Illuminating whatever the gripper is holding, a white LED is mounted to the "hand" of the arm [5].

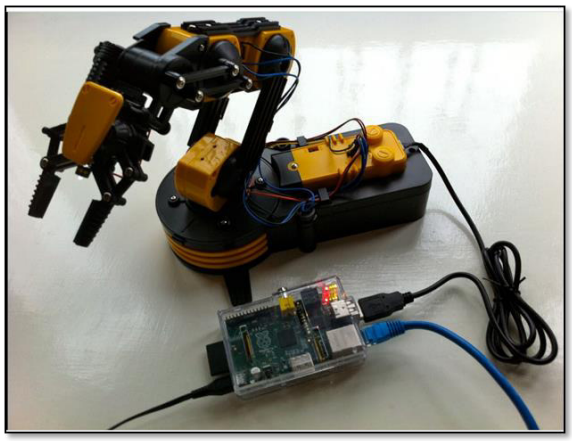

Figure 3. OWI 535

Methodological guidelines for the construction and modeling of educational works in the first high school stage (grades 5-7):

- The teacher gives brief historical and technical information about the model being constructed.
- Model construction analysis. Students, together with the teacher, discuss the constructive features of this model, the principle of its operation.
- After assembling the model, students create a program from the model and test it.
- Students attempt to modify elements of the design and program. In addition, they monitor, analyze and draw conclusions about changes in the operation of the device.
- Presentation of the best models.

Thus, the role of the teacher in the classroom is minimized. He advises and corrects the students' activities.

IV. CONCLUSION

Robotics has the potential to bring positive benefits to education. Educational robotics provides a modern approach to implementing the elements of technical creativity in technological education by combining the construction and programming of learning robots. Constructing and modeling learning robots allows the student to actively participate in the learn-ing process. Students are faced with challenges that encourage them to use their imaginations, work in teams and apply knowledge from the fields of mathematics and physics. Educational robotics encourages students to take an active role in their learning and develop their own knowledge through its active methods. Techno-logical tools can be used in tehnological education to create new learning opportunities in practics.

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Text-Iconic Method of Learning with Sign Language Support in Shared Virtual School Environment

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Abstract – The main goal of this work is to transfer the text-iconic method of learning into the 3D collaborative environment. Paper contains the introduction to the matter as well as analysis the existing solutions. Virtual shared school environment is presented together with an explanation of component placements as well as game instructions. Every component is then analyzed and explained. Paper also contains the conclusion and possible improvements as well as future plans with a related topic.

I. INTRODUCTION

Virtual reality has picked up the pace of development as the pandemic period showed the importance and efficiency in virtual/digital related solutions [1]. Virtual reality found its effectiveness and attractiveness in medicine [2] [3], education [4], art [5] and so much more. Learning via Virtual Environment brings many advantages such as no need to commute, possibility to teach in laboratory space, so there is no need to buy expensive tools and environment is safer, possibility to have high level of interactivity due to the haptic devices used in virtual environments when using head mounted displays (HMD), and more. It was also proved that virtual environments have high potential in education for disabled people [6]. Students with special needs are often not capable to learn in traditional way. For example, student with dyslexia will have much more difficulty to learn about nature just with a book as a source of information. In virtualized collaborative environments students with sensory disabilities, learning disorders, physical disability can learn more effective as trough the scripts given by a teacher in traditional way [7]. Another example proving effectiveness can be wheelchair simulator [8]. Immobilized person can learn to manipulate the wheelchair and gain the confidence in a safe space of virtual environment. Often courses and tools provided by the state are expensive, so the wheelchair simulator is economic effective as well. As there are many different disabilities, there are many different needs.

This paper is focused on text-iconic method of learning [8] with a sign language support in Slovak language within the virtual environment. This method is actively used in a *Spojená škola Pavla Sabadoša internátna Prešov*, located in Prešov in Slovakia. This method helps students with learning disability, mental disability, or mute people to learn to read via pictures. As mentioned earlier in introduction, pandemic proved that some methods of interpretation of the curriculum can not be replaced by online video calls or written guidance only. Therefore, environment where students can learn to read via this method was created. This paper contains related works to the matter, brief explanation of learning method as well as implemented environment description.

II. RELATED WORKS

As mentioned in introduction, virtual schools have picked up the pace of development especially after covid. It showed the need for alternative solution of education where teachers nor students do not need to be present. Virtual environments can be beneficial not only as a remote way of teaching, but also, they can replace certain elements due to which it would not be realizable such as heavy equipment, safety reasons, financial reasons.

Following work called *Virtual Shared School* [9] is focused on chemistry and math class in virtual environment reminiscent of school. Work is dedicated to HMD technology solution as well as desktop solution. There is possibility to sign in as teacher or student. Teachers have ability to place, style and save objects for a class. They are also able to give an ownership of an object to a student, so he or she can manipulate or present an example with it. It is possible to chat and call within an environment so the avatars – teachers/students, can communicate with each other.

There are also works that use mixed reality technologies to enrich already existing classrooms.

Work called *Shifting Virtual Reality Education to the Next Level – Experiencing Remote Laboratories through Mixed Reality* [10] is dedicated to simulated scene using HMD technology. Scene contains six-axis robots performing collaborative tasks for implementation of virtual laboratories and simulation of various engineering applications. It teaches engineering skills and knowledges and partially replace the need to be present in a classroom, where the robotic arms are located.

Another work using augmented reality is dedicated to help deaf and hearing-impaired students via affordable augmented reality glasses. Work is called *Assistive Technology for Hearing-Impaired and Deaf Students Utilizing Augmented reality* [11] and the implemented system can assist students in their education with real-time transcribing, speech emotion recognition, sound indications features, as well as classroom assistive tools. Although this work does not contain the virtual environment, but it is focused on students with special needs and it is using the virtual reality technologies.

Last but not least, there is work that teaches and prepare students for school entrance examination in junior high school. Work is called *Virtual Experiment Platform For Middle School Entrance Examination* [12] and it integrates the experimental knowledge of the middle school entrance examination into the virtual experiment. Work is dedicated to HMD technology as well.

III. VIRTUAL ENVIRONMENT DESCRIPTION

Virtual school consist of one room, where all objects, tasks and decorations are utilized. As the principle of the text-iconic method is not so complex, there was no need to create the wide environment. This method is primarily taught trough the physical cards in school. One of the processes can be as follows: Students will learn the meaning of the specially designed cards (read more in [8]), they can learn it via spoken word or sign language. Then they will receive the pack of cards and a paper with a written sentence. Students then need to assign the card to the correct word. This way they can learn to read written words with a picture association. The same process was intended to convert into shared school environment. But before environments details and visualization, let's have a look at an environment, objects, and tasks placement. Following figure 1 represent the components that are placed in a virtual shared school as well as their placement.

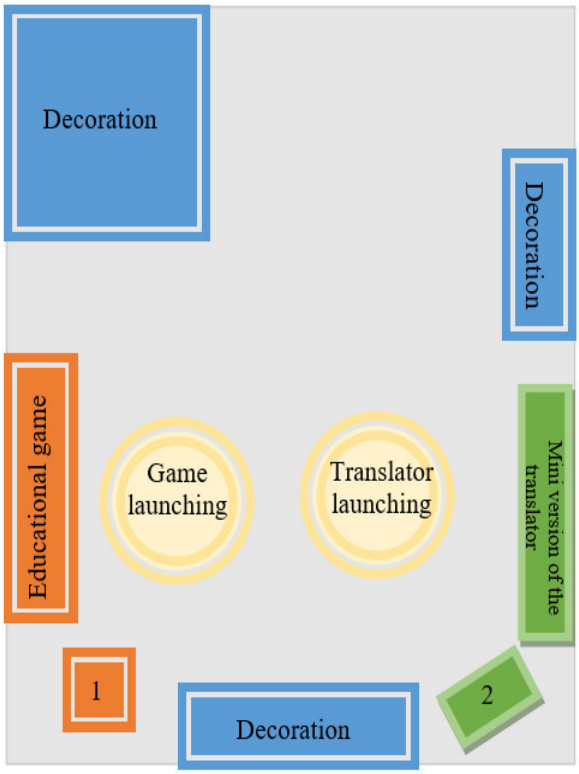

Figure 1. 3D cave at Technical University in Zvolen

Room consists of following components:

- Decoration components help with an authenticity and enrich the environment so it does not seems plain.
- Educational game component is a game presented on a wall where user can unscramble the sentence via pictures. He or she needs to put the pictures in a right order to complete the level. Educational game has an option to choose the difficulty
- Component presented with number 1 is for muting or repeating instruction to the educational game.
- Game launching component start the instruction for educational game and then launching the game.
- Mini version of the translator (MVT) component is a board of cards explaining the meaning of the cards. Cards are categorized to nouns, adjectives, verbs, prepositions, conjunctions, and others.
- Translator launching component will launch the MVT board with an instruction how to interact with it.
- Canvas component will display meaning of a card in MVT when clicked, in a sign

language presented on canvas via recorded person.

Every component besides static decoration plays active part at virtual school. These components are perceived as interactable objects. So basically, user can do two activities in a room. One is focused on learning meanings of a cards and other is training reading skills via filling correct pictures as was proposed in chapter III. Following figure 2. represents 3D view of the room.

Figure 2. 3D View of the room

The view is flipped by 180 degrees according to figure 1. As this is collaborative environment, there is plenty of empty space for the players, so they do not get in the way to the other users. Edges of a room are handled by a wall visualization with assigned collider, so the user is not able to get out of the map. Decorations such as couch, plants or lamps are not handled by the collider so there is more room and freedom of movement.

IV. TECHNOLOGY AND AVATARS USED IN SHARED VIRTUAL SCHOOL

The name of the paper indicates that the environment is collaborative. Therefore, this chapter is briefly presenting the technology and avatars used in the virtual school.

Whole environment was built in Glitch with an A-frame support. As it is web-based, it is not only platform-free solution, but it was also possible to implement network attributes provided by network-aframe library. Avatars are adjusted to support desktop avatar control as well as HMD avatar control. User needs to enter the webpage of the work and then he or she is spawn in the environment. Following figure 3. represent the avatar.

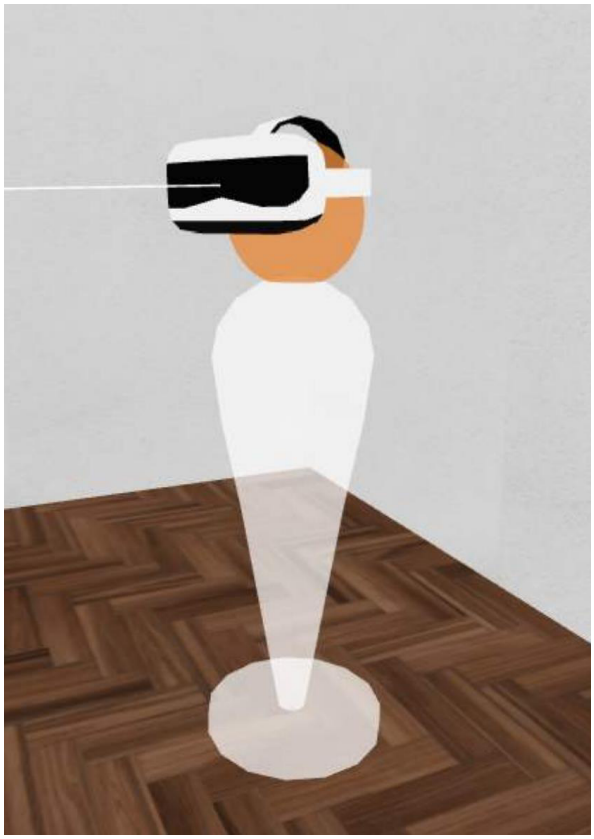

Figure 3. Avatar in shared school environment

From avatar heads goes the white line visible for every user in the environment. Line represents the pointer where is user looking. At the end of the pointer is a circle which helps user to click on an object. Functionality of this can be compared to a mouse on a desktop computer. Circle is in a center of a user view. Circle can be noticed in a figure 7. further in a paper.

Following figure 4. shows multiple players in the shared school environment.

Figure 4. Multiple players in the shared school environment

It is possible to notice that every avatar is looking on something different, either it is solving the educational game, looking at the MVT board, canvas with sign language or admiring the decorations. Interactive components are not shared with other avatars so every student can see or solve their own content.

V. MINI VERSION OF THE TRANSLATOR (MVT)

Some students know only sign language but do not understand the cards or the written word. Others on the other hand, understand the cards but do not understand the sign language nor written word.

As it was mentioned in chapter III., MVT activity serves for explaining the meaning of cards used in text-iconic method of learning. But MVT can be used to teach not only the meaning of the cards, the word in a relation to the card but also allows mute people with a learning disability that prevents them to learn to read written word in a traditional way to learn the sign language. Visualization of the activity is represented in figure 5.

Figure 5. Visualisation of MVT activity

It is possible to observe the green board where cards are display and canvas, where meaning of the cards is represented via sign language. To start this activity, user needs to stand before the board so he or she can listen to instruction what to do. Instructions explains, that in order to display the cards, user needs to click on a blue, red, yellow, white or black button. Every button represents different part of speech.

- Blue – non-living nouns
- Red – verbs
- Yellow – adjectives
- White – prepositions, conjunctions, and other parts of speech
- Black – living nouns

The categorization via colors is due to the whole concept of the cards. Cards are framed in this color which student then know what type of speech this picture within is assign to. Following figure 6. represent the example of an adjectives.

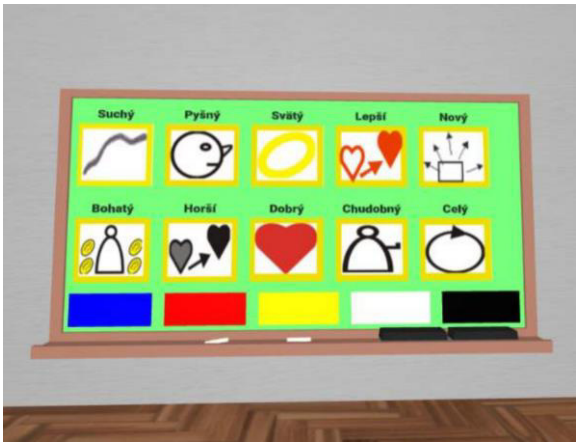

Figure 6. Example of an adjectives on MVT board

Whole work is dedicated to Slovak language but translation of the cards in order first row to right is: *dry, proud, saint, better, new, rich, worse, good, poor, whole*.

User can click on a specific card and then on canvas to display the translation of a card in sign language. Following figure 7. represent the example of adjective *whole*.

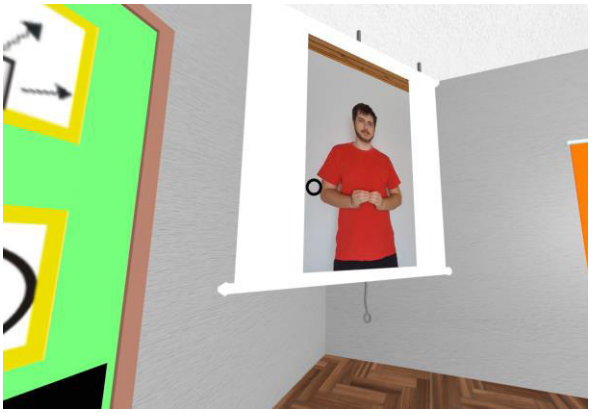

Figure 7. Example of representation card *whole* via sign language on canvas

Video is played on repeat so student can either understand the sign for picked card or train the sign.

VI. EDUCATIONAL GAME

Game can be started by stepping on a carpet in front of the turquoise board. Then, instruction how to play the game and how to interact with it will be explained with a woman voice. The movement of a player is frozen, while the voice is explaining the instructions. It was implemented due to the fact that some students might be impulsive enough to try to interact with a board before knowing what to do. Unfortunately, subtitles for this voice were not

implemented but noted as a future improvement. Following figure 8. shows the initial visualization of the game.

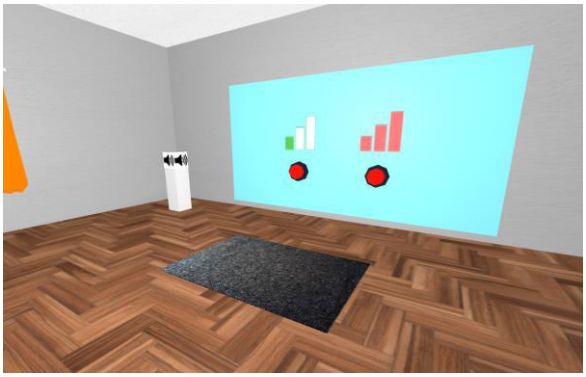

Figure 8. Initial reprezentation of an educational game

Game consists of two difficulties. Difference is the length of the sentence that needs to be build. Student has set of cards and needs to put them in a correct order in a space under the written word. There are more cards than available space, so student is challenged not to only put the correct order but understand the written word as well. Following figure 9. Shows the example of a sentence.

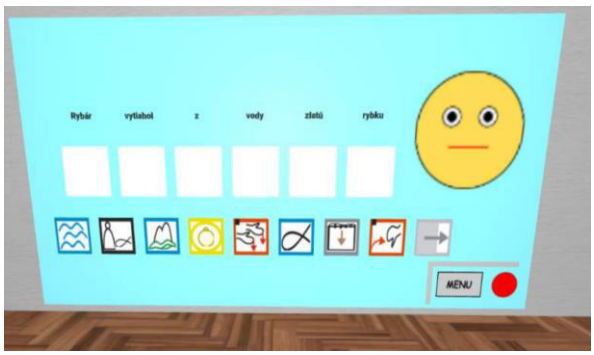

Figure 9. Example of a sentence in a educational game

Sentence in literal translation divided in sections: *1. Fisherman 2. pulled out 3. from 4. water 5. golden 6. fish.* By given instruction, student needs to select the card and then the blank space under word. Following figure 10. shows the correctly solved sentence.

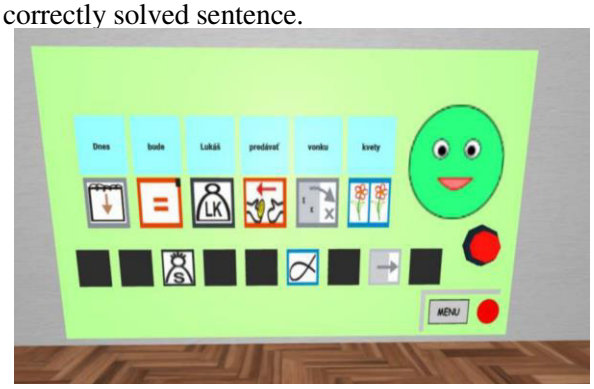

Figure 10. Correctly solved sentence in educational game

If all the spaces are filled with the card, game will evaluate the sentence. If the sentence is correct, smiley face will turn green and smile. Otherwise, it will turn red and smiley face will be sad. Student can reset the cards and put them back into the initial row by clicking the red button.

Higher difficulty of a game is by filling not only the one sentence but a short fairy tale story.

If students misheard the instruction, he or she can listen to them again by clicking on a box with a volume icon on it. From the figure 1. it is the component marked as the number one.

VII. Conclusion

In this work, solution for shared school environment for text-iconic method of learning was successfully created and tested by 20 users. Although solution needs some improvements such as adding a voice to MVT for students that does not know cards, written word nor sign language or create more activities in a room, perhaps more rooms with different topics, we believe that using virtual reality technologies is attractive for students therefore they are more willing to learn as most of them perceive this kind of classes as more fun. We plan to continue to improve the way of learning for disabled students using virtual reality.

Acknowledgment

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The Relationship Between Education Management and Organizational Learning as Part of Knowledge Management

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Abstract – Education management is a key factor in educational institutions for achieving a higher and better level of knowledge. This complex and important discipline can also be important for companies and non profit organizations. Development of this discipline can have a positive effect on educational policy in order to evaluate and improve the education system at all levels. Continous education is important for achieving the productivity and goals of all organizations, and when it comes to improving knowledge at the organizational level, there is a significant connection between education management and organizational learning. Organizational learning as a discipline is an integral part of education management in companies and it is important for overall knowledge management in the organization and the developmet of human recources. This paper aims to present and emphasize the relationship and mutual influence between education management and organizational learning.

Key words: education management, knowledge management, organizational learning.

I. INTRODUCTION

The field of education management and and long-term development of all companies is accompanied by rapid changes that directly affect the quality and effectiveness of both education management and organizational learning. All organizational systems, including educational institutions, should take a certain amount of responsibility and initiative in order to respond to the changes and demands of the environment in the most efficient way. In order fot this to be possible, it is necessary to develop and improve the education management system which, with knowledge management system and organizational learning, will encourage the satisfaction of organizational goals.

Education management could be defined as the acquisition of a large number of skills and knowledge in formal educational institutions [1]. Education management of all organizational systems, wheter educational institutions or production and service companies, implies management development and management training. Management development includes managerial skills and knowledge necessary for the development of employees, while management training determines organizationally specific training for those who are already at the management level. Education management includes selection and commitment to existing ideas, contexts and principles, experience and opportunity for those who are learning to practically apply existing concepts. Education management includes the evaluation of those who learn, as well as the feedback on the process and quality of learning.

Educational and production systems at all organizational levels should develop human recources and increase the quality of knowledge and information. In an organized structure and modern environment, education should play a key role in imparting knowledge. Education can be based on the national need and in accordance with the improvement of culture and knowledge of modern management [2]. Educational organizations as a link between knowledge producers and knowledge researches emphasize the need for development and improvement in order to respond to social, political, economic and cultural changes.

II. DEFINITIONS AND IMPORTANCE OF EDUCATION AND KNOWLEDGE MANAGEMENT

There is a clear connection between education management and knowledge management, of which organizational learning is an integral part. Both of these concepts aim to improve and

develop the education system and knowledge of individuals in a certain organizational system and environment, and the benefits of the effectiveness of these systems are expressed through the improvement of business, the development of corporate culture and society as a whole.

In addition to the mentioned definition of education management, it can be said that this concept represents the application of the field of management which means that education management refers to the application of the best practices and theories of management in the field of education. Education management includes three main study areas, namely human resources that include education staff, communities and stakeholders, as well as users of the education service. In addition to educational institutions, this field of study can be applied to companies in order to improve the knowledge of their employees. Second field of study in education management are learning resources such as planning tools used as media or curriculum, which can also be applied at the level of a production or service company. Finally, the third field of study includes financial resources and funds as supporting factors that help mantain quality education [3]. As well, whole area of education management is related to:

- Development goals,
- Planning and implementation of educational programme,
- Administration,
- Problem solving,
- Advanced training,
- Evaluation.

People and their knowledge, as key business resources, have the greatest influence on the success of the company's operations. Individuals, with their knowledge and skills, give meaning to the organization. People as an organizational resource are significantly more complex than other resources. Human working potential cannot be exploited as a machine, but it can be improved and developed by effective applicationof knowledge in the organization, which is very important for long-term success.

According to the above mentioned, knowledge management as an organizational innovation has been present in the business world for decades. As a discipline, knowledge management has reached a state of maturity where the principles, practises and tools that make it unique can be discerned. This discipline has created a foundation for the creation of new disciplines, concepts and categories to study the important ways in which organizations use knowledge to create value. It can be said that knowledge management represents the ability to act, and knowledge management and knowledge management represents a systemic and integral approach in identifying, managing and transfering all information ownership in a corporation including the experiences and expertise of employees, databases, policies and processes [4].

The management process as a whole, as well as educational management and knowledge management, consists of five basic functions that are used to achieve educational goals [5]:

- Planning,
- Organization,
- Managing,
- Coordination,
- Controlling.

Knowledge management, as well as the education management, encourage the learning of the organization and its employees, strenghthening cooperation within it and continuously improving the achivement of organizational goals. These subsystems of management do not change other important business strategies, but they have the function of important business strategy, especially when they are combined [6].

III. ORGANIZATIONAL LEARNING AS AN IMPORTANT PART OF MANAGEMENT

The fact that knowledge represents one of the most important business resources today, organizations should apply permanent learning and improvement in order to achieve their goals. Permanent education is an important term for all types of organizations today and in the future because it represents a tool for achieving competitiveness, both for companies and individuals. Permanent education implies contuinous improvement of the organization and its members and enrichment of existing knowledge and skills. It is important that

employees learn and transfer knowledge in the workplace, which includes training, mentoring and directing the workforce in organized system.

The modern economy imposes an ever-faster pace of market changes, and the organization of the future should contain ever-present change, teamwork, people who create a vision, employee training, delegation and management, unnecessary interdependence and an adaptable corporative culture [7]. Learning organizations encourage leadership development and are characterized by practises and procedures that result in minimal interdependence, and that rely on a large number of developed information processing systems. The importance of changes to which organizations are increasingly exposed is reflected in the importance of lifelong learning in the corporate environment.

It is necessary that the dominant percentage of organizations, especially domestic ones, turn into learning organizations, because the modern corporate environment emphasizes knowledge as the main factors of competitive advantage. Modern business requires intensive application of knowledge and multidisciplinarity, and a learning organization that encourages creativity and adaptability provides skills in finding information, effective communication, critical thinking, managing business projects and processes and teamwork.

The learning term implies the acquisition and creation of potential and actual abilities in order to take an action that is considered effective, that is, to create knowledge. The learning term means acquiring new and supplementing existing information in order for individuals to positively change their behaviour and successfully adapt to and influence the environment. Learning involves the assumption of supporting continous improvement in the value creation chain for the enterprise. It can be said that learning is a dynamic process that manifests itself by continously changing the nature of the organization through the application of innovations, exchange of goods and cooperation [8].

The concept of a learning organization can be related to management's efforts to create innovative companies, because management is increasingly concerned with creating and atmosphere stimulating for learning. In organizations that are complex in terms of their structure, size and processes, there are multiple learning processes and each group and individual has its own knowledge base and own learning abilities. The ability of the organization to develop starts from appropriate advantage that supports competence of an enterprise is the result of continous learning. Learning can be seen as an organizational process by which a company is able to mantain and improve existing or create new performance based on experience [9].

The term of organization implies the connection of parts into a whole for its complete functioning. The organization itself represents a system that includes natural and technical elements, material and immaterial resources. All types of organizations function with the aim of achieving personal, group or social goals. Parts of such systems perform certain tasks in order to achieve goals and the very concept of organization implies the maintenance of the system and the coordination of its parts. Material and non-material organizations are the result of human activities, and in order to improve the organizational system and follow turbulent changes, it is necessary to apply organizational learning at all organizational levels [10].

IV. THE RELATIONSHIP BETWEEN EDUCATION MANAGEMENT AND ORGANIZATIONAL LEARNING

It has already been mentioned that educational institutions represent a type of organizations that need to adapt to rapid changes, just like production and service companies. What can be pointed out as their shortcoming is the insufficient ability to change and accept changes. As educational organizations have become the center of knowledge-dependent societies, many administrators and policy makers believe that a reactive approach to changes is not sustainable. In order to be able to control and make decisions about the course of their existence and business, educational institutions should become entrepreuniral and direct their business outside the framework of the bureaucratic organizational structures. It is important for educational institutions as organizations to apply the creativity and knowledge of their members in a more

productive way, just as modern companies do [11].

What is necessary for educational organizations, like all organizations, is a proactive approach to demands of the environment, changes and resistance to changes. Although this managerial approach to organizing schools and universities may seem like corporalization, it is important to know that schools and universities, as well as all complex organizations, must improve their ability to adapt to a turbulent environment. Therefore, by applying organizational learning to all forms of organizational structures, including schools and universities, modern and productive organizational structure is achieved. What organizational learning also provides is the basis for the development of innovations. An important part of certain organizational theories is that, as the organization becomes larger and more complex, innovation is more difficult to mantain and produce. Innovation is the basis for preventing the ossification of the organization, and learning organizations develop an innovative environment.

Developed information systems are key to the functioning of all types of organizations, and the evaluation of information systems seek to provide an understanding of tasks and decision making through the mapping of key factors for the investment process. Certain authors note that the organizational culture of learning is influenced by the transformation of information through the internal and external environment of the company, which often results from investments [12]. These claims prove the fact that there is a clear connection between education management and organizational learning as the subsystems of management that include financial resources. For companies, it is importat for their employees to be involved in knowledge processes and review organizational information because the organization needs to continously give „something to learn“.

The United Nations have set out the principles of the Responsible Governance Education (PRME) initiative. The number of institutions that adopt this principles is growing, and what has been expressed is the risk that many of them will not operate according to the same. What is necessary for the institutions, according to certain authors, is implicit thinking in terms of the gradual transformation of education management. Non-observance of the PRME principles present a series of challenges for organizational learning [13].

Corporate responsibility is a response to society’s great expectations regarding sustainability. Although some companies have engaged in a learning process with their stakeholders to integrate social and environmental issues into their activities, many others limit their operations to reporting and rhetoric, which non-government organizations have criticized. This implies that organizational learning leads to the transformation of educational management that leads to sustainable business practices. By following these principles, educational institutions advocate for the integration of the idea of responsible management in their research and organizational structures, which is directly related to corporate social responsibility applied by modern production and service companies.

As in all companies, in many high education organizations there is a need for organizational changes. Continuous organizational learning is essential for successful and lasting institutional changes. Educational organizations have distinctive characteristics. General development and improvement of institutional efficiency and effectiveness is an example of first-order change and learning at one level when there is a mismatch between desired and achieved goals in the organization. This represents the first step in the improvement of education management [14]. Continuous training and professional development at all organizational levels may be one of the priority areas in modern business. Organizational learning is an important factor of business transformation in the digital age, oriented to technologies, procedures and processes that are flexible and knowledge based in complex environment [15].

V. CONCLUSION

In modern business conditions, achieving business excellence is a goal that most companies strive to achieve. Achieving that goal implies continuous and effective improvement of all business factors and one of the most important factor is the improvement of knowledge

productivity. Knowledge represents the imperative of modern business and, as such, represents the most important resource for achieving success and competitiveness of companies. In today's business world, all companies, particularly educational institutions must include the principles of management and organization in their structure and can not be based only on traditional humanistic principles. Implementation of organizational learning in all organizational structures has strategic, structural and cultural challenges, but it is important to know that organizational learning is necessary to enable positive transformation of education management. Organizational learning, education management and knowledge management as subsystems of management aim to provide and better manage people, processes, technology and intellectual property.

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The Use of Augmented Reality in Geometry Teaching

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Abstract – Digital media nowadays create new ways to teach, learn and interact. Prospective teachers are using technology to transfer their knowledge in a more interesting and accessible way, while at the same time making students more engaged and motivated. AR, as a technology, has the potential to be an effective learning tool in formal and informal learning environments. This paper, present the development of the AR application for geometry teaching for primary school students. By augmenting the student's vision we enhance their ability to visualize what they are trying to learn. With the developed AR application,they can learn to make the differences between 2D and 3D shapes and how they relate to one another. The designed application is built using a WebAR-based approach and marker-based detection technology.

I. INTRODUCTION

Rapid development of the technology has influenced its inevitable entrance in the learning processes. Educators are constantly looking for resources and tools to get students engaged, motivated and excited about the content they are teaching [1-6]. An interesting option nowadays is augmented reality (AR) [7,8]. The AR technology can be used to assist the teacher in transferring the knowledge and assist the students in grasping that knowledge.

Augmented reality refers to technologies that dynamically blend real world environments and context-based digital information. It expands the physical world, adding layers of digital information onto what we can see with the naked eye. Three characteristics are important for augmented reality [9]: 1) combining real and virtual world 2) allowing real-time interaction 3) aligning real objects or places and digital information in 3D.

AR applications can be divided into two main categories, according to the used device: optical-based and video-based applications. In optical-based applications, various AR glasses such as HoloLens or Magic Leap are used as AR devices. They enable users to visually perceive reality that surrounds them, complemented with virtually designed objects. However, the usage of glasses as additional equipment, increases the costs of the AR system. In video-based applications, a real image received via video cameras is combined with virtual images on the screen of a computer or a mobile device. Smartphones, tablets or computers equipped with digital cameras can be used as AR devices in this case. The availability and prevalence of these devices allows video- based applications to be used in a variety offields.

II. USING AR IN EDUCATION

AR technologies have been around for more than 50 years, but only the recent proliferation and consumerization of mobile technologies made affordable AR systems available for the broad public. It has been asserted that education is one of the most promising application areas forAR [10].

Augmented reality can be integrated into the classroom in all grades and across the curriculum. Various studies have examined the use of AR-based technologies for teaching and learning in various subjects and context: natural science, medicine, engineering, languages, history, artsand in various learning environments: kindergartens, primary schools, secondary schools, universities, laboratories etc. [11,12].

Most students in all levels of education experience problems when learning math. These problems usually are related to their abstract thinking ability [13, 14, 15]. For example, students often have trouble understanding the topics of geometry and 3D objects, since teachers are using two-dimensional drawings while explaining 3D objects (or shapes). Visualization in mathematics is a necessary condition for a conscious understanding of the subject of study, which contributes to increase the interest in the phenomena and objects under study, activation of mental processes that determine the process of cognition and stimulation of the cognitive activity especially for preschool and schoolchildren.

To overcome these problems, educators need to improve students' spatial abilities. Some research studies have examined the AR effects on students' spatial abilities. Martín-Gutiérrez et al.

[16] produced an AR book (called AR-Deheas), designed for use in technical drawing courses. In their study, they reported significant positive effects of using the AR book on students' spatial abilities. Roca-González et al. [17] and CarbonellCarrera et al. [18] studied the effects of AR applications on university students. In both studies, the spatial orientation skills in students who were part of the experimental group increased significantly compared to the students in the control group. Lin et al. [19] conducted an experimental study with secondary school students. They divided the students by their mathematics achievements in three groups: high, medium and low achievement. Their results showed that AR applications had no significant effect on the spatial ability of high achievers, hada small but positive effect on medium achievers, and had a significant positive effect on low achievers.

Some researchers investigated the effects of 3D modeling technology on the students' spatial skills. Huang and Lin [20] conducted a study with high school students and showed that 3Ddiagrams improved mental rotation skills, while 3D modeling-printing technologies improved both mental rotation and visualization skills. Katsioloudis et al. [21] examined the effects of two-dimensional drawing, versus 3D models and found that the students who printed their 3D models increased spatial skills more significantly than those who made two-dimensional drawings. All these findings indicate that students are more engaged and learn better when they have the opportunity to visualize the objects. AR applications, with its 3D displays and interaction features, are considered a suitable tool for enhancing students' spatial ability and achievement.

III. WEB-BASED AUGMENTED REALITY

There are two primary ways for people to experience AR. One is application-based AR, and the other is web-based AR. App-based AR provides an immersive augmented reality experience that is accessible through downloadable apps. On the other hand, web-based Augmented Reality (WebAR), as its name suggests, is a technology that allows users to consume AR experiences through a web browser. This means that the application does not need to be downloaded on the user's device and can be used online. This offers users convenience as it simplifies the process of consuming AR, which, in turn, creates conditions for increasing the number of end users. The WebAR technology is still in its early stage, but it's growing rapidly, andis expected to replace app-based technology in the near future.

The main advantage of WebAR is how widely supported it is. This technology runs on any commonly available web browsers (including Chrome, Safari, Firefox, Opera, Edge, and several others). When it comes to devices, WebAR works on nearly any recent hardware, provided it has internet access and a camera. Specific aspects of AR, however, function better on newer, more powerful devices. Screen size also affects the user's experience, as complex features are easier to engage with on larger screens.

WebAR development is easy and flexible, due to available frameworks, that provide a solid foundation on which to build apps. In the following, we will list some popular frameworks for WebAR development.

- AR.js - is one of the most popular frameworks for developing WebAR solutions. It is a cross-browser Javascript lightweight framework that is used for WebAR development. It is compatible with Three.js for rapid WebAR development.
- Three.ar.js - is a helper library for creating WebAR-based solutions. It utilizes WebARonARCore and WebARonARKIT which enable developers to create mobile-based Android and iOS user experiences.
- ARToolKit - is based on ARToolKit open-source tracking library. It combines WebGL and Three.js for the rendering of 3D models. The support for this library is currently stopped, but it's still widely used for creatingWebAR experiences.
- Argon.js - is a JavaScript library known for the simplicity of creating WebAR-based user experiences. It can be used for both appand web development. This framework utilizes features like marker and image tracking and lays on a complex ordinary system.
- Awe.js - the main features of this framework are motion sensors, location-based solutions, and AR markers. It works using device APIs, WebGL, and WebRTC in the background.

- X3DOM - is an open-source framework andruntime for 3D graphics on the Web. It enables web developers to incorporate AR content into web pages, directly within the HTML itself. This eliminates the need for any external plugins or libraries, as the sceneis an integral part of the page.

Generally, there are two types of AR, based on the types of triggers: marker-based and markerless AR. Marker based AR, also known as image recognition AR, is the most commonly used in WebAR. It requires a designated marker (usually an image, logo, QR code etc.) to activate an augmented experience. The user is able to scan the marker using the phone/tablet/computercamera and a digital experience will appear. This allows the user to move around the marker and see the digital experience in 3D.

IV. APPLICATION DESIGN

The idea behind the developed application is to allow the end-users to preview or visualize the 3D Geometric Shape by scanning its geometric net template.

The designed application is built using a WebAR-based approach and marker-based detection technology. As a development framework we have used AR.js combined with the ARToolkit and the Three.js library. The application structure is composed of a Three.js scene, camera, and renderer, which are the main objects of the application. The ARToolkit source object is used as the main entry point of the application. The ARToolkit library utilizes three different objects:

- ArToolkitSource: this object is used to initialize the application and the browser window, and it's used for positional tracking. Since the application will use a webcam as the main source, the source type in the ArToolkitSource object was set as 'webcam'.
- ArToolkitContext: this is the context (main engine) of the application. It initializes the application's main functions like Projection Matrices, cameras, etc., and finds the markerposition in the image source.
- ArMarkerControls: it controls the position of the marking by using the Three.js controls API. The patterns for marker detection are defined there.

Regarding the 3D object that should appear on the screen, the predefined three.js 3D models were used. Five geometric shapes (cube, sphere, cone, cylinder, and tetrahedron) were defined using the THREE.Mesh function. These geometric shapes were chosen as the most basic 3D shapes, taught in introductory geometry courses (more geometric shapes can also be added in the future). Colors and textures for each of the geometric shapes were also defined.

In the development environment, each 3D shape is linked with a particular marker. As we mentioned earlier, we used the images of geometric shape nets, as a pattern marker. Markers are distinct patterns that cameras can easily recognize and process. They can be paper-based or digital image. When the application detects the marker, it identifies the corresponding 3D model and recalls it. Then the software renders the 3D model over the marker, making itvisible to the user (Fig.1). In this way the user's reality is augmented. The interaction between the user and the system is through movement of the marker. Students can move the marker or rotate it so they can see the object from all sides.

Figure. I. Developed app in action. Preview of the 3D shape-cube, on the top of its net template,along with basic characteristics: faces, edges and vertices.

V. CONCLUSION

The AR technology can be used to augment all of the user senses, although the vast majority of applications are focused only to the sight by combining virtual graphics with the reality the users see. In this paper the focus is on vision as one of the most important aspect in learning. The paper presents the development of the AR application for geometry teaching for primary school students. By augmenting the student's vision we enhance their ability to visualize what they are trying to learn. With the AR application

they can learn to make the differences between 2D and 3D shapes and how they relate to one another. They will also learn the most important characteristics of 3D shapes, like: faces, edges, vertices… Exploring shape in a new and exciting way using AR gives students a broader depth of experience and a greater frame of reference when facing challenges in the future. When it comes to solving problems relating to 3D shape they will have a tangible first-hand memory of creating shapes from nets.

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Experimental use of Alternative Biometric Devices in a Multimodal User Interface for Trustworthy Interaction in A Virtual Reality Environment

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Abstract - The content of this paper is the use of biometric devices as alternative inputs in a multimodal user interface with an application also in a virtual reality environment. In recent years, it is possible to observe a growing number of implementations of these technologies. The specificity is their use in reliable human-robot or therapist-patient communication. The paper focuses on the description of the testing and subsequent extension of EMG devices usage in this communication. The application described in the paper can create arbitrary strings using gestures sensed by the EMG device. Created gestures can be managed, recorded and displayed graphically using this application.

Keywords - human-robot interaction, multimodal user interface, virtual reality, EMG device

I. INTRODUCTION

Human–human interactions are of different types and in modern society they are gradually being extended to interactions between humans and computers (human-computer interaction, HCI) especially humans and robots (human–robot interaction, HRI), covering three "co-actions" (cooperation, communication and collaboration). In particular, robots with humanoid shape have been proposed as a plausible controllable tool for studying social interactions [1]. In the context of HRI, the robot can learn by action observation from a human. The studies focusing on human MNS are numerous and the related mechanisms can be replicated in cognitive robots. At the same time, humanoid robots have been demonstrated to play an increasingly important role in human society, with their applicability across many tasks or contexts [2].

The most important part of HRI is the nature of interaction. An interaction entails a permanent information-processing loop where both partners continuously perceive and affect (act on) each other. In HRI this is non-trivial because of qualitatively different "hardware and software" between the two partners (despite the anthropomorphic look of the humanoid robot). The difficulty arises from the fact that the communication loop is enabled by a highly noisy brain-computer interface (BCI) pathway constraining the reliability of information being transmitted. Therefore, from the point of view of ease of communication using an adequate interface, it is excellent if biometric input elements are used.

HRI has demonstrated a rapid progress in the last decade [3] as a promising new field offering numerous applications ranging from industrial collaborative scenarios, through educational school settings for children, to domestic environments for elderly people, in which a socially-intelligent robot play an important role [4]. A core subfield within HRI is represented by human-robot collaboration [5] where both partners aim to achieve a common goal in real time. This requires reaching a deeper level of interaction, shared understanding, and coordination [6] using the most adequate interface for humans. Such an interface is also provided, for example, by virtual reality systems

Virtual reality (VR) [7] offers a number of benefits, some of which are specific for the considered task. VR represents an advanced technology allowing the designers to create rich virtual environments with 3D visual scenes and objects. VR can be defined as a type of user-computer interface that implements real-time simulation of an activity or environment allowing user interaction via multiple sensory modalities [8]. VR simulators allow exposure to realistic and challenging environments through the presentation of dynamic graphics and audio, while also maintaining safety and control. VR offers a wide range of applications, for example, in entertainment, art, design, neurorehabilitation, and others. Typically, VR is enabled by a head-

mounted display (HMD) or virtual CAVE systems (e.g. LIRKIS virtual CAVE) [9].

HRI is naturally multimodal, exploiting multiple communication channels such as vision (eye gaze), body position, pointing gestures, emotions, or speech. Availability of multiple channels supports reliability and stability of the interaction (towards the common ground) and the recognition of behavior. VR usage offers a number of advantages over physical HRI (HCI): high flexibility in environment setup, good control of independent variables, safety, and possibility for teleoperation, to name a few [10]. VR is becoming realistic and has become more usable with regards to research purposes, including the replication of physical HRI studies. However, this only works when the participant is sufficiently immersed in the VR environment. There exist solutions with mostly good immersion, but a number of challenges remain [11].

In 2019, the LIRKIS G-CVE (Global Collaborative Virtual Environments) [9] [12] was designed in authors home laboratory LIRKIS as a web-based globally accessible VR/MR system over the internet. The system includes Entity-Component-System pattern that allows the rapid development of virtual environments with various extensions and features. Each of the components can perform different functionality: processing physical effects and object collisions, obtaining inputs from the VR/MR interfaces (multimodal mode), monitoring user interactions and managing virtual entities. This article deals with the expansion of the multimodal interface of this system by some non-traditional biometric devices.

II. BIOMETRIC DEVICES

From the point of view of the multimodality of user interfaces based on VR and the related technologies, the following types of biometric sensors/devices are most often used:

- *EMG sensors* are sensors designed to measure muscle tension values. These sensors are placed on individual muscles and subsequently provide information on the tension of individual muscles. In practice, these sensors are most often used to recognize user gestures. Such devices are most often in the bracelet shape and contain sensors that are distributed evenly around the user's hand/leg.
- *IMU sensors* are made up of either two or three sensors: Accelerometer and gyroscope when using two and accelerometer, magnetometer and gyroscope when using three. Together, these sensors form the IMU unit. This unit is able to determine rotations in individual axes and motion information. In practice, IMU units are used as part of devices and they detect the position of the given device.
- *Flexible resistance sensors* work based on measured resistance. Such a sensor has the shape of a strip (tensometer). The latter is formed by a printed resistance strip with changing resistance. The resistance of such a strip depends on how much the strip is bent. Based on the resistance, it is possible to determine how much the sensor is bent. These sensors are used to obtain information about the bending of the user's joints. These sensors are most often used in data gloves or full-body suits.
- *Optical sensors and cameras* are mainly used for sensing the user's position. Two main approaches can be used to accurately determine individual parts of the user's body. The first one is the use of special markers located on the user. These markers are subsequently very easy to recognize using a grayscale image and to determine the position of individual markers using multiple cameras. The second approach does not use special markers but different types of optical sensors and recognizes the user by analyzing recorded images. Another use is face or gaze recognition. Data from the face or the place where the user is looking, can be used to control the program or the user's avatar.
- *Audio sensors* are most often used for sensing the distance from reference transmitters or objects in the scene. Such distances can subsequently be used to determine the location of the device or the user. Recently, such sensors are replacing optical sensors that are used for sensing the user when using virtual reality glasses. The advantage of audio sensors compared to optical ones is that audio sensors do not need sensors placed around the scene, but only built-in sensors in the glasses are enough. Recently, the use of audio sensors for recording user gestures has been investigated. This technology uses the Doppler effect, which refers to the change in wavelength of a moving object.

In Figure 1 are shown some sensors (devices) used in laboratory during work. We primarily focused on the use of EMG devices as alternative input devices.

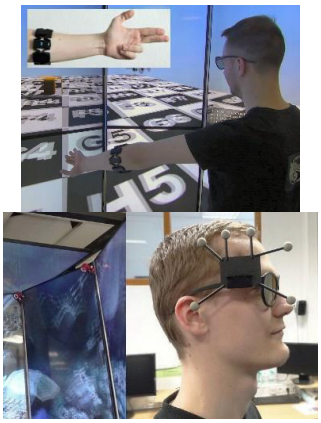

Figure 1. EMG device MYO (left), Optitrack devices (right) in LIRKIS laboratory during test

III. EMG DEVICES

Two EMG devices were available in the wristbands form: the MYO Armband and the gForce 100 (Figure 2).

Myo Armband is a device for controlling a computer or virtual reality. It was developed by Thalmic Labs. This device uses the user's gestures. The basic principle of user gesture recognition is based on electromyography. The LIRKIS laboratory is equipped with two devices. Myo Armband takes the form of a wristband that the user wears on the forearm. The Myo Armband is equipped with software that is composed of two artificial neural networks. These neural networks have the task of pre-processing data from sensors, which are subsequently used for gesture recognition. This device is able to recognize five gestures: *Fist*, *Wave left*, *Wave right*, *Fingers spread* and *Double tap* (double tap of thumb and middle finger).

Myo Armband is equipped with several types of sensors, IMU and EMG sensors. IMU sensors are used for monitoring of the wristband orientation. These sensors are a three-axis gyroscope, a magnetometer and an accelerometer. EMG sensors are used to measure the electrical values of the muscles, which change when the muscles are contracted and expanded. The wristband contains eight EMG sensors.

OyMotion gForce 100 is similar to the Myo Armband EMG wristband. The gForce 100 wristband is manufactured by OyMotion. This wristband contains EMG and IMU sensors. This wristband can recognize 6 gestures. The device also includes a three-axis gyroscope, a magnetometer and an accelerometer. The LIRKIS laboratory is equipped with one gForce 100 wristband.

The gForce 100 EMG device was selected for testing to support the multimodal interface.

Figure 2. EMG devices MYO Armband (left), gForce 100 (right)

IV. GFORCE 100 DEVICE TESTING

The OyMotion gForce 100 wristband sends the evaluated gesture as a string of bytes. In this string is a byte indicating the message that it contains the gesture and the gesture value. After the bytes translation into a readable form, the gestures are marked with values 0 - 6. (TABLE I.). Therefore, the gesture history is created as a list of numbers from which the strings for testing are composed. Strings of recognized gestures are stored in a text file as a sequence of numbers, in which each digit represents a single gesture. The sequence of gestures starts with the rightmost digit and ends with the leftmost digit. The developed application works with gestures using the enumeration type. The enumeration type allows you to work with the gesture as a number or its text label. Text is used for displaying performed gestures and creating a textual representation of a chain of gestures.

TABLE I. GESTURES EVALUATED BY THE WRISTBAND AND THEIR NUMERICAL VALUES

Gesture	Value
GF_RELAX	0
GF_FIST	1
GF_SPREAD	2
GF_WAVEIN	3
GF_WAVEOUT	4
GF_PINCH	5
GF_SHOOT	6

In terms of testing, three types of testing were performed:

1. During the first test, the wristband was put on the hand according to the instructions. The aim of this test was to determine the accuracy achieved by a new user. The test was performed without previous device testing. In this test, it is also possible to monitor the formation of muscle memory during the gestures execution. During this first test, an accuracy was achieved in the range from 45% to 70% and the average accuracy achieved

was 55.84%. The achieved accuracies for individual gestures are shown in TABLE II. (Correct recognition value is average from all series and all participants). Each gesture was performed in 10 series 20 times in a row. The accuracy started to improve after a few repetitions, but the participants (3) still were not used to given gestures. The wristband did not mark the performed gesture incorrectly as another one, but always when the gesture was not recognized, the gesture was marked as a relaxed hand position.

TABLE II. ACHIEVED ACCURACIES IN THE FIRST TEST

Gesture	Correct recognition	Accuracy
FIST	11/20	55%
SPREAD	12/20	60%
WAVEIN	9/20	45%
WAVEOUT	10/20	50%
PINCH	14/20	70%
SHOOT	11/20	55%

2. The aim of the second test was to find out how training with a device affects the accuracy of gestures recognition. Three participants performed a 10-minute training session with the device before this test. The participants also tried gestures to find the ideal position during this training. They also tried to find the best position of the wristband on the forearm, where the device responds best to gestures. The accuracy was achieved in the range of 60 to 80% and the average accuracy reached 75%. Compared to the first test, the accuracy was better by up to 20%. The accuracies for all gestures are shown in TABLE III. (Correct recognition value is average from all series and all participants). The average achieved accuracy would be even better if it was not reduced by the *Shoot* gesture. The *Shoot* gesture achieved up to 15% lower accuracy than the second lowest accuracy gesture. This low accuracy was achieved because the device recognized the *Shoot* gesture as a *Fingers spread* gesture. The wristband was in the position where it best recognized all other gestures. According to participants, the *Shoot* gesture is the worst to train and it is the most problematic. Better accuracy of gesture recognition was achieved when the hand was released to a free (relax) position after each gesture, or a different gesture was performed. The accuracy also increased during training when participants performed the gesture more forcefully and they kept the muscles involved in the gesture tense.

TABLE III. ACHIEVED ACCURACIES IN THE SECOND TEST

Gesture	Correct recognition	Accuracy
FIST	15/20	75%
SPREAD	16/20	80%
WAVEIN	16/20	80%
WAVEOUT	15/20	75%
PINCH	16/20	80%
SHOOT	12/20	60%

3. The goal of the third test was to find out whether the added time for training will have an additional effect on the accuracy. Also, the aim of this test was to improve the detection of the *Shoot* gesture, which achieved the worst results in the second test. Before the third test, the participants had 20 minutes for training. As during training before the second test, the participants tried to find the ideal way of gestures performing and the correct position of the wristband. During this third test, accuracy was achieved in the range from 75% to 95% and the average achieved accuracy reached 85.8%. The average accuracy increased by 10% from the second test. The accuracy values of individual gestures are shown in TABLE IV. (Correct recognition value is average from all series and all participants). As in the previous testing, the *Shoot* gesture has the lowest achieved accuracy (75%), but its accuracy has increased by 15% compared to the second test. This improvement was achieved because participants spent more time on this gesture than the others during training. Also participants could no longer find a better position for the wristband during this training. The overall achieved accuracy of gesture recognition was already close to the accuracy stated by the manufacturer. Based on the results of this test, it is possible to say that for ideal gesture recognition it is advisable to spend at least 20 minutes on gesture training.

TABLE IV. ACHIEVED ACCURACIES IN THE THIRD TEST

Gesture	Correct recognition	Accuracy
FIST	17/20	85%
SPREAD	17/20	85%
WAVEIN	19/20	95%
WAVEOUT	18/20	90%
PINCH	17/20	85%
SHOOT	15/20	75%

The tests have shown that the time spent on training has the greatest influence on the resulting accuracy. The position of the wristband on the hand has a great influence on accuracy only in the beginning, and the correct position can be found quickly.

The ideal position of the wristband, in which it achieved the best accuracy in gestures recognizing during the test, is located approximately in the middle of the forearm. The last test proved that in order to achieve the best possible accuracy, it is advisable to spend at least 20 minutes gestures training. The second and third tests show that the most demanding gesture to train is the *Shoot* gesture. This gesture should be given the most time during training. Using the above-mentioned procedures, an average accuracy of 85.8% was achieved during the last test. With training lasting more than 20 minutes, it is a big assumption that it is possible to approach the 95% accuracy stated by the manufacturer.

V. THE EXTENSION OF THE DEVICE IMPLEMENTATION INTO INTERFACE

While the previous tests focused on the user experience, the following section will briefly describe the implementation of the device. The goal of the device implementation into interfaces was also to extend the set of recognizable gestures and to enable recording of data within the implementation in multimodal interfaces and thus extend their capabilities. A software to communicate with the device and acquire data about the gesture and angles of the device defines the basis of this implementation.

For an extension of recognized gestures set, it is best to use EMG sensors of the wristband, but the manufacturer does not allow access to the EMG data of the gForce 100 wristband by default. It is possible only when using the more expensive gForce Pro. Therefore, gesture string were used to extend recognized gestures set. These strings are formed by the mentioned built-in gestures of the wristband. A lot of new gestures can be created using strings. A strings of different lengths combination is possible, but it is possible that shorter strings will be contained within a longer string. Therefore, a care must be taken when creating strings to ensure that shorter ones are not contained in longer ones.

To determine the string, the application needs to know what gestures were performed. Therefore, the application saves the history of the last ten performed gestures. First, when recognizing a string of gestures, it is checked whether the history contains the necessary number of records to recognize the given string. A string of the same length as the checked string is created from the history and then they are compared. If they match, the string is evaluated as done and the check ends.

To display the currently executed string, the application creates its graphical representation, which is displayed to the user. Model images of gestures are used as the basis of this process. These images were chosen because they show the correct execution of individual gestures. This can help the user learn built-in gestures. When a built-in gesture is recognized, the corresponding image of the given gesture is displayed. The string image needs to be created for each string separately. Due to the large number of possible combinations, it is not convenient to have images of all options stored. For this reason, the application creates this image anew every time it recognizes a string. To create such an image, the images of the individual gestures of the string are gradually inserted. The image prepared in this way is then displayed by the application.

VI. THE TESTING SOFTWARE

The testing software includes 3 screens. The main screen appears after opening the application (Figure 3). The tasks of this screen are: managing the connection of the wristband, displaying data from the wristband, turning on recognition of gesture strings, recording data and switching to other screens.

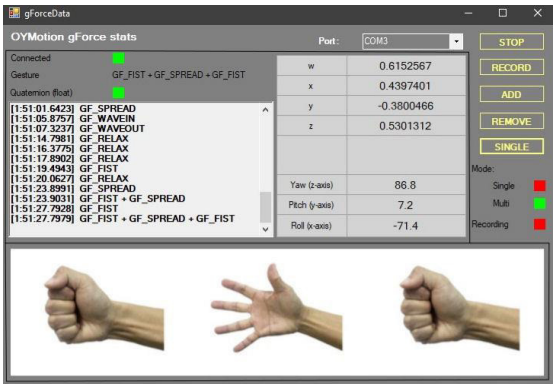

Figure 3. The main screen of the application

The next screen is the screen for deleting and viewing gesture strings. Its main task is to display all the strings that the application knows. In this list, it is possible to mark the strings that the user wants to delete. The last screen serves to facilitate the creation of gestures. This screen contains buttons for adding individual gestures to the string. The string being created is displayed at the top of the screen. The application allows the creation of a string of up to 10 gestures. The Figure 4 shows the example of a real use of the application. In this figure is shown an example of a gesture with a gForce 100 EMG wristband attached, including a displaying of its processing on the screen.

Figure 4. Example of a gesture with an EMG device attached and its processing in the application

VII. CONCLUSION

This paper dealt with the extension of the multimodal interface of the VR system developed in the LIRKIS laboratory (the authors' home laboratory) with some non-traditional alternative biometric devices in the case of its implementation as an environment for human-robot or therapist-patient communication. A core subfield within HRI is represented by human-robot collaboration where both partners aim to achieve a common goal in real time. This requires reaching a deeper level of interaction, shared understanding, and coordination using the most adequate interface for humans. Such an interface is also provided by the aforementioned virtual reality system. HRI is naturally multimodal and the implementation of VR technologies only enhances this fact. Availability of multiple channels supports reliability and stability of the interaction. The article focused on the description of testing (at the level of user experience)) and the subsequent extension of EMG devices (gForce100) use in this communication. The application described in the paper can create arbitrary strings using gestures captured by the EMG device. In future work, we will focus on testing and implementing other alternative devices that can be used for communication within the multimodal interface provided by the developed VR system.

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Overview of Cellular Vehicle-to-Everything and Vehicle-to-Everything Based on Dedicated Short-Range Communication

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Abstract- Intelligent Transport System allows to increase performance, better traffic flow, more efficient and safer transport of passengers and goods, thus reducing air pollution and increases travel comfort. Nowadays, users are demanding greater availability, faster and more stable connection with higher capacity for upcoming devices and systems that will have capabilities from communicating with each other to performing tasks remotely. The introduction of the 5G network has a major impact on Vehicle-to-everything technology. The fifth generation network is designed for the highest possible level of energy efficiency, and enables the transfer of more data in a shorter time compared to previous mobile networks. In this paper, a review of the literature on the Dedicated Short-Range Communications and Cellular V2Xtechnologies is presented and the differences between them are investigated. The results of the research showed that while C-V2Xinitially appear to have better performance, the range and reliability of Dedicated Short-Range Communications are more than adequate for key security applications. Most importantly, a Dedicated Short-Range Communications device that uses the VAVE wireless standard cannot communicate with a C-V2X device using Long-Term Evolution and vice versa. It is necessary to work on new technologies to improve various possibilities.

I. INTRODUCTION

Vehicle-to-everything (V2X) is a technology that allows the vehicle to communicate with the traffic that surrounds it. V2X technology consists of several components:

- V2V(Vehicle-to-Vehicle)enables communication between vehicles
- V2I(Vehicle-to-Infrastructure)communication between vehicle and infrastructure
- V2N(Vehicle-to-Network)allows vehicles to communicate with a wireless network
- V2P(Vehicle-to-Pedestrian)communication of vehicles with pedestrians
- V2H (Vehicle-to-Home)technology that allows the vehicle to communicate with the owner's house. [1] [2] [3] [4] [5] [6][7] [8]

Two leading radio access technologies called IEEE 802.11p and C-V2X are currently on the market. DSRC is supported by IEEE 802.11p and Wireless Access in Vehicular Environments (WAVE) protocol stack[9]. Cellular technology is a powerful candidate to support traffic communications because it has great coverage. DSRC access technology is unique and widespread to provide V2X communication. Although C-V2X has attracted the attention of researchers in academia and car companies.C-V2X can promote the effectiveness of promising V2X applications for traffic safety, the environment etc. [10]

In this paper, two technologies DSRC and C-V2X are presented. A review of the literature on the Internet was made, where conclusions were made about the advantages and disadvantages of these technologies. The subject of research are the mentioned technologies, and their mutual differences. The problem of research is that there are relatively new technologies that are constantly evolving and advancing, so only at the moment something can be concluded because it is expected that the mentioned technologies will be further developed.

II. LITERATURE REVIEW

V2X communication can be used for the purpose of preventing traffic accidents and improving road safety. Research has shown that the assumption is that V2X technology would prevent more than 80% of traffic accidents by warning of hidden dangers on the roads that otherwise could not be noticed [1][11].One of the fundamental components of V2X technology is security[12]. Key security items relevant to V2X are Authentication and Identification, Integrity, Privacy [12].To enable V2X for users, two layers are required: the communication layer and the application layer. Several initiatives to standardize

V2X technology have been implemented through the European Telecommunications Standards Institute (ETSI). The technical specifications of ETSI TS 103 097 and ETSI TS 102 941 define security and privacy procedures. In order to achieve the standardization of V2X technology, cooperation was achieved between ETSI and the 3GPP consortium, which is a group, ie a partnership project that brings together standards committees, regulators and industry bodies at the international level[12][13][14].

A. Dedicated Short-Range Communications (DSRC) technology

It uses 5.85-5.925GHz frequency range which is dedicated for vehicular communication to support the development of intelligent transportation systems, specifically by using V2X protocols. The DSRC provides safety and infotainment communication services. DSRC relies on radio communication transceivers mounted on vehicles as well as road side units. Researchers evaluate the different performance parameters of the DSRC such as frequency, vehicle speed, and the number of vehicles that can be on a single channel, etc. [15]. The number of vehicles on one channel, which is a measure of congestion, seems to be one of the main issues with the DSRC since having fifty or more vehicles significantly decreases the message delivery percentage and increases the latency[15][16].

Various organizations regulate and specify standards and frequency bands for DSRC technologies in different regions. "According to the ITU-R M.1453recommendation of the International Telecommunication Union (ITU), ITS distinguishes the (5.725-5.875) GHz band and describes two methods for DSRC technologies: active (transceiver) or backscatter (transponder). ITU has also developed recommendation ITU-R M.1452 for DSRC applications in millimetre wave ranges (up to 81 GHz). Two sections of the DSRC frequency spectrum can be distinguished in North America: (902–928) MHz and (5.850– 5.925) GHz. The 902–928 MHz band is specified in ASTM E2158-01 standard, which is developed by American Society for Testing and Material (ASTM), while Institute of Electrical and Electronics Engineers (IEEE) defines 5.850–5.925 GHz band in protocol, called IEEE 802.11p. Three frequency spectrum bands for ITS could be distinguished in Europe: (5.470-5.725) GHz, (5.795-5.815) GHz and (5.855-5.925) GHz" [6]. The physical and Medium Access Controllayers of the first and third frequency bands are regulated by European Telecommunications Standards Institute (ETSI) standard ETSI ES 202 663. The physical layer of the (5.795-5.815) GHz band is described by the European Committee for Standardization (CEN) standard CEN EN12253. Two frequency bands are distinguished for ITS in Japan: (5.770-5.850) GHz and (755.5-764.5) MHz regulated by the standards of the Association of Radio Industries and Businesses (ARIB). The physical, data and application layers of the first frequency band are described by ARIB STD-T55 and ARIB STD-T75. Theuse of the 700 MHz radio frequency band is regulated by the ARIB STDT109 standard [6].

B. 4G and 5G based Cellular (C-V2X) technology

CV2X technology is regulated by the 3rd Generation Partnership Project (3GPP). Automotive, telecommunication, other mobility and transport technology industry leading companies have created the 5G Automotive Association (5GAA) with a goal to expedite the development of the C-V2X. As shown in Fig. 1 the enhancement of C-V2X has gone through three stages [2].

The 5G network has been defined within Report 14 (Release 14) and improve within Report 15 (Release 15), entitled "Phase 1" and defined in more detail in Report 16 (Release 16), or recognizable as "phase 2". The C-V2X can support a wider range of capabilities than previous vehicle connectivity options, such as WLAN technology or a standard better known as IEEE 802.11p for Intelligent Transport Systems (ITS) only. The two standardized C-ITS technologies are 3GPP LTE-V2X PC5 (known as LTE sidelink) and IEEE 802.11por ITS-G5, a standard by the European Institute for European Telecommunications Standards Institute

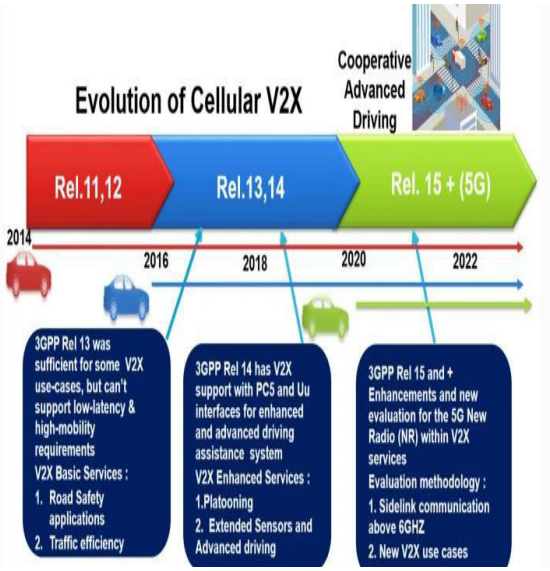

Figure 1. C-V2X standardization and evaluation [2]

(ETSI)[17]. Release 14 specification upgrades existing technologies to enable faster data transfer, improve the mobility of NB-IoT devices, increase energy efficiency, and ultimately enable the development of a 5G mobile network. The first set of 5G specifications was completed in March 2019 in the Release 15 standard, as the first phase of 5G system development. The first commercial 5G mobile networks based on the Release 15 standard were launched in South Korea and the US in April 2019[18]. Release 16 standard represents the second phase of the development of the 5G mobile network [19]. The most recent, as of this writing, is Release 17, scheduled for 2022. The C-V2X uses two complementary modes of transmission (modes) to provide a wide range of safety features while driving. These modes are [17][20]:

1. Direct communication between vehicles (Vehicle-to-Vehicle - V2V), between vehicles and infrastructure (Vehicle-to-Infrastructure - V2I), vehicles and other road users, such as cyclists and pedestrians (Vehicle to Pedestrians - V2P). In this mode, the C-V2X operates in the 5.9 GHz frequency band - ITS spectrum, which is identified and harmonized internationally for security reasons. In this mode, the C-V2X operates independently of the mobile network.
2. Network communication, in which the C-V2X implements a conventional mobile network to enable vehicles to receive information on road conditions and traffic situations. In this mode, the C-V2X operates in the spectrum approved by mobile operators to enable connectivity to its users.

The C-V2Xalso supports Vehicle-to-Network (V2N) applications [21] delivered via commercially licensed cellular spectra. This mode can also be used to provide network support for security-related features, as well as for commercial services, where the involvement of a mobile operator is required to provide access to cloud-based data or information[17].The reason to use the cellular communication system is that the system is capable of covering short range to long range, is capable of supporting large capacity, and is available in various fields.

III. DIFFERENCES BETWEEN DSRC AND C-V2X

The C-V2X allowing to serve more road users in a specific part of the spectrum. The C-V2X can provide a higher level of safety for more road users than alternative technologies. In addition to offering superior direct communication, the C-V2X offers a higher level of security than 802.11p for all modes. DSRCuses Wi-Fi-based access technology whereas C-V2X adopts cellular-based access technology. This makes DSRC suitable for short range communications, but it does not provide robust connectivity when the vehicle density is high. CV2X can support a longer coverage range butits direct communication transmission mode does not provide the desired high reliability[3].

C-V2X, with its SC-FDM modulation, is also able to achieve concurrent transmissions while DSRC cannot. The cellular technology overcomes network collisions using retransmission, usually activated at high speed, which can also increase its communication range.

Communication standard for V2X, WAVE uses WLAN technology [22][23] to establish DSRC channels so that the vehicles can communicate directly to other entities within short to medium ranges (typically 300 meters). DSRC is essentially a modification of Wi-Fi. The technology was considered a huge breakthrough in the automotive industry because it allows for data to be transmitted between two devices without going through any intermediaries, making it highly useful for rural and remote areas without any telecommunication infrastructure. DSRC is known for having very low latency due to the elimination of the intermediary. C-V2X utilizes cellular radio instead of WLAN, meaning that it utilizes the same set of cellular radio technology as cellphones do. The major difference that sets C-V2X apart from DSRC is that it allows both direct and indirect communication. In direct C-V2X, vehicles communicate directly with other vehicles (V2V) and roadside units (V2I) the same way as how DSRC works. Under indirect C-V2X, vehicles communicate with other entities indirectly via the cellular network (V2N), which is something DSRC cannot do. Indirect C-V2X is useful because the cellular network can collect data from many cars, and thus can be more effective at managing traffic on a larger scale. Originally designed in Release 14 to use the LTE standard, 3GPP later added compatibility for 5G and 5G NR in Releases 15 and 16.On the pros, supporters of C-V2X generally suggest that cellular radio technology has better growth potential for faster speeds and higher reliability. C-V2X is more sustainable as it offers a long-term path for constant improvements. The price of cellular chipsets is cheaper than that of WLAN chipsets. There had been no side-by-side testing proving that one performs better than the other in application [7].It is important to take advantage of

both access technologies. At present, coexistence of both technologies are not significant as C-V2X is not mature while DSRC has issues like small coverage and low throughout.

IV. RELATED WORK

The studies available for C-V2X are not as much as those for DSRC, as it is a newer technology. Authors prove that C-V2X sidelink mode 4 performance exceeds that of DSRC in the link budget, and this has been confirmed in real applications in. While in using sidelink mode 3 centralized resource control in C-V2X, there appears a better performance from better spectrum utilization as in. But as traffic density increases, the performance of C-V2X also deteriorates due to interference resulting in C-V2X mode 4 from frequency reuse, which decreases reuse distance [2].

Some authors have shown that the recently standardized 3GPP C-V2X can provide superior performance with respect to IEEE 802.11p for emerging beyond day-one applications, with particular focus on truck platooning. C-V2X Mode 3 greatly improves reliability compared to IEEE 802.11p due to centralized radio resource scheduling for the sidelink/PC5, which enables smaller inter-truck gaps that translate into higher traffic efficiency and safety. The C-V2X Mode 4, which can be deployed without network infrastructure support, may outperform IEEE 802.11p for periodic traffic due to semi-persistent resource scheduling, but resource re-selection triggers must be carefully tuned to avoid persistent collisions. Therefore, C-V2X with the combination of Mode 3 in areas covered by LTE infrastructure and Mode 4 in areas outside of the coverage is better suited for truck platooning than IEEE 802.11p from the platoon density angle[24].

Recent studies proved that DSRC and C-V2X could both perform acceptably in safety applications if the density is not very high, and the required end-to-end latency is not more than 100 ms. However, as such applications require a very high Quality of Service (QoS), both RATs are not yet up to the expected performance. To decrease the gap between the performance of DSRC and C-V2X and to increase the facilities offered by both as more modes of operation and higher throughput, IEEE 802.11 Next Generation V2X began in March 2018formed in 2019 IEEE Task Group 802.11bd (TGbd), Also, 3GPP is working on developing a New Radio (NR) V2X for its Rel. 16, building atop of 5G NR that was standardized in 3GPP Rel.15. The QoS of use cases required to be supported by NR V2X is expected to be far much higher than that mentioned earlier for C-V2X as it requires an end-to-end latency that does not exceed 3 ms and reliability of 99.999% [2].

V. DISCUSSION

Both technologies differ in some features. This can be seen from Figure 2. DSRC uses a wireless standard called VAVE while C-V2X uses long-term evolution (LTE), a chip technology used by almost all mobile phones.

DSRC radio cannot talk to C-V2X radio, and vice versa. C-V2X initially appear to have better performance, and the range and reliability of DSRCs are more than adequate for key security applications. However, they also have some similarities and this can be seen in the figure 2 where it is shown through the cross section. DSRC and C-V2X use the 5.9 GHz band for direct communication from one radio to another. Both technologies use the same message sets (SAE J2735 and J2945) and use cases. They use digital signatures to ensure security and trust in message providers.

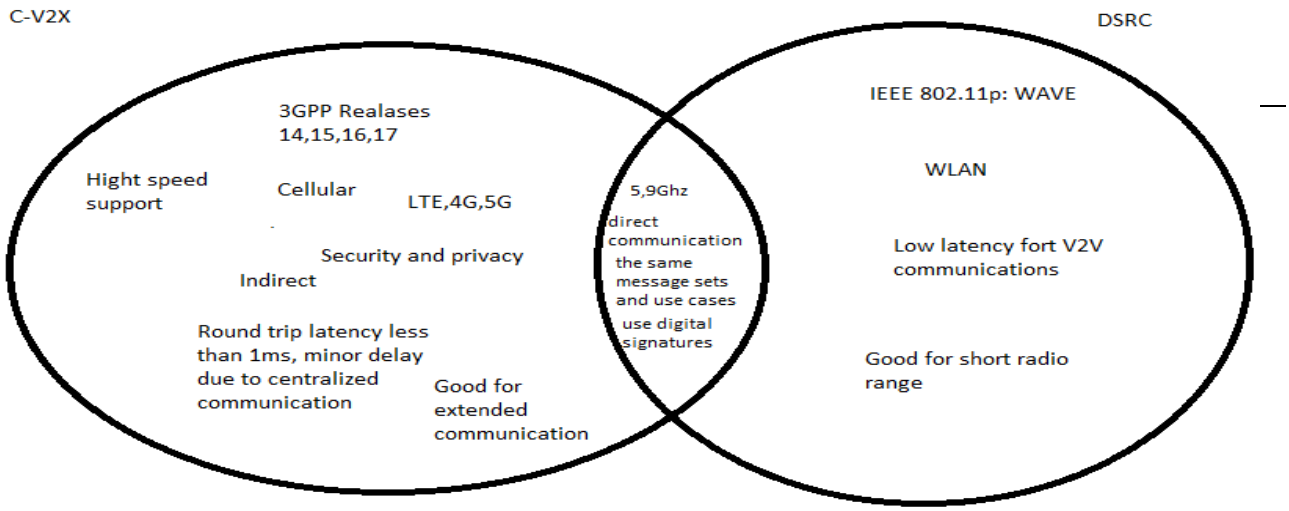

Figure 2. Demonstration of technologies using sets

VI. CONCLUSION

ITS has become one of the most globally researched topics. Currently there are two main V2X data transfer technologies for ITS applications: DSRC and C-V2X. Emerging IoT technologies can also be applied in ITS systems. DSRC uses a wireless standard called WAVE while C-V2X uses long-term evolution (LTE)-the chip technology that almost all cellular phones use. A DSRC radio cannot talk to a C-V2X radio, and vice versa. While C-V2X initially seems to have better performance, the range and reliability of DSRC is more than adequate for the key safety applications. Most notably, a DSRC device using a WAVE wireless standard cannot communicate with a C-V2X device using Long-Term Evolution (LTE), and vice versa.

In the future, it could be explored which technology is more applicable because the technologies are relatively new and constantly evolving. Cellular technology seems to have many advantages over DSRC, but DSRC is still used. It would be desirable to learn about these technologies in universities because it is something new and current and something that will develop even more in the future. It is desirable to constantly work on making cars more comfortable, the flow of information faster, fewer traffic accidents, etc. If the students learn more about this, maybe the mentioned technology will be developed even more or maybe a better one will appear that will allow people to be more satisfied.

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The Importance of Application of Industry4.0 and 5.0 in the Education System

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Abstract: In this paper, the focus is on the importance of applying Industry 5.0 in the educational system. The role that entrepreneurship plays both in the world and in educational institutions, economic assets of the Republic of Serbia is becoming an increasingly important element of economic growth and development of the entire state system. In recent years, there has been constant work on the development of this area, whereby the main carriers of development are the education of employees, additional education in micro, small and medium enterprises. Every company that aims to grow successfully must constantly improve the entire management system.
Keywords: education, education, industry, entrepreneurship, human potential, quality.

I. INTRODUCTION

Within the modularly structured smart factory, cyber-physical systems CPS (Cyber-Physical Systems) monitor physical processes, create a virtual copy of the physical world and make decentralized decisions. Through IoT, cyber-physical systems communicate and collaborate with each other and with people in real time. Through IoS, value chain participants offer and use internal and inter-organizational services. The term Industry 4.0 fully meets a wide range of concepts, including steps in mechanization and automation, digitization, networking and miniaturization [1]. The development towards Industry 4.0 has a significant impact on the manufacturing industry and represents the latest trends in automation technologies. Industry 4.0 is a manufacturing industry that uses state-of-the-art technologies, equipment, processes and work methods. It brings great benefits to businesses such as increased productivity, competitiveness and profits. Existing production systems generally do not yet apply all Industry 4.0 concepts, which should change in the near future. That gap, which was discovered by the research, should be filled with a higher percentage of satisfaction of the concept of Industry 4.0. A smart factory is defined as a production solution that provides flexible and adaptable production processes that will solve the problems that arise in production establishments in dynamic and rapidly changing conditions [2].

Education and training of employees represents something that is constantly supplemented and continuously improved. Every global change leaves a mark on education, on the next generation. Application Industry 4.0 is full of technologies of different characteristics, which greatly affect education, modifying various processes both in educational institutions and in all business processes. Technologies 4.0 facilitate and intensify teaching, while penetrating the essence of the relationship between lecturers and students [3]. Mexico is a country that is not able to follow the trends of Industry 4.0. This causes poor student success, which directly affects the increase in the unemployment rate and the decline in the economy rate [11].

II. APPLICATION OF ENTREPRENEURSHIP METHODS IN EDUCATIONAL INSTITUTIONS

Although there are many definitions of the term entrepreneurship, one of the leading ones is the definition of the European Union, which defines entrepreneurship as a way of thinking and a type of process that creates and develops economic activity by combining risk-taking, creativity and/or innovation with good management, in a new or existing organization. When it comes to entrepreneurship in Serbia, in the last few years numerous measures and facilitations have been observed for future entrepreneurs, especially in the sector of micro, small and medium-sized enterprises, and another of the changes taking place in the economy is the digitization of business and the separation of digital entrepreneurship as a separate scientific fields [4].
In addition to companies that conduct their entire business in a digital environment, there are also those that have adapted to the market in which they operate in one of the listed segments. When it comes to digital resources, examples include Converse and Ikea. On the website of the Converse company, there is an option to create sneakers according to the customer's wishes, after

which he can order and buy them. Similarly, Ikea offers the option of planning rooms in the house, as well as consulting with experts, either
through the website or in person. In terms of digital services, one example is the Philips company, which designed a special application for its Philips Lumea product that reminds users of important dates related to the use of the product, which is a very useful option repeatedly rated as extremely useful by users [5].

In recent decades, successful manufacturing companies in the most developed countries have focused on producing products according to customers' designs, in small volume, with high value and with high margins. In the business model of large-scale production of standardized products, long and complex value chains were formed. In addition, the trend of globalization and outsourcing of business processes and activities has made value creation chains and their production and service operations more complex, but also more difficult to manage and monitor. From a global value chain perspective, manufacturing companies import most of their raw materials from China and other developing Asian countries. In this way, major global value chains, including both manufacturing and service sectors, in the last two decades have become significantly dependent on China as a global supply chain partner [6]. In Spain, it was applied at one universitycombined teaching, with the intention of demonstrating the practical use of 4.0 technologies to students who had no previous experience with it through appropriate methodology [10].

III. IMPORTANCE OF HUMAN POTENTIAL IN INDUSTRY 4. AND INDUSTRY 5. O

Human potential 4.0 is aimed at attracting educated and talented experts, improving the working and organizational environment and other tasks aimed at improving the company's strategic results. They are imbued with 4.0 technology and follow modern market trends with particular impact. In human resources 4.0, it is understood that experts have different needs and that the movement of workers is much more frequent than ten years ago. Precisely because of this, it is necessary that work is not an end in itself, but that it provides the best possible experience through the improvement of the workplace itself. For a generation that has been surrounded by technology since birth, it is only natural that they are also surrounded by it in their workplace. Traditional workforce management models are becoming more strategic as companies realize that their employees are the core of their business. Furthermore, the application of new technologies (either from own development or by purchasing from third parties) these models can automate a large part of bureaucratic tasks [7]. According to Steinberg (2021), "there has never been a better time in the history of society to finally get that visibility so we can make better business decisions." If the recommendations are not sufficiently respected, companies in value chains with long delivery times, which lack complete visibility in the entire value chain, are in the "danger zone"[8].

In today's globally connected society, communication between people from different parts of the world is done cheaply and quickly via the Internet. Radical changes in people's lives have occurred precisely because of the increasing use of computers, easy access to the Internet, that is, the application of modern information and communication technologies.

Today, there are free online services that offer users various possibilities for communication [9]. The modern business environment requires companies to adapt to the novelties emerging on the market. In order for a company to achieve a market advantage, it is necessary to present all its products and services on the market in a unique and recognizable way that will differentiate it from the competition. Employee development is critical to overall market success. Without improving human resources, the products themselves will not be innovative and different. It is necessary to monitor the competition but also potential external collaborators. By implementing a strategy based on the use of human resources, the company significantly improves its ranking. The global market requires constant training of employees, following new trends in personnel education. Education encourages an innovative way of doing business, which is of great importance for every individual in society. Increasingly, companies make selections based on qualifications and candidates' willingness to further improve, learn and acquire new skills. Today, it is very difficult to motivate candidates to spare time for additional educational content in

addition to their work obligations during the day. It is also important to note that the right training is extremely important. There are two problems: the selection of workers whose knowledge will be invested in, as well as the right type of training. Investing effort in carefully selecting workers does not in itself guarantee that they will be effective. Even workers with a high improvement potential cannot perform their work if they do not know what they are doing and how to do it [12].

IV. CONCLUSION

Organizations that are smaller due to limited resources at their disposal are often limited in their innovation activities compared to large companies. Access to a wider range of knowledge and resources becomes possible through cooperation, which can positively affect the implementation of Industry 4.0 and technologies related to it. The global market requires constant training of employees, following new trends in personnel education. Education encourages an innovative way of doing business, which is of great importance for every individual in society. Constant improvement implies the introduction of radical changes in all business processes, which is also part of a strategy based on the application of human resources management. Hiring human resources and using them in the right way and at the right time will reduce the company's overall operating costs. In this way, there will be an increase in business efficiency with the achievement of positive results. industry 4.0 is a new production concept that is focused on creating "smart"
products and processes, through the use of smart machines and through the transformation of traditional production systems into smart factories [13]. The future of production according to Industry 4.0 consists of ubiquitous integration, where each element of production autonomously exchanges information, initiates actions and is independently controlled [14]. Based on all of the above and researched literature, it can be concluded that technology 4.0 and 5.0 are an integral part of educational institutions and companies in the futur

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How to Increase Mathematics Teacher's Digital Competencies

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Abstract – Digital literacy is imperative among teachers but their education does not necessarily provide adequate knowledge for proper use of available digital resources and for adjustment to new digital technologies. A project that improves and enhances the digital skills of mathematics teachers will be presented in detail. The project originates from a local initiative but has international funding.

I. INTRODUCTION

The demands for digital competencies are growing by the day. A math classroom has not been excepted from that either. Consequently, it is important for math teachers to be well familiar with the tools that meet the demands.

The project idea comes from local mathematics teachers. Recent obstacles and difficulties imposed by the pandemic have made many teachers rethink the value of developing and having digital competencies. The realization however led to facing other issues: evident limitations and issues in terms of equipment, humble computer skills, and the lack of knowledge of the appropriate tools.

After the Covid-19 pandemic started, it was obvious that the teachers` digital competencies had to be further improved. Especially mathematics teachers had difficulties with the online teaching process because of the nature of mathematical instructions which have to be explained, presented, and discussed step-by-step. For that purpose, we organized more workshops, where we instructed mathematics teachers for creating digital learning materials using GeoGebra and LaTex [1], [2], [3].

Taking into account all the mentioned above and also the need for comprehensive training for teachers to conduct online and hybrid classes, the project "Fostering Mathematics Teacher's Digital Competencies" was designed to give all mathematics teachers at the local level the opportunity to further improve their digital skills.

The project focuses on pen tablets, GeoGebra, and LaTeX as available digital resources of particular interest to the quality of online teaching, especially in crisis situations. The planned training will improve the digital competencies of mathematics teachers, and thus their teaching abilities.

Within the project and our research, we paid particular attention to the local mathematical community, in order to help teachers, and therefore students too, at all levels of education, in the best and most effective way.

International Mathematical Union (IMU) [4] is a non-governmental and non-profit scientific organization that promotes and supports international mathematical activities contributing to the development of mathematical science in any of its aspects, pure, applied, or educational. Within the IMU organization, there is a Commission for Developing Countries (IMU DCD) managing IMU initiatives in developing and economically disadvantaged countries [5]. Through the Project Support Program, they help local initiatives and contribute to education and local capacity building.

Within this paper, the project "Fostering Mathematics Teacher's Digital Competencies" will be presented in detail, by its aims, target group, schedule, expected results, and possible continuation and extension.

II. RELATED WORKS

Digital technologies are present in the modern educational process for quite some time. There are many studies and researches concerning the optimal use of computers and software, both, for empowering teachers with digital skills and for students to improve their learning results.

Some of the earlier studies dealt with the research of teachers' attitudes towards the application of digital technologies, as well as how teachers, depending on the technologies they use, organize the teaching and learning process. It is interesting that such research has shown that,

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depending on how they apply technology, different types of teachers can be distinguished [6]. Also, there were researches where special attention was paid to the types of digital tools used by mathematics teachers. Digital tools are categorized, as well as the pedagogical foundations and the corresponding activities. The optimal approaches and potentials for use of technology in mathematics education are recognized within this study [7].

The implications of teachers` training for use of digital technologies and their effects on learning outcomes were also the theme of recent studies. Some findings indicate that the best results are obtained by using digital technologies as support for traditional instruction methods [8].

The efficacy of professional development programs for teaching mathematics with technology is yet under consideration. It is closely related to teachers` self-beliefs about teaching with technology. The research results imply that beliefs about teaching with technology are regarded as crucial factors for teaching mathematics with technology [9], [10].

At the local level, one of the first researches was conducted with elementary and high school mathematics teachers in Zrenjanin, concerning their attitudes towards the accessibility and use of digital technologies [11]. The results of the research showed that mathematics teachers have positive attitudes toward computers and their use in the educational process, and they expressed the need for further education and improving their digital skills.

III. LATEX AND GEOGEBRA AS TEACHING TOOLS

LaTeX, as a text editing tool, and GeoGebra as an interactive mathematics application can be used by teachers to improve the quality of teaching mathematics. Both programs are free and accessible. Moreover, both are well documented online, in both Serbian and English languages.

LaTeX is a high-quality text editing tool. It is frequently used by mathematicians in both science and education. Mathematicians use LaTeX because of its customizability, stability, and simplicity in typing mathematical formulas [12]. LaTeX is free, which is another important perk. Its availability is one of the reasons why it is so popular and widespread. The variety of LaTeX editors like TeXmaker, LyX, TeXworks, etc, provide users with a preferred work interface. LaTeX is well documented. The official website provides a wide variety of instructions and tutorials on using LaTeX for document preparation [12]. Aside of that, the website provides a list of relevant publications on using LaTeX [12]. The documentation and literature in the Serbian language are also available on the websites of different Serbian universities [13], [14].

GeoGebra is an open-source mathematics software suitable for different levels of education. It is very usable as a tool in teaching mathematics, especially geometry, algebra, and statistics [15]. One of the aims is to make mathematics approachable by helping students visualize abstract mathematical concepts. The software is also well documented and a lot of usable instructions can be found on the official website [15]. The website of *GeoGebra Centar Beograd* provides documentation and instructions in the Serbian language [16].

IV. DETAILED DESCRIPTION OF THE PROJECT

A. *Motivation*

The necessity for the project was confirmed by both, the teachers and the students. Due to the Covid-19 pandemic, the educational process has been dislocated from classroom to online teaching. The main problem was delivering mathematical teaching content. The problem was caused by the following fact: the teachers do not have and do not handle appropriate equipment and software tools appropriate for writing and presenting mathematical content. The project supports simple digital resources - modest equipment and open source software tools.

Situations, when the educational process has been dislocated from classroom to online teaching demand digital competencies of mathematics teachers. Many of them possess computers with lower performances, and their technical skills are insufficient (especially the senior ones).

B. *Goals and aims*

The project goal is to bring mathematics teachers into being fully functional in the teaching process, regardless of whether it is in the classroom or online. The primary project aims are to train mathematics teachers on how to properly use:

- Pen tablets - for immediate online teaching,
- GeoGebra - for graphing functions and presenting 2- and 3- dimensional geometrical shapes and for creating dynamical teaching materials,
- LaTex - for writing mathematical teaching materials.

The additional aim is to repress senior teachers' repulsion toward digital resources. It is evident and confirmed by themselves, but they will overcome the obstacle within the project training and intensive communication with collages having similar problems.

C. Mathematicians in the project

The target group consists of mathematics teachers from local primary and secondary schools. Each school will delegate two math teachers for the training, due to the limited resources. Approximately 40 people, apprentices, and teachers (two main and two assistant educators) will attend the training.

A wider mathematical community will be reached by the project. Approximately 60 mathematics educators from the region will be presented with the project, to gain the project materials and to participate in the final event. It is to be expected that the apprentices will share their experience and gain knowledge with their school colleagues.

D. Institutions in the project

The project will be implemented in Zrenjanin, Serbia, by Technical Faculty "Mihajlo Pupin", University of Novi Sad. As the basic institution, it provides infrastructure, administrative staff, workspace, and equipment. The local School administration institution supports the project and finds the planned training beneficial for the mathematics teachers, schools, students, and the whole community. The institution encourages schools and their teachers to join the project by active participation in the training.

E. On the training

Training will be organized for the local mathematics teachers so they could adapt digital resources. The capacity building will be achieved by increasing personal knowledge and skills surrounding the usage of GeoGebra, pen tablets, and LaTeX in the teaching process.

Local project initiative provides the simple organization of events, intensive cooperation of the local community of mathematicians, and exchange of experiences.

As the project duration suits to official schoolyear calendar (2022/2023), there will be three trainings in the first semester (autumn), and another three at the beginning of the second one (spring). The final project recapitulation will be held in the last month of the second semester.

The autumn training will cover installations and initial use of all necessary digital resources, while the spring ones concern advanced use. In the meantime within the project duration, occasional consultations will be held in local schools.

V. DISCUSSION AND FURTHER WORK

This project addresses mathematicians' digital competencies and skills needed for effective teaching of mathematical content, regardless of whether it is in the classroom or online learning. Educational capacities are built by local initiative and based on free online digital resources supportive for mathematics.

After the project finish, training will be continued to support and foster mathematics teachers' self-education in the domain of digital literacy. The overall goal is to increase the quality of the teaching process in mathematics and to facilitate the preparation of teaching materials.

More, the project will provide precious experience to all participants, and will be used as a case study in further research. It will be used as a base point for other educational projects and seminars.

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Application of Sorting Algorithms in Shopping Assistant Application

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Abstract - Sorting algorithms are widely used in a broad variety of applications. The sorting is very important in the programming and in the real life. Also, is easier and faster to find some elements in a sorted array than in the unsorted array. For easier searching, sorting algorithms are necessary in the programming process. In this paper, we will present their use in shopping assistance application. The motivation for this application follows from everyday problems which arise while we are looking for some products in a shop.
The shopping assistant application uses Tim Algorithm for sorting of the products in order in which they are arranged in the shop.

I. INTRODUCTION

In the programming is needed to sort elements of the data structure into some specific order very often. The most common are numerical (from highest to lowest, or from lowest to highest) order or some alphabetical order. As examples of sorting are the following: lists of words can be sorted alphabetically or by the length, list of countries can be sorted by their population, by their area or by calling code. The data sorting is necessary because the sorted data are always easier for searching or analysis. Also, efficient sorting is important for optimization of the other algorithms that require sorted input data, [1, 2, 3].

Because many algorithms can be applied only on a sorted data, the data sorting is the first step for searching. For example, a binary search is faster that linear search, but binary search can be applied only to a sorted data.

Sorting is so important and potentially so time−consuming. This is reason because the sorting has been the subject of research in the computer science. As a result, very sophisticated methods for sorting have been developed [4].

The sorting has a wide application in all fields in science and in the real life [5].

- *Commercial computing*

Many organizations as financial, commercial or government institutions use sorting for organization of their data. Sorting algorithms can be used for sorting accounts by name or by number, for sorting transactions by place or time, for sorting mail by postal code or address, for sorting file by name or date.

- *Search for information*

If the data are sorted, then searching through it is faster and more efficient.

- *Operation research*

Sorting is used in job-shop scheduling, when the goal is to complete all jobs (job j requires t_j seconds of processing time) with minimized average time. If the shortest processing time is the first used rule, then the jobs are scheduled in increasing order of the processing time. If the longest processing time is the first used rule, then the jobs are scheduled in decreasing order of processing time. In the two cases for ordered processing times (either increasing order or decreasing order) sorting algorithm must be used.

- *Numerical computations*

Many numerical algorithms use sorting to control accuracy in calculations.

- *Graph theory*

Dijkstra's algorithm is the most famous algorithm for finding the shortest path between the nodes in the graph. For implementation of Dijkstra's algorithm, priority queue can be used. In a priority queue, elements with higher priority have priority before elements with lower priority. For this reason, elements in priority queue must be sorted. Also, Prim's algorithm is used for finding minimum spanning tree. And for implementation on this algorithm, priority queue can be used. Other algorithm for finding minimum spanning tree is Kruskal's algorithm. This algorithm uses sorting algorithm for sorting of all edges in non-decreasing order of their weight.

- *Data compressing*

Huffman compression is a classic data compression algorithm. For implementation of this algorithm, priority queue is used.

- String processing

All algorithms for string processing are based on sorting.

In this paper, we used Tim sort algorithm in Shopping Assistant Application. We used this sorting algorithm for sorting products in the shop by category and by the order in which they are arranged (organized) in the shop.

II. SORTING ALGORITHMS

There are many algorithms for sorting, a few of them stand out as the most effective. All the algorithms that will be presented here have advantages and disadvantages, depending on the size of the data that needs to be sorted. The algorithms that will be presented are the following: Insertion Sort (insertion method), Selection Sort (selection method), Bubble Sort, Merge Sort, Quick Sort and Tim Sort [6, 7, 8, 9].

We will consider all these algorithms.

- Insertion Sort

Insertion Sort is a simple sorting algorithm that provides data sorting like sorting in playing cards. The array is visually divided into a sorted and an unsorted subarray. Elements of unsorted subarray are selected and placed in the correct position in the sorted section. If the array is sorted in increasing order, it is necessary to find the position in the array with a value greater than the value of the element that is inserted. If such position does not exist, then the position of the new element is after the last element in the sorted array. (This element is greater than all elements in the array). The new element in the position which is found is inserted, and all elements of the array are shifted from one place to the right. The shifting is made, to release space for new elements.

A. Time complexity of insertion Sort

Best case time complexity: $O(n)$.

If the array is already sorted, then the inner loop will not be executed and the outer loop will be executed $n-1$ times.

Worst case time complexity: $O(n^2)$.

If the array is reversely sorted, then the inner loop will be executed maximum times.

Average case time complexity: $O(n^2)$.

- Selection Sort

This algorithm sorts the array by repeatedly finding the minimal element of the unsorted subarray and putting it at the beginning of the array. The algorithm maintains two subarrays, the subarray which is already sorted and unsorted subarray. In every iteration of the algorithm, from the unsorted subarray the minimal element is selected and moved to the sorted subarray.

B. Time complexity of Selection Sort

The time complexity of algorithm is $O(n^2)$ as there are two nested loops. One loop to select an element of the array (one by one) and another loop to compare that element with all other elements from the array.

- Bubble Sort

Bubble Sort is the simplest sorting algorithm that works on the principle by swapping the adjacent elements if they are in the wrong order. To sort an array with this algorithm, it is necessary to make passes through the array. In each pass, pairs of adjacent elements are compared, and if it is necessary, the elements will be swapped. After each iteration, the smallest element among the unsorted elements is placed at the beginning.

C. Time complexity of Bubble Sort

Best case time complexity: $O(n)$.

If the array is already sorted in increasing order, the algorithm will determine in the first iteration that no pairs of elements need to be swapped and then will terminate immediately. The bubble sort algorithm must perform $n-1$ comparisons.

Worst case time complexity: $O(n^2)$.

Average case time complexity: $O(n^2)$

- Merge Sort

The Merge Sort is recursive sorting algorithm that is based on the Divide and Conquer principle. With this algorithm, the array is initially divided into two equal halves. Each subarray will be independently sorted of the other. With the algorithm, the array is recursively divided in two equal halves until it cannot be further divided. The empty array or array with one element is a base case of the recursion. Finally, when the two subarrays are sorted, the merging of two subarrays is made.

D. Time complexity of Merge Sort

Time complexity of this algorithm is $O(n\log(n))$.

Merge Sort is a recursive algorithm, and its time complexity can be expressed by the following relation:

$T(n)=2T(n/2)+O(n)$.

- Quick Sort

The algorithm Quick Sort is Divide and Conquer algorithm. The algorithm solves problems, so the problem is first divided into smaller subproblems, then the subproblems are solved and their solutions are combined. In this way, the algorithm solves the basic problem. At the beginning, the algorithm selects an element as pivot. The pivot can be selected in different ways: always select the first (or last) element as a pivot, select a random element, select median. The pivot is put at the correct position in the sorted array. All smaller elements are put before the pivot and all greater elements are put after the pivot. In this way, in the first subarray are put the smaller elements than pivot, and the second subarray consists of the greater elements than the pivot. The algorithm Quick Sort recursively is applied more times until the subarray is empty or it has only one element.

E. Time complexity of Quick Sort

Best case time complexity: $O\left(n\log\left(n\right)\right)$.

In each step of dividing, if partitioning algorithm always chooses the middle element as pivot (two subarray with equal length are obtained), best case scenario will be occurred.

Best time complexity can be expressed by the following relation: $T\left(n\right)=2T\left(n/2\right)+O\left(n\right)$.

Worst case time complexity: $O\left(n^2\right)$.

The worst-case is when the partitioning algorithm selects the largest or smallest element as the pivot element every time (one subarray has only one element, and all other elements are in the second subarray).

The worst time complexity can be expressed by the following relation:

$$T\left(n\right)=T\left(0\right)+T\left(n-1\right)+O\left(n\right)$$

Average case time complexity: $O\left(n\log\left(n\right)\right)$.

Can be expressed by the following relation:

$$T\left(n\right)=T\left(n/9\right)+T\left(9n/10\right)+O\left(n\right).$$

III. A SORTING ALGORITHM USED IN PYTHON

Tim sort algorithm is a sorting algorithm designed and implemented by Tim Peters in the programming language Python in 2002. This algorithm is derived from the Insertion sort algorithm and Merge sort algorithm. First is analyzed the array that needs to be sorted. Depending on the results of this analysis, the most appropriate approach is chosen.

If the array has less than 64 elements, then Tim Sort chooses Insertion Sort algorithm for sorting. This algorithm Insertion Sort is the most effective algorithm for sorting small arrays, [10].

If the array has more than 64 elements then the algorithm will make a first pass through the array, looking for the parts of the array that are strictly increasing or decreasing. These parts are known as runs. If some of the parts are in decreasing order, then the algorithm will reverse those parts [10,11].

These runs, one by one, are sorted by using of the Insertion Sort algorithm. In the second step, the runs are merged by using the Merge Sort algorithm.

If the size of the array is less than the run, the array will be sorted by Insertion Sort algorithm. The size of the run may be from 32 to 64 depending on the size of the array. We can note that the merge function performs well when the size of the runs are powers of 2, [10, 11].

In the best case, the time complexity of Tim Sort algorithm has complexity $O\left(n\right)$ and in the worst and average case, time complexity is $O\left(n\log\left(n\right)\right)$.

Tim Sort is better than the other sorting algorithms because it uses a combination of multiple sorting algorithms and manages to maintain sorting stability. This algorithm finds wide application and is used as the default sorting algorithm in the Python programming language.

IV. SHOPPING ASSISTANT APPLICATON

The motivation for this application follows from everyday problem with which every citizen encounters when is shopping in a shop. Namely, the customers waste a lot of time finding all the products that want to buy from the shop. They often pass the same path more times looking for desired products. The solution offered by this application is simple and effective. The application contains all product that are found at the shop. The products are sorted by category. Customers can choose desired products that are stored in the shopping list. After this, the products from shopping list are sorted according to the order in which they are arranged in the shop. By help of this application, the customer can create his shopping list and take the products from the list in a given order. On this way, the time that the customers spend for shopping will be significantly reduced.

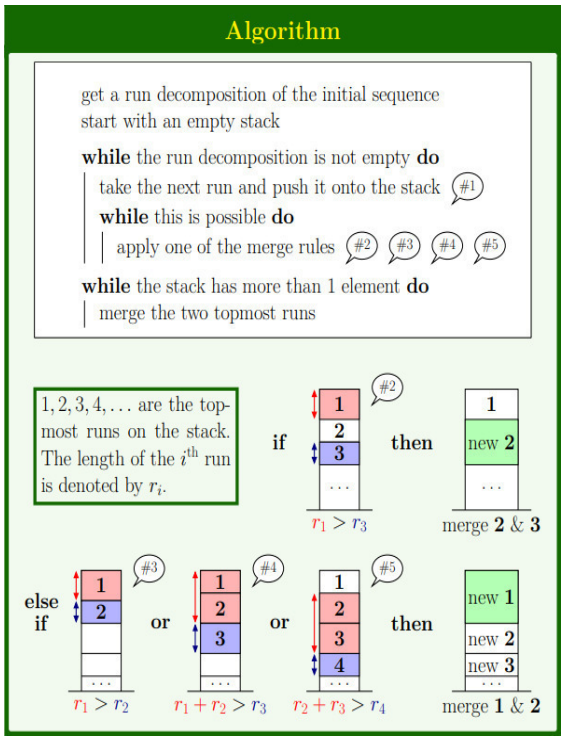

Figure 1.Time Sort algorithm [12]

The Shopping Assistant App is created using Python in combination with the framework Kivy. The interface is simple and user-friendly, with products organized in categories placed on the left side of the screen, whereas the right side of the screen is reserved for the shopping cart, as well as the buttons for sorting, removing a product or resetting the list.

Upon opening the application, the user can select various items from the given categories which appear in the shopping cart in the order that the user selects them. After choosing all the desired products, the user can click on the button "Sort" and the list of products in the shopping cart gets sorted according to the order in which they would be placed in the shop that the application is modeled on. By clicking the button "Remove", the user can remove the last added item from the shopping cart. The "Reset" button gives the user the option to delete the whole list of products and start anew. An extra feature is the counter which shows the user the number of products currently present in the shopping cart.

The code behind works in a simplistic and straightforward manner. The products are given a number that refers to their placement in the shop and are sorted using the default Python function for sorting that utilizes the algorithm Tim Sort. The code is split into two files, one being the Kivy file that contains the details of the interface and the other being the Python file with all the functions and necessary building blocks that create the application.

Figure 2. Graphic-user interface

The Shopping Assistant App is an easy-to-use application that provides users with a smoother and less time-consuming shopping experience.

CONCLUSION

Tim Sort is an efficient and fast sorting algorithm that is used in many applications and solves different types of problems. It implements the idea that many real data sets contain ordered subsequences. It has a very important role in the application because it enables quick sorting of the products selected by the user. On the other hand, the application solves a big problem with which every customer is encountered and represents an innovative solution that has the potential to become a necessary part of everyday shopping in many shops in the region and wider.

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Youth Entrepreneurship Development through Effective Education Management: Framework, Challenges, and Guidelines

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Abstract – The modern business environment has significantly affected business performance of enterprises across industries and countries. In such conditions, entrepreneurship can be a potential solution for improving economic growth and overall economic prosperity. Youth entrepreneurship as a concept derives from entrepreneurship and it significantly reduces youth unemployment rates. Therefore, it is necessary to improve entrepreneurship education through effective education management. In this paper, theoretical models are developed with the goal to adequately address this subject. The paper provides a strong basis for future research in the domain of youth entrepreneurship development and effective education management.

I. INTRODUCTION

In the current global economic crisis, competitiveness on a national level for the majority of countries has taken a toll [1]. National economies face difficult challenges, as they didn't fully recover from the COVID-19 pandemic and the current energy crisis accompanied with inflation contribute to the economic decline [2]. In such conditions, unemployment rates tend to increase and the standard of living declines for a large percentage of the population. For these issues, there is no clear solution, as the changes on the market are too dynamic [3]. However, entrepreneurship has been noted as a strong factor of economic development and economic growth. Entrepreneurial activities have the potential to increase the value creation process from multiple inputs into highly valuable economic outputs [4]. Further, youth entrepreneurship can significantly change the economic landscape of a country in a positive manner. By activating the youth a new environment can be created where ideas, risk taking, knowledge and skills are not limited by working in other enterprises, and where the youth start their own business [5]. Therefore, it can be argued that entrepreneurship is a key component of economic prosperity. Furthermore, this highlights the importance of entrepreneurship education and its effective management. Entrepreneurship education has been shown to positively affect entrepreneurship activities and it can significantly contribute to new entrepreneurial endeavors [6].

In this paper, entrepreneurship development among the youth through effective education management is discussed. The main goal is to address the necessary framework and challenges of youth entrepreneurship development in the context of education management. Theoretical models are developed in order to concisely and effectively investigate this subject. In addition, suggestions and guidelines regarding improving entrepreneurship development through education management are noted.

The paper consists of three main sections (excluding the Introduction and Conclusion sections). The first section addresses the key role of entrepreneurship for economic development and the importance of effective education management. The second section presents how youth entrepreneurship development can be improved through effective education management. Finally, suggestions and guidelines for improving entrepreneurship development are discussed.

II. ENTREPRENEURSHIP, ECONOMY, AND EDUCATION

It was noted earlier that entrepreneurship has multiple aspects of importance. More precisely, entrepreneurship positively affects economic development and economic growth [7]. Entrepreneurship can also positively affect the reduction of unemployment rates and it can contribute to increasing the standard of living [8]. It can be argued that entrepreneurship as an economic concept manages tools through risk taking for creating products and services, which provide non-linear value. This means that entrepreneurial activities, compared to traditional

business models, can provide higher ROI. From here, it can be argued that entrepreneurship education has to be improved and intensified on a national level. Entrepreneurship education is a complex construct that involves institutions, educators, learners, funding, infrastructure, and long-term systematic actions [9] [10]. The goal of entrepreneurship education is to increase youth entrepreneurship activity. Youth entrepreneurship reduces youth unemployment rates and generates innovation and value [11] [12].

Further, when it comes to economic development in the context of entrepreneurial activities, it mainly refers to the creation of value process and the development of new markets. New value creation from static inputs can significantly improve volume on the market and thus moving the economy forward [13]. In order to improve the outcome of entrepreneurship education, it is important to address the principles of effective education management. The discipline of education management includes a wide array actions and tools (mentorship, leadership, guidance, support etc.) [14] [15]. On Figure 1., the mentioned theoretical model is presented.

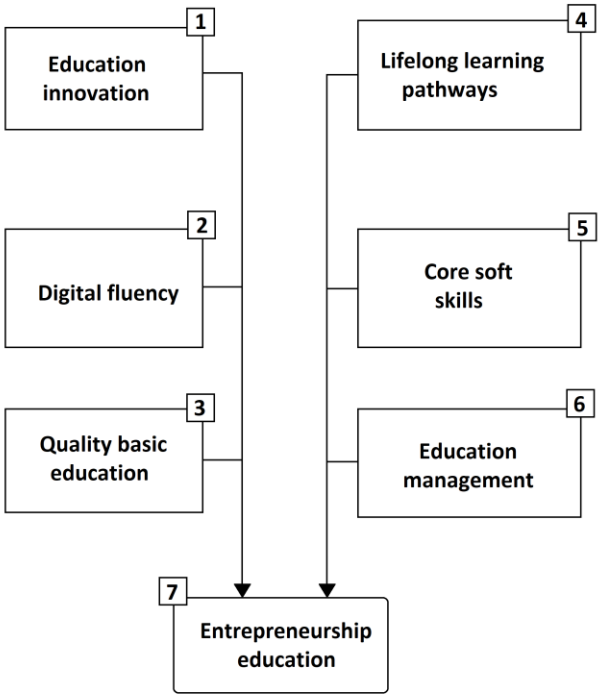

Figure 1. Entrepreneurship education framework

Based on the theoretical model presented on Figure 1., it can be seen that Entrepreneurship education (7) is affected and characterized by:

- the level of innovation in education (1) and how these innovations translate into percentages of newly formed business.
- Digital fluency (2) which indicates how well are computers and other IT hardware and software used for entrepreneurial activities.
- Quality basic education (3), refers to continuous quality of education.
- Lifelong learning pathways (4) refer to the attitude and willingness of learners/students to pursue continuous learning and self-improvement.
- Core soft skills (5) such as work ethic, teamwork, decision making, conflict resolution, time management, communication, and attitude.
- Education management (6) refers to the actions and processes that form an effective education management system.

Overall, the presented model outlines the main factors of influence on entrepreneurship education. As such, it provides sufficient detail for further analysis.

III. ENTREPRENEURSHIP EDUCATION MANAGEMENT FRAMEWORK

Based on the brief literature overview and the theoretical model of the entrepreneurship education framework presented on Figure 1., a second theoretical model of youth entrepreneurship development is developed. The model is presented on Figure 2. There are four main groups of factors that affect youth entrepreneurship development:

- Education management system
- Collaboration with enterprises
- Social innovation and digital economy
- Government support

The main focus is on education management systems, as the paper's subject mainly analyzes its effect on developing a suitable environment for youth entrepreneurship development.

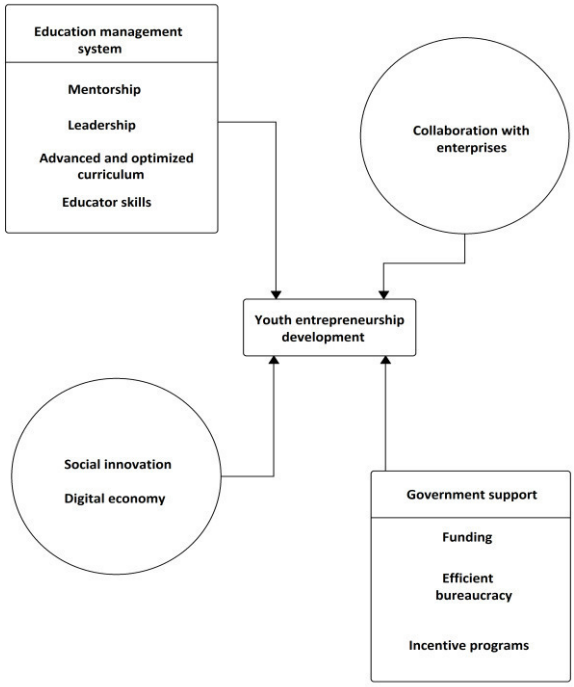

Figure 2. Model for youth entrepreneurship development

Based on the model presented on Figure 2., it can be seen that youth entrepreneurship development is characterized by the education management system, which includes mentorship, leadership, advanced and optimized curriculums where ICTs are applied in business, and the competencies and skills of the educator. Further, youth entrepreneurship development is affected by social innovation, social influence and the complex mechanisms of the digital economy.

Additionally, collaboration with enterprises play a huge role when it comes developing youth entrepreneurship and improving entrepreneurship education. Finally, government support in the form of funding that includes education institutions, entrepreneurial loans with flexible and affordable interest rates, new technologies in schools etc., efficient bureaucracy where paperwork does not affect entrepreneurship activities, and incentive programs for starting new businesses. The main challenges in youth entrepreneurship development are mainly strategic in nature. There is a lack of a systematic approach on a national level, and there are no clear strategic plans in place. Thus, it is necessary to take these issues into consideration when discussing and analyzing youth entrepreneurship.

IV. SUGGESTIONS AND GUIDELINES

Based on the analyzed literature and the developed models, the following suggestions and guidelines for improving youth entrepreneurship development are noted:

- The education system should be modified and focus should be given to the new economy that strives on knowledge, value, and content.
- Entrepreneurship education should be introduced on all levels of education.
- Co-curricular planning and timetable preparing should be in-sync and through the support of enterprises.
- Strategic and long-term collaboration between education institutions on all levels of education and enterprises should be encouraged, established, and nurtured.
- Students and teaching staff have to be motivated to thoroughly teach and guide future entrepreneurial endeavors.
- Effective education management practices such as reducing bureaucracy, reducing funding paperwork, and other time-sensitive activities should be strived towards to.
- Systematic change is required on a local level (schools, faculties, universities) and on a broader level (national, international).
- Education management has to take into consideration financing, budgeting, incentive projects from national and international governing bodies.
- Entrepreneurship education should be value-driven and not strictly traditional business-driven.
- On a local level, entrepreneurial workshops could be created for potential young entrepreneurs.
- SMEs and large enterprises should organize specialty classrooms where the majority of knowledge and skill will come through practices in specific domain.
- On a national level, incentive programs and incentive funding should be provided for potential new entrepreneurs.
- A new education management system should be considered where processes are evaluated and objectives are clearly defined.

Overall, youth entrepreneurship development can be improved through optimized education management practices. Focus should be on new business startups. Mentorship programs, seminars, education system sponsored courses can increase entrepreneurial activity among the youth. Youth entrepreneurship should be a long-term nation-wide strategy that is supported by the education system where operational activities are based on effective education management.

V. CONCLUSION

Youth entrepreneurship development is a complex task that should be focused on given the current economic climate where job security is typically low. An effective education management system should be infused into all levels of education where the youth is motivated and supported to start their own business. The main goal should be creating an entrepreneurial friendly environment, where economic value can be created. The programs that derive from such an effective education systems have to be supported by government agencies through funding and reducing bureaucracy.

The main limitation of this paper is the lack of empirical data from schools and universities. However, the paper provides a solid basis for future research in this domain. For future studies it is recommended to analyze the potential of collaboration between education facilities and enterprises and to determine the potential of such collaboration. In addition, details on strategic steps regarding effective education management can be discussed.

ACKNOWLEDGEMENT

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Digitalization in Language School Teaching- Russian Language Teaching on the Territory of the Autonomous Province of Vojvodina

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Abstract - Based on previous research experience of national minorities in Vojvodina, we recognized the need to research digitalization process through application of concept of online teaching of russian language on the territory of Autonomous province of Vojvodina. Time frame of the research was beginning of COVID-19 pandemic (from March 2020 to October 2021) because COVID-19 forced both elementary and secondary schools as well as private language schools to intensively hold online classes[1]. Our empirical research consisted of two parts. In the first part, questionnaires were provided to: teachers employed in primary and secondary school institutions on the territory of the Autonomous Province of Vojvodina with mandatory and compulsory classes of russian language and teachers who teach russian language in private language schools. In the second part of the research, we hold semi-structured interview with representatives of local authorities- the Provincial Secretariat for education, regulations, administration and national minorities, as well as with representatives of the The Russian House — Russian Centre of Science and Culture in National Council for Russian Minority in Autonomous province of Vojvodina. The empirical part of the research included analysis of new documents, search engines and electronic databases regarding the online teaching.

I. INTRODUCTION

Since the beginning of the COVID-19 pandemic period, over 1,000,000 children have stayed at home due to the closure of primary and secondary schools, and language schools were forced to adapt their teaching process and activities to these conditions and introduce the possibility of this form of teaching. In 2020, several international and domestic institutions and organizations advised and supported parents, educators and students of all generations, whether they attend classes within the regular schools or in language schools with distance learning support, and cooperation was achieved in making the innovative educational solutions. A more open and flexible approach is applied both in the process of teaching and learning within virtual classrooms, as well as in the administrative activities of teachers and school staff which can be used in future post-covid era. The cyberspace we live in today is unimaginable is without computers as mass personal means and networks in which they are terminals for producing and receiving information - the Internet [2]. Big in part, independent learning can be organized if modern teaching technology is effectively used [3]. Technology enables good teaching, provides an excellent platform for collaboration, but it cannot fundamentally improve bad methodological practices in continue [1]. Prepared teaching materials using modern technologies are far richer and more diverse and enable teachers and students to organize more interesting and effective learning through a greater number of different ones shape. Technical – technological progress, and especially the development of information and communication technology, have brought enormous changes in teaching, which is manifested primarily in the organization of content, application of new methods, techniques and media [5]. The goal of learning foreign language is to acquire the highest degree of linguistic autonomy, so that it can successfully deal with all communicative situations that require it knowledge of the target language. The user should also be given the opportunity to recognize and understand his weaknesses in order to strive more for the development of skills in accordance with his personal language needs and possibilities [4].

There is ongoing increase of interest in learning russian as most spoken slavic language and the fourth most widely spoken language in the world. In Serbia, 68,042 primary and secondary school students learn russian. When it comes to regular school system, a mandatory requirement is

[1] Empirical research was provided in 2021. during the engagement on project ''Social and economic effects and sustainability of online teaching- school teaching of russian language in the period of COVID-19 pandemics'' financed by Provincial Secretariat of Higher Education and Scientific Research (Reg.No. 142-451-2112/2021-01)

that schools must already have a teacher who can teach that language. As high school teachers point out, the problem is that they are powerless to meet students who did not learn russian in elementary school, but who want to learn russian, because the criteria stipulates that the second foreign language must be the one the students learned from fifth grade. The situation is different in the small number of private schools in Serbia, where the number of russian language course participants are increasing. We assume that this fact has economic background, because the russian company "Gazpromneft" operating in Serbian Oil and Gas Industry, employing thousands of serbian workers, affirm them to learn russian. Also we had migration flow in Serbia and Montenegro a decade ago, but recent migration flows caused by social crisis that Russian Federation has regarding military operation in Ukraine, will certainly have a social impact on russian community and russian entrepreneurs in Serbia and interest for the language.

II. RESEARCH METHODOLOGY

The empirical research that we conducted in the period from June 2021 to October 2021 had three phases. The first part of the research included collection of data by e-mail and direct contact using 2 semi-structured questionnaires. The first questionnaire was made for the school administration, and the second questionnaire was made for teaching staff who are employed in primary and secondary schools in the territory of the Autonomous Province of Vojvodina teach mandatory and complusory russian language classes. Also, the same two questionnaires were sent to the administration and teaching staff engaged in the process of learning Russian in private language schools. To fill out the questionnaire, a total of 110 schools in the territory of the Autonomous province of Vojvodina with organized russian language classes were contacted - 70 primary and secondary state and private schools, and 40 private language schools. Questionnaires were delivered by e-mail and direct contact (researchers collected the printed versions of questionnaire filled in schools and left in secretariat). The first questionnaire for school administration was mainly filled out by school secretaries, who forwarded questionnaire to their russian language teachers. In the second phase, data was collected by e-mail, telephone and direct contact where representatives of local government authorities were contacted - the Provincial Secretariat for Education, Regulations, Administration and National Minorities, who refered to representatives of 3 existing school administrations - the School Administration in Novi Sad, the School Administration in Zrenjanin and the School Administration in Sombor, who are in charge of primary and secondary schools in the territory of the Autonomous Province of Vojvodina. Their representatives responded the questionnaire. However, as the interviews were planned for September 2021, due to the growing negative epidemiological situation related to the COVID-19 pandemic, we agreed that the answers to the questions from the questionnaire would be submitted electronically. Also, the National Council of the Russian National Minority and Russian House were contacted and responded the semi-structured questionnaire. We also also analysed new documents, search engines and electronic databases related to online language teaching in previous year of the COVID-19 pandemic. The combination of these methods gave a more complete insight into effects and sustainability of the concept of online teaching regarding russian language teaching in the territory of the Autonomous Province of Vojvodina.

The questionnaire related to the administration of state and private primary and secondary schools as well as private language schools was divided into questions covering several key areas: 1. The possibility of monitoring russian language online classes before the start of the COVID-19 pandemic, 2. Changes in organizational and administrative structure , 3. Changes regarding students' interest in learning russian language/categories of citizens for learning the Russian language through a course, 4. an insight into digital tools used in teaching russian language and factors, 5. Education and training programs for teachers for the process of digitalization and the use of information technologies in the teaching of the russian language and their experience with them, 6. cooperation with national and international institutions and organizations in the implementation of online teaching of the russian language and experience with it. The questionnaire for teachers in state and private primary and secondary schools as well as private language learning schools, was divided into questions covering several key areas: 1. types of digital tools for distance language learning used so far and what was the frequency of use, 2. what did have an influence on the decision to use those tools and experience with them, 3. The impact of digitization and the use of information technologies on the learning process in classes and in what way, 4. positive and negative effects that digitalization and the use of information technologies had on teaching and the acquisition

of materials, 5. The sustainability of the existing model of digitalization and the use of information technologies in school teaching and how it can be improved, 6. Needs for training in the area of using digital tools for distance language learning. Questionnaires that were made for local institutions, i.e. school administrations, whose competences are related to activities on the implementation of the digitization process and the use of information technologies in the teaching of minority languages in primary and secondary schools on the territory of the Autonomous Province of Vojvodina as well as the National Council of the Russian National Minority, included the following key areas:

1. forms of digitalization and the use of information technologies and digital tools in the teaching and use of minority languages in primary and secondary schools in the territory of the Autonomous Province of Vojvodina
2. the impact of these processes on learning and use of minorities' languages
3. the impact of these processes on the formation of language teaching models
4. training programs related to the use of digital tools in the teaching of minorities' languages - organization, familiarity with programs organized by other domestic institutions and organizations in this field
5. cooperation with international institutions and organizations regarding digitalization and the use of information technologies in the teaching of minority languages
6. the sustainability of the digitization model and the use of information technologies in language teaching and specific measures that should be taken to improve it
7. predictions and expectations regarding this process even after the COVID-19 pandemic.

III. RESULTS OF THE EMPIRICAL RESEARCH

The answers obtained by applying 4 semi-structured questionnaires within the framework of the conducted research were extremely short, and the respondents did not show particular interest in a more extensive insight into the issues of digitalization and the application of informational technologies in the teaching of the russian language; they are presented descriptively, with very few descriptive elements and without specifying more specific indicators that would indicate a deeper understanding of the development of the online teaching model and the specific effects that could have on long-term

All the respondents who were contacted perceived digitalization and the use of technologies in the teaching of russian language as something that is short-term and implemented in extreme necessity due to the global crisis caused by the COVID-19 pandemic.

According to the results of the research applying questionnaire (survey) in the collection of data in state and private primary and secondary schools that teach the Russian language, among the digital tools teachers used daily were digital textbooks (100% of respondents), most often Microsoft Teams as a management system learning and communication tool for distance learning and mobile phone use (80% of respondents), they occasionally used free-cam screen recording as a tool for class presentations, screen recording and giving video instructions (85% of respondents), Google questionnaire as a tool for distance quizzes and formative assessment and from tools that encourage collaboration and engagement of users - they used Viber every day (100% of respondents). Of the educational content managed by students, E-classroom and mobile applications for reading were used, and Read Era was occasionally used (65% of respondents). Mostly, teachers were not familiar with digital tools in the art of reading, and they also did not use platforms for video conferencing and monitoring of general education news or systems with offline functionality. Also, platforms for open mass online courses were not used. The decision to use the mentioned digital tools was mainly influenced by the agreement within the school and the recommendations of colleagues (100% of respondents) because in regular circumstances when teaching on-site, lecturers do not use digital tools in teaching because they do not have adequate training or technical equipment and resources for their use. Most of these digital tools are easy to use and they are free for download, so it was the main reason for use. Both regular school teachers and language school teachers believe that the information technology sector and companies involved in these technologies should invest more time in training teachers to implement new distance learning tools because it leads towards future of their professional development. The majority of teachers attended seminars on this topic (74% of respondents) and expressed a desire for additional training, given that it represents a new and unfamiliar work and professional environment for them. The fact that today in the Republic of Serbia only 15% of teachers (out of a total of 83,597

teachers in regular primary and secondary education) have the competence to use ICT (informational and communicational technologies) follows our findings. The Ministry of Education, through the "Digital School" program, made it possible to publish examples from practice, in order to motivate other colleagues to educate for working in a new environment. An E-diary was created, and digitalization of teaching became widespread, as first, second, fifth and sixth grade teachers were trained to use digital textbooks. At the same time, all publishers had to create digital editions for their textbooks. One group of publishers went step further, creating E-classroom, a platform where a teacher can hold class, communicate with pupils/students and monitor their activities and progress. On the website of the Institute for the Improvement of Education and Upbringing, carrying out development, advisory, research and other professional work in preschool, primary and secondary education and upbringing, and with the aim of monitoring, providing and improving the quality and development of the education and upbringing system, a platform is available for conducting public interest trainings developed within the project "Improving the quality of education and upbringing through the establishment of the National Education Portal", which is implemented by the Institute for the Improvement of Education and Upbringing in partnership with the UNICEF mission in Serbia and the Ministry of Education, Science and Technological Development, thanks to the financial resources of the Swiss Agency for Development and Cooperation. The Faculty of Education in Sombor, University of Novi Sad, has been majoring in Media Designer in Education since 2004.-the occupation that is extremely promising in the world, and it involves the work of a teaching associate who deals with the creation of multimedia materials and the setting up distance learning platforms that combine the use of modern technology, media and art in the teaching and education. However, this profession has not yet found its place on the serbian labor market. The teachers pointed out that the transition to online teaching and the use of digital tools and information technologies had positive effect on students and that one of the most common positive effects were psychological impact- teachers noticed much less nervousness in communicating in a foreign language and manifestation of individual creativity among students, which can be linked to the fact that students were in their primary environment- they worked from home. The negative side of this process is that most teachers and students still prefer to use traditional methods and tools in teaching and there is a certain difference between students in information literacy in groups. Significant negative effects were not observed among students, but were observed among teachers who were engaged as teachers of the russian language in primary and secondary schools and additionally worked as teachers in private schools in the form of overload and insufficient preparation of digital content for the lesson, which makes the lesson monotonous and poor content. According to the results of research related to private language schools, the pandemic did not generally bring more interest in russian language. If it was so, the reason were discounts for online classes that language schools offered in the period of COVID-19 pandemic, so pandemic itself indirectly might influenced the increase in interest in online learning of the russian language. Young people mostly between 20 and 30 years were interested, and the interest mostly related to module of intensive A-level courses (60% of language schools surveyed), after which they continued to attend semi-intensive online B-level courses (33% of language schools surveyed). According to the majority of respondents who filled out the survey as administrative staff, online teaching did not bring any significant changes in the administrative and organizational sense (53% of respondents from the total number of all schools). From local government and institutions and bodies responsible for implementing educational policies and improving the status and process of learning the language that has the status of national minorities' language, we received very extensive answers with a lot of information regarding the effect. Also, constructive proposals were made regarding the model of language learning in the territory of the Autonomous Province of Vojvodina, for the reason that institutions such as the National Council of the Russian National Minority, Russian House and diplomatic-consular mission and institutes, are in charge of educational strategies and innovations in language teaching in our country. At the time of the research, the National Council of the Russian National Minority was planning to implement the project of digitalization and the use of information technologies in language study, including leading experts - philologists from Russia to create an interactive version of the textbook for the optional subject "Russian language with elements of national culture" and start preliminary works on harmonizing the technical details of the project. According to their opinion, in order to gain access to modern methodological interactive materials and technologies, one should directly address the sources that created and spread them - expert centers and institutions, including special centers

for training and retraining teachers, including the Russian Center for Science and culture in Serbia, including the International Center for Russian as a Foreign Language, etc. If all the above suggestions are implemented, the teaching of the Russian language in schools will begin to keep up with the times, given the enormous possibilities of modern digital technologies. Access to the portal is provided on the website of the National Council of the Russian National Minority. Portal "Education in Russian" Project of the State Institute of the Russian Language named after A.S. Pushkin whose goal is teaching russian as a foreign language, popularization and promotion of the russian language and education. The combination of a platform for distance learning, system for teachers' remote professional development, mass online russian courses for people of different ages learning language and social network for thematic communication of portal users provides an opportunity for everyone who wants to learn russian independently or under the guidance of tutor, to pass a test for knowledge of russian language and obtain certificate confirming the level, knowledge on various topics in open online courses of the russian, to become a partner of the portal, declaring and participating in projects implemented on the portal in the field of study, promotion and preservation of russian. With this portal, teachers of russian can improve their qualifications in the field of professional activity, mastered one or several training programs presented on the portal. By subscribing to online training on the "Education in Russian" portal, users portal are offered the opportunity to complete free online training by subscribing to the studies of one or more courses. On the other hand, on the website of the Russian House in Belgrade, as the largest center for science and culture in the Republic of Serbia, courses for children and adults, as well as about seminars, webinars, improving the professional competences of teachers and educational exhibitions, study scholarships and universities in Russia can be find. There is also virtual access to cultural events and institutions made possible by the Google Company and Rossotrudnichestvo (Federal Agency for Commonwealth of Independent States, Compatriots in Dispersion and International Social Cooperation) whose offices in 80 countries promote russian culture, science and education abroad. Among them are YouTube channels of leading russian theaters, Google Arts & Culture for access to virtual tours of russian museums and sights, and other educational resources. In addition to these institutions, russian universities, offering online learning, contribute to the increased interest in learning language outside the framework of state formal educational institutions. Popular russian web-sites in serbian language, such as, "Russia Beyond Serbia", five learning sites are recommended, namely: Moscow State University "Lomonosov" (MGU), which offers russian language skype learning for 16 euros. Internet company ''Russia Today'' launched free russian language learning program for different levels of knowledge - beginners can get acquainted with the russian alphabet, while there are more advanced lessons for those who already know the cyrillic alphabet. Participants have the opportunity to master the courses using teaching material: from simple exercises to grammar tables and tests. The third site is "Russian For Free", which contains a rich archive of step-by-step learning materials. Here you can find simple exercises for beginners (writing, games for vocabulary development), but also very demanding tasks (musical video material and cartoons in Russian). There is also a collection of the most common phrases for tourists. On web-site you can also find a trial version of the application for private learning via Skype, which costs only one euro. The fourth way is available through the application "The Easy Ten",by learning 10 words every day". Words can be selected from several groups dedicated to certain topics, which are then converted into the desired format with the help of software designed for that purpose. In this way, you can also practice pronunciation and solve audio tests, which is a fun way to learn language, especially suitable for users of modern phones, because notifications on the device and access via social networks are available to them, which allows them to compete with friends in solving tests. The application is free on App Store and Google Play. The fifth option for learning language is provided through podcasts. One of the easiest ways to learn a foreign language is to listen podcasts (audio files), on the way to school or work or during a long drive instead of listening to the radio. Tatjana Klimova has recorded 200 short dialogues, in which she explains the meaning of complicated words - which is an excellent choice for those who want to enrich their vocabulary. In Russia, in addition to online learning, summer schools for learning language are also offered, for which the "Russia Beyond Serbia" website recommends one of the seven summer schools in Russia, namely: Moscow School of Economics (at the price of 2,869 euros for eight weeks, fees, accommodation, instructor assistance and visa support services are included), State Institute of the Russian Language "A. S. Pushkin" from Moscow (price from 480 to 590 euros), St. Petersburg Polytechnic University "Peter the Great" (at a price from 230 to 650 euros), St. Petersburg Electrotechnical University

"LETI" (from 208 to 485 euros), Lobachevsky University from of Nizhny Novgorod (485 euros), Ural Federal University from Yekaterinburg (932 to 1970 euros) and Tomsk State University (695 euros). In April 2018, the Babbel language learning platform compiled a ranking list of the european languages most popular among speakers with 120 million native speakers. Knowledge of russian language can provide an excellent job in contemporary russian companies, which cooperate with many companies, institutions, and countries. As the official language of the United Nations, it has been neglected in our educational system since the beginning of democratic changes and european integration. As many language teachers believe, learning Russian creates a balance and helps serbian language not to disappear from the world language scene due to the influence of western languages, primarily English and German.

IV. RECOMMENDATIONS

According to the results of the research, the existing model of digitalization of teaching and learning the russian is quite sustainable, and to improve that model, we made a joint conclusion in which direction measures could be taken: development of programs for remote quality control, introduction of remote testing in russian as a non-native language (the purpose of such control is to identify the level of knowledge of russian, solve the problems that arise due to the lack of coordination between schools and institutions near school according to their socio-cultural tasks (media, libraries, museums, theaters), which significantly hinders the development of this entire area, combining the efforts of the employees of various cultural institutions in order to create a unique field of mastering the russian, to coordinate pedagogical strategies using educational and cultural resources of museums, theaters, and libraries operating in a certain region with incentives at the local and regional level to strengthen the capacities of primary and secondary educational institutions, as well as language schools, conducting training and active participation of teaching staff in the process of modeling digital teaching and using information technologies in teaching and educational practice. to additionally stimulate companies that deal with the development of digital educational technologies and distance learning systems for the education and training of teaching staff in this area, to encourage closer cooperation and the establishment of associations of teachers and professors, encourage the use of digital tools in the russian in the teaching-educational process, to encourage the largest possible number of scientific research projects related to the issue of digitization and the use of information technologies in the teaching process, encourage as many domestic and international scientific and professional conferences as possible, in which domestic and international teachers and scientists in this field will participate, to encourage domestic and international scientific and professional conferences on themes like digitalization and the impact of informational technologies on educational and teaching processes.

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Latest Technologies in Web Site/Application Development

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Abstract – Nowadays, numerous technologies have been developed which, among other things, enable the development of websites, i.e. application. This paper presents a possible mix of technologies that can be used for these purposes and that was proposed from the perspective of the members of the development team. Therefore, comfort in work, benefits of programs possibilities and ready-made solutions, modernity, fast implementation, compatibility and simple use of the product, i.e. site/application, were taken into account. This selection of technologies can be used as a guide when developing any modern application/site.

I. INTRODUCTION

A web application and a website can be developed by using the same technologies and they include, among others, TypeScript, SCSS, HTML5, Bootstrap and other modern technologies that are necessary for a visual overview of information. Also, modern programming languages are included within a modern framework that can be selected for website/application development needs.

This paper presents a possible mix of technologies that can be used for these purposes and that was proposed from the perspective of the members of the development team. Therefore, comfort in work, benefits of programs possibilities and ready-made solutions, modernity, fast implementation, compatibility and simple use of the product, i.e. site/application, were taken into account.

JavaScript is primarily designed for use within web browsers where this language is used to write scripts that affect the functionality of HTML pages. Node.js is a platform on which JavaScript code is written and allows its execution outside of the web browser.

AdonisJS is a JavaScript/TypeScript framework for developing a website and/or an application. It contains everything needed to develop a fully functional web application. Thanks to this, AdonisJS can be used for almost all functionalities, including: models, registration, login, data validation, bookmarking pages containing the same content, sending e-mail messages, etc.

The content that the user/visitor can see when accessing the site/application is written using Hyper Text Markup Language (HTML), which is a standard tool for creating web pages. This language can be used in combination with the Bootstrap library, which contains predefined elements such as: the layout of the navigation menu, footer or page header, tabs... The user of the library can take advantage of these ready-made elements and embed them (for example, using CSS or SCSS -a) into the site in order to create modern user interface.

Elements defined using HTML have a default appearance that does not conform to modern design. In order for these elements to reach their full potential, Cascading Style Sheets (CSS) may be used, that is a standard tool designed to beautify HTML elements. The fact that the design of web pages is becoming more and more complex and thus the CSS files are getting bigger, CSS is used in combination with Syntactically Awesome Style Sheets (SCSS) which allows easier maintenance of styling files, creation of variables and mixins, that represent styles that can be used more than once.

Following chapters describe the basics of selected technogies for web site/application development.

II. NODE.JS

Due to its asynchronous nature, i.e. the ability to execute several different pieces of code at the same time, the primary purpose of Node.js technology is to create network applications. In addition to Node.js, there are other technologies such as: Java, .NET, Python... The development team can opt for Node.js technology in order to ensure that the same programming language

"extends" to both front-end and back-end a part of an application.

It has a predefined method by which an HTTP server is created on the user's computer. It also contains a method that tells the server which port to 'listen' on. These predefined methods can be seen in Figure 1 where the server will be accessed via the 127.0.0.1:3000 URL with the response: "Hello World".

```
const http = require('http');

const hostname = '127.0.0.1';
const port = 3000;

const server = http.createServer((req, res) => {
  res.statusCode = 200;
  res.setHeader('Content-Type', 'text/plain');
  res.end('Hello World');
});

server.listen(port, hostname, () => {
  console.log(`Server running at http://${hostname}:${port}/`);
});
```

Figure 1. Setting up a server with a basic configuration

Node.js represents a server environment that is available to everyone due to its open-source feature, i.e. the source code is available to the public. Another extremely important feature is that it works on several different operating systems – Windows, Linux, MacOS, etc.

A parallel can be drawn between PHP and Node.js in case they need to handle file requests. PHP handles file requests as follows:

1. Sends a task to the computer's file system.
2. Waits until the system opens and reads the file.
3. Returns the content to the client.
4. It is ready to handle the next request.

Node.js handles file requests as follows:

1. Sends a task to the computer's file system.
2. It is ready to handle the next request.
3. When the system has opened and read the file, the server returns the contents of the file to the client.

Based on the above comparison, it comes to the conclusion that Node.js eliminates waiting for replies and continues with the next request in the sequence, making it a better candidate to use. It offers creation possibilities, i.e. generating dynamic page content, creating, opening, reading, deleting and closing files on the server. It also offers collecting data from form and adding, deleting and modifying database data used for website/application development. [1]

III. JAVASCRIPT

A program, often called source code or just code, is a set of special instructions that tell a computer what tasks to perform. Code is usually stored in a text file, although JavaScript allows you to type code directly into the console. [2]

JavaScript is an important programming language because it is the language of web browsers. Its connection to the browser makes it one of the most popular programming languages in the world. At the same time, it is valid for a programming language that is counted among those with a "bad reputation". Application Programming Interface – API (a software intermediary that enables the exchange of information between two applications) of the browser and Document Object Model – DOM (a programming interface for web documents; represents a page so that programs can change the structure, style and content of the document) are complex, however, a fact is that it is difficult to work with the DOM using any programming language. [3]

Like any programming language, JavaScript has its pros and cons. The good points are about functions, free typing, dynamic objects, and expressive literal object notation. On the other hand, the programming model based on global variables is bad. JavaScript functions are first-class objects with (mostly) lexical scope and are the first lambda language (allowing one function to be passed to another, where the function is treated like any other variable) to become known.

IV. ADONISJS FRAMEWORK

AdonisJS Framework is primarily intended for creating web applications. Its main feature is that it operates with dynamic, not only static, data. Beside this framework, for the same purposes, the following are available: Express, Koa, etc.. If Express is used, the time required for application development should include work on defining the external libraries that will be used, while AdonisJS provides these libraries by default. In this way, application development using the AdonisJS framework is noticeably shorter. Development teams still opt for Express because it has been in use longer, or so the project description claims. If Koa is used, which is a slightly more modern version of the Express framework, it is also necessary to take into account the work on defining external libraries in the time needed to develop the application, while they are default in AdonisJS.

AdonisJS is a framework that contains a Model View Controller template structure that is inspired by the Laravel web framework that uses the PHP programming language. Consequently, like Laravel, it reduces application development time by focusing on essential details such as: speed of development, insight into all phases of the life cycle, authentication, data validation, etc.

Developers/users around the world have created numerous libraries that can be used within Node JavaScript, to make the implementation of various projects much easier and more interesting for them. AdonisJS is a framework that covers front-end and back-end development and has an emphasis on comfort, stability, development speed and security for developers. [4]

AdonisJS contains a library and packages for sending e-mail addresses. These packages have pre-defined options. It contains its own user authentication system, where this system supports three different types of authentication.

Adonis strives to standardize both packages and processes, reducing development costs (shortening training time) and enabling developers to be more efficient from the start. It also enables elimination of some repetitive activities and simplifies the maintenance of the application and tests. [5]

Due to the provision of the most essential libraries when talking about the realization of a web application, the AdonisJS framework is very suitable for developers who are new to using Node.js technology. Also, its command line is very useful, because with predefined commands the programmer can generate most of the folders and files with the initial structure, which cancels the need to write the same code over and over again. This implies that the entire structure of the project can be created via the command line (Command Line Interface – CLI, is a mechanism used to interact with the operating system or some software, which involves entering commands to perform specific tasks), after which the content of those files should be filled with arbitrary code. In some cases, an application can be fully developed in just a few hours. [6]

V. MODEL VIEW CONTROLLER

Depending on the amount of data that needs to be displayed to the users of the website/application, the development team may choose to use the Model View Controller (MVC) architectural pattern. Using the MVC software pattern separates the source code that deals with data from the source code that deals with the user interface, which makes the development of these parts of the application easier and simpler. The goal of using MVC is to divide the web application, which is based on interaction with users/visitors, into three components: **model**, **view** and **controller**.

The model contains data, i.e. refers to the database used within the application. Tables with their fields are stored inside the database. The web application consists of a database containing several tables with corresponding fields.

A **view** displays data from a model in a form that is suitable for interaction, usually as a user interface component. Each component behaves depending on what the user wants to see, that is, it depends on dynamic input data.

The controller coordinates between the model and the view, where that coordination is mostly based on user input. For example: when the user/visitor clicks on the button that provides access to the listing page, then the controller knows which view component the user is on, and therefore knows which data corresponds to that component, i.e. what data should be sent and how to edit them if defined.

Therefore, certain items have their own models that define which data will be displayed on the view component, they have several different view components (for example, a page where there is a list that displays all the relevant content from the database or an individual profile) as well as controllers that contain procedures which enable the creation and updating of components.

VI. HYPER TEXT MARKUP LANGUAGE

Hyper Text Markup Language (HTML) is the standard technology when it comes to creating web pages. The web pages that are created contain paragraphs, headlines, images, video clips, audio tracks, etc. It is used to define the structure of texts, media and embedded objects within web pages and electronic mail. [7]

The basic application of this language can be found when talking about the problem of separating specific elements on one page, where by using this technology and its capabilities it is possible to precisely define where the title or any other element should be located. Within this language are also implemented elements that aim to describe the characteristics of a particular web

page. These features include keywords, content description, author information, and the like. This information is extremely important for meta data and is precisely separated from the page content itself. [7]

VII. CSS AND SCSS

Cascading Style Sheets (CSS) involves styling the basic elements of an HTML document such as font size, background color, text color, etc.

There are several ways to write CSS, they are:

• Inline, the style is defined inside the HTML tag,

• Inside the <head> tag there is a <style> tag,

• The most preferred method is external CSS, because it separates the settings for the appearance of the page from the definition of the page elements themselves, which improves visibility.

From the moment of its creation, HTML had one purpose – to display what the author of the document defines (paragraph, title, etc.). After the appearance of new tags within HTML, developers were increasingly faced with problems when creating a web page. Therefore, the World Wide Web Consortium (W3C), which is the non-profit organization responsible for standardizing HTML, created styles as a supplement to HTML, which is a major milestone when it comes to web design. [8]

The Syntactically Awesome Style Sheet (SCSS) allows styling files to be much better organized. This is achieved by creating mixins, which are actually styles that can be used multiple times if needed. An extremely important feature of this technology is nesting, that is, any selector can be placed inside another selector.

VIII. CYPRESS

Cypress is a JavaScript end-to-end testing framework. It is built on a completely new architecture, where it does not use Selenium which is used by most other automated testing tools. It is also open-source, which means that the improvement of the framework, in addition to the main developers, is also due to the community that often uses this tool. Open-source allows the framework to progress better and faster than it would be the case if only the core team worked on it. It is specifically intended for developers and QA engineers so that they can realize anything they want.

Some of the features of this testing tool are:

1. "Traveling through time" - photos are saved during execution, whereby the user has an overview of what exactly happened before and after execution,

2. Easy debugging - readable errors that make debugging faster and easier,

3. Refreshing the user interface - the tool automatically refreshes the user interface if there is any change in the test,

4. Waiting for commands – Cypress waits for commands or input before continuing,

5. Ability to control network traffic,

6. Effective results,

7. Ability to run tests on different web browsers.

Most of the tools used for testing work by running outside of a web browser and then executing commands. Thanks to the Node.js platform, Cypress is executed in the same loop as the application, i.e. behind this technology there is a Node.js server process. Node.js and Cypress processes are constantly communicating, synchronizing, and performing tasks. Cypress has the ability to modify code that has a chance of interfering with it, thereby controlling the entire automation process. This fact puts this technology in a unique position to understand what is happening inside and outside the browser. This significantly affects its ability to deliver effective solutions compared to other technologies. [9]

IX. TYPESCRIPT

The TypeScript language is very similar to the JavaScript programming language, the only difference being that TypeScript offers additional syntax. It represents a syntax superset of JavaScript that adds static typing. Unlike JavaScript, TypeScript allows you to specify the data types that are passed within the code and there is an option to report an error if the data types do not match. This eliminates the need to read the official documentation. For example, if a function expects a string data type and is passed an integer, then an error will be reported. [10]

Some of the features of this technology are:

• TypeScript is JavaScript and JavaScript is also Typescript,

• They adopt the same basic building blocks and knowledge of one language enables the use of another,

• A valid JavaScript file can be renamed to a TypeScript file and compiled,

TypeScript technology contains three basic components:

• Language – consists of syntax, keywords and data type annotations.

• TypeScript Compiler - Converts instructions written in TypeScript into their equivalent JavaScript instructions.

• TypeScript Language Service – exposes an additional layer around the main compiler pipeline. This service supports a common set of typical edit operations such as statement completion, signature assistance, code formatting and drawing, colorization, etc.

X. CONCLUSION

The technologies presented in this paper were selected from the aspect of actuality, efficiency, speed and comfort in work during the development of a website/application. It is a fact that the choice of framework greatly affects the process of web application and website development. In addition to using JavaScript on the back-end and front-end of the application and website thanks to the Node.js platform, Adonis.js can reach its full potential. The development team does not waste time to find external libraries that are compatible with the current version of the project. Adonis.js provides everything from routing to data validation during user login and content creation. In addition to providing all the necessary libraries, Adonis.js uses the MVC software pattern that allows the structure of the website/application to be as transparent as possible.

Therefore, the proposed technologies can be used for the development of any website/application.

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Microcomputer TK8-A for Solar System

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Abstract – In this paper we consider the main parts of the TK8-A microcomputer. We explain how all the elements work and what function the individual parts of the TK8-A microcomputer have in a solar system for water heating

Keywords: microcomputer TK8-A, solar system, sensor, valve, tank

I. INTRODUCTION

In this paper we will focus on non-pressurized solar water heater and the TK8-A microcomputer.

Solar water heater is the conversion of sunlight into renewable energy for water heating using a solar thermal collector. 'Solar Water Heating' systems, or 'Solar Thermal' systems, use free heat from the sun to warm domestic hot water.

There are mainly two types of solar systems for water heating:

- Pressurized solar water heater
- Non-pressurized solar water heater

Pressurized solar water heater also called phase change thermal conductivity full pressure solar water heater is typically characterized by an enclosed heating unit containing copper tubes connected indirectly to a tank. . The phase change thermal conductivity collector is composed of vacuum tube, phase change heat pipe and heat transfer aluminum wing. Because of the threaded connection between the phase change heat pipe and the water tank, and there is no liquid in the vacuum pipe, it can withstand pressure.The high-pressure Direct Pressure Solar Water Heating System features evacuated tubes and heat pipes. The heat pipes absorbs solar energy and converts it into heat energy, this energy is then used in the process of heating water. There is no direct connection between the heating fluids in the copper tubes and the water being heated. Pressurized systems allow you to have a closed loop and a circulation pump so that the water in the pipes is constantly pumped through the solar collectors where the water gets hot, then around all the pipes so there is always hot water instantly at the tap Pressurized solar systems work on the same principle as a regular water heater. If we have a hot water outlet, the system automatically receives cold water and the tank is constantly refilled, so the water pressure at the inlet is the water pressure at the outlet. The controllers used in this type of systems are mainly for observing the characteristics.

Non-pressurized system are also called straight-in all-glass vacuum tube solar water heaters. Because the vacuum collector and water tank are sealed by sealing rubber ring, they can not withstand pressure.The non-pressure solar water heater normally uses the non-pressure water shutdown, the efficiency is high and the service life is long. The low-pressure gravity system consists of a vacuum glass tube collector, an insulated storage tank and optional stand parts (make up tank). The water is delivered to the tank on the roof by a pump of some kind or from a water tower, which naturally means there is some pressure and then the evacuated glass tubes are filled with water and exposed to sun, thus heating up the water in the glass tubes.This system is completely compatible with shower pumps and other household pumps to add water pressure in the house. But the tanks and the panels or tubes are not pressurized themselves.

Non-pressurized solar water heater has microcomputer that regulates the level of water in the tank. In non-pressurized solar water heater, the tank is not loaded with water automatically, when the user spend water from tank the system not load automatically cold water. The user can use up all the water in the tank and then add cold water in the tank. The loading of the water in the tank and heating of the water with electric heater the user is made it with microcomputer TK8-A.

In this paper we will focus only on the non-pressurized solar water heater and the TK8-A microcomputer and we are going to explain withc part need to be active so user can load cold wather in tank and how can user whart the wather in thank with electic heater.

II. MICROCOMPUTER TK8-A FOR SOLAR SYSTEM

The microcomputer TK8A is using for controlling the working of the solar system for water heating. The microcomputer can perform an operation like fill the tank with cold water, turn on the electric heater for heating the weather in the tank and other operation.

For controlling the solar system with microcomputer TK8-A the user needs to have also the other parts that need to be attach to the microcomputer so he can make the function of controlling.

The parts that need to be attached for the micromicrocomputer are listed below:

- Top sensor
- Solenoid valve
- Electric heater

A. Top sensor

The top sensor is the part that is on the picture 1. The top sensor is on the top of the tank and it have 4 sensors on his body. If the water level in the tank is higher than the first sensor, then the microcomputer light that the tank is filled with water 25%. If the water level is higher than the second sensor than the microcomputer light that the tank is filled with water 50%. If the water level is higher than the third sensor than the microcomputer light that the tank is filled with water 75%. If the water level is higher than the fourth sensor than the microcomputer light that the tank is full of water 100%. In the picture 2 is show the part where the microcomputer gives information for level on the water in tank.

Also the top sensor is using not only to show the level of the wather in tank nut also to show the temperature of the whater. So the top sensor is also a termostat that measures the temperature and give that information to the microcomputer.

On the picture 3 is swohen the place whre the top senson need to be attached on the microcomputer.

Figure 1. Top sensor

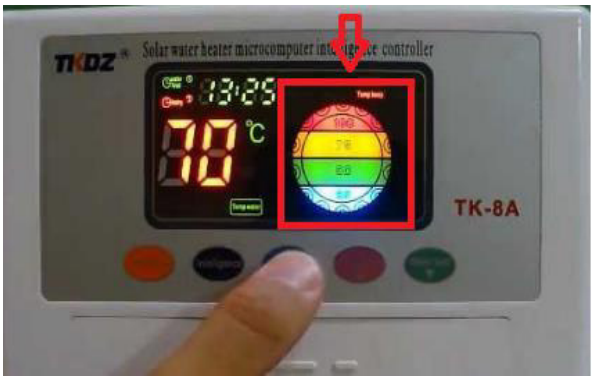

Figure 2. information for level on the water in tank

Figure 3. Plug in for top sensor

B. Solenoid valve

The solenoid valve is using for filling the tank of the sollar system with cold whater. So when the user press the button on microcontroler that want to fill with cold whater that the solenoid valve is opening and cold whater is filled to the tank. For give the comand on solenoid valve to open the user need to press the green butoon on the micromicrocomputer that is named “Water load▼”. When the user press the button “Water load▼”, then the solenoid valve open and fill the tank with cold water. When the level of the water in the tank it reach the forth sensor on the top sensor than the solenoid valve is closing because the tank if full with water 100%.

On the picture 4 is showen the solenoid valve, and on the picture 5 is showen where the solenoid valve need to be attached on the micromicrocomputer TK8-A.

Figure 4. Solenoid valve

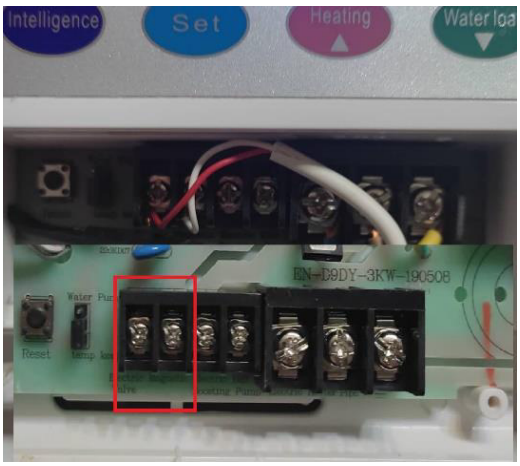

Figure 5. Plug in for solenoid valve

The solenoid valve have specifications that are listed bellow:

- 1/2" Nominal NPS
- Working Pressure: 0.02 Mpa - 0.8 Mpa
- Working Temperature: 1°C ~ 75°C
- Response time (open): ≤ 0.15 sec
- Response time (close): ≤ 0.3 sec
- Actuating voltage: 12VDC
- Actuating life: ≥ 50 million cycles
- Weight: 4.3 oz
- Dimensions: 3.3" x 1.69" x 2.24"

C. Electric heater

Electric heater is attached in the tank and is coneccted also with the microcomputer TK8-A. The electric heater is using for heating the whaet in the tank. So when the user of a sollar system is not satisfied with the temperature of the whater in the tank he can activate the electric heater. The electric heater is activating on the button on the microcomputer that is named "Heating▲". But first before to activate the electric heater the user need to define the temperature that want to reach , this can be done with pressing the button Set and user can define the temperature with press on the buttons "▲" UP and "▼" DOW. After selecting the temperature that want to reach the user is activating the electric theater. On the picture 6 is shown the electric heater and on the picture 7 is shown where the electric heater need to be attached to ne microcomputer.

Figure 6. Electric heater

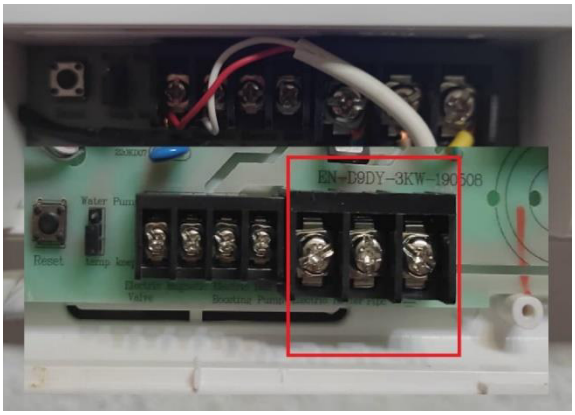

Figure 7. Plug in for electric heater

Wen the user have attached all the parts whit the microcomputer than can start with the controlling of the working on the sollar sustem. On the picture 8 is showen where the parts (Top sensor, magnetic valve and the electric heater) need to be attached.

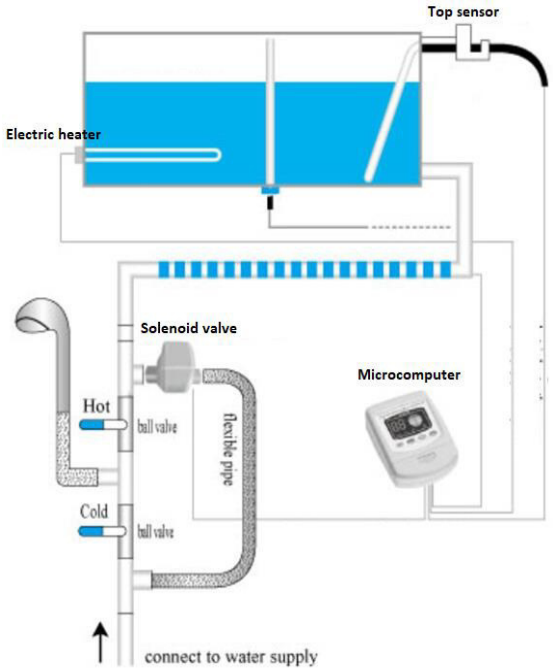

Figure 8. Installation diagram

III. CONCLUSION

The microcomputer itself has the appropriate settings for the solar system and it works and communicates perfectly with the peripheral parts. Improvements to the next series are possible in the part with remote control, the user can have information about the level and temperature of the water in the tank from a distance and manage them according to his needs.

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Formative Assessment In Distance Education - Examples From The Practice Of English Language Teaching In Primary School

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Abstract - The aim of this paper is to present the selected methods in formative assessment in the online learning process. The school subject is English as a second language in higher grades (13- or 14-year-olds). The grammar point is Passive Voice. The selected formative techniques are derived from learning outcomes (based on Bloom's taxonomy) and show activity types (based on Laurillard's Conversational Framework). Teachers are constantly encouraged to improve their digital competences to make the learning process easier, more memorable and more interesting. This paper shows how an English teacher, but also other teachers, can use ICT tools to achieve outcomes and improve students' performance and competencies.

I. DISTANCE EDUCATION IN LANGUAGE LEARNING TODAY

Distance education has been around for more than two decades now all around the world. It encompases many levels and forms, from the lower primary school to postgraduate courses. Students, as well as their parents, may choose distance learning for many different reasons. Schools, on the other hand, offer a wide variety of content, student support and types of examinations.

All school subjects can be taught through distance learning. In more communicative ones, however, like languages, both native and foreign, the physical separation of the teacher and students may present more of a challenge. The reasons for this are language-specific contents like fluency, intonation, listening and speaking practice, and the basic need for communicating a message. In order to monitor their students' progress in these reciprocal activities, foreign language teachers are required to make an additional stretch and effort to make their learning activities brain-teasing and pleasing to students. This is true for all language proficiency levels and ages, but especially more so for primary students. The reason is that in the traditional classroom, all four types of learners (visual, auditory, kinesthetic, tactile) [1] can be catered for. In distance learning, on the other hand, kinesthetic and tactile are, naturally, in the background, while visual and auditory take precedence. Cooperation, peer learning, pair work, small groups and short project-based tasks are a true dare both for teachers and students in distance learning circumstances. Due to all the above mentioned reasons, students are much more dependent on their own competencies and efforts. That is why it is a teacher's mission to make the learning process more interesting and enjoyable, as well as to encourage self-confidence and student autonomy. Assessment, as part of that process, in these circumstances should not be too time-consuming, since organization of time is a relevant issue in distance learning. It should also be such that it directs students towards a desired outcome, i.e. provides instant feedback and can be repeated a necessary number of times. One of the best methods for language learning is through trial and error.

II. THE PURPOSE OF FORMATIVE ASSESSMENT

Assessment is a continuous pedagogical activity that positively determines the attitude towards learning and knowledge and encourages motivation to learn [2]. This implies that assessment of students' achievement and effort should be done on a regular basis. The positive component of assessment suggests that the activity should come natural and not stressful to students and that they should regard it as a positive direction towards better academic results and self-confidence. Thus, assessment is an excellent way to build self-confidence and internal motivation in students, which are both a much needed basis for

success in any type of learning.

Formative assessment is a part of that process. It refers to a wide variety of methods and techniques that teachers use to assess the comprehension of their students on a topic or unit, to better understand their learning needs and to make future planning easier and more student-centered. It may vary from asking a simple question to check understanding of a general point to a short quiz to an elaborated self-assessed essay against a defined set of criteria. While formative assessments help teachers identify learning needs and problems, in many cases the assessments also help students develop a stronger understanding of their own academic strengths and weaknesses. When students know what they do well and what they need to work harder on, it can help them take greater responsibility over their own learning and academic progress [3]. In traditional classrooms, these techniques are somewhat dependent on the physical presence of teachers and students. In distant learning, however, where physical presence is not a must, ICT tools are a very powerful means to achieve the same goal. Many ICT tools are, of course, used in traditional classrooms, but in distant learning they hit the bull's eye - they are visually attractive, easy to replicate, time-efficient, and provide instant feedback.

III. BLOOM'S TAXONOMY IN FOREIGN LANGUAGE CLASSROOM

Bloom's taxonomy is a system that classifies cognitive skills and educational learning objectives. Created by psychologist Benjamin Bloom in 1956, this model arranges six levels of thinking into a hierarchy, from the lowest to the highest level [4]. The lower-order thinking skills are remembering (recalling facts and basic concepts), understanding (explaining ideas and concepts), application (use of information in new contexts), while higher-order thinking skills would be analysis (drawing connections among ideas), evaluation (justifying an opinion) and creation (producing new or original work). Bloom's taxonomy can be used to plan new or revise existing curricula; test the relevance of course goals and objectives; design instruction, assignments, and activities; and develop authentic assessments [5]. The goal in a foreign language classroom is to develop higher-order thinking skills as much as possible, in order to master communication, whether oral or written.

IV. LAURILLARD'S COMMUNICATIVE FRAMEWORK

Professor Diana Laurilard of University College London developed six learning types. They are widely used in language learning, as they offer teachers a variety of different activities, i.e. cater for different needs of learning types. The framework comprises learning through the following: acquisition; investigation; discussion; practice; production and collaboration [6]. The essence of the framework is the attribute 'communicative', which makes it very practical and useful in foreign language classrooms.

V. EXAMPLES FROM THE PRACTICE OF ENGLISH LANGUAGE TEACHING IN PRIMARY SCHOOL

The grammar point of the lesson is Passive Voice - Present Simple and Past simple. The students are 13-14 years old. The learning objectives are: to activate prior knowledge of the elements needed to understand the Passive Voice; to learn how to form and when to use the Passive Voice; to apply the newly learned knowledge in new situations. The time frame is 90 minutes.

The activities of the formative assessment presented here are created for distance learning, where the teacher sends the basic material to students via email or some type of online classroom. Each student does the tasks from home.

Ideally, this lesson is done online in real time, on a platform which enables the teacher to present the lesson and students to follow it. Another option is for the teacher to upload the material on a platform or some kind of classroom or online bulletin board (e.g. Edmodo, Google Classroom, ClassDojo, etc.).

A. Practice - bring into action previous knowledge

Time: ten minutes.

Role of the students: Do an online activity. Repeat if necessary. Do self-assessment on spot. Send feedback about the level of success to the teacher.

Role of the teacher: Create an online crossword; Set up a formative assessment task; Send the online crossword to the student; Analyze feedback from the students and send them formative assessment results.

Description of the activity: Students are sent an online task (one task or several tasks - a

crossword, a matching task or similar) with past participle of various verbs, both regular and irregular. After that, students do the assessment task and send feedback to the teacher (for the whole lesson together).

The formative assessment technique(s) used in this activity is the online task has self-assessment built in the exercise (e.g. https://agendaweb.org/exercises/verbs/past-participle/irregular-verbs-1-10). The student can repeat the exercise(s) as many times as needed until they have got a maximum score. For formative assessment, students fill in the Google form poll (or just answer the teacher's questions in a regular word document): How hard was the task, on a scale from 1 to 5? (1-very hard; 2–not very hard; 3–I managed somehow; 4–I was successful; 5–I knew all the answers right away).

The teacher congratulates students who did well, and suggests others to revise verbs from the list of irregular verbs and do the task again. If more than 50% of students did badly in this task, then the teacher sends them a few more tasks to revise past participle (which is necessary in order to do the passive form correctly).

B. Remember - recall facts or basic concepts

Time: 15 minutes.

Role of the students: Watch the video or read the text.

Role of the teacher: Finds an appropriate video online which explains formation and use of the passive voice. Alternatively, the teacher can give the students a useful link (e.g. https://www.englisch-hilfen.de/en/grammar/passive.htm) or type the instructions about the passive voice in a word document / PPT / Prezi or similar and upload it on a platform or Google classroom, depending on the agreed manner of communication. Along with the video/text, the teacher gives several comprehension questions for students to answer. It can be a link to a Google form or similar, or simply answers on the subsequent piece of paper in a word document or slide in a ppt. The student can check his/her answers.

Description of the activity: The students watch the video/presentation about the passive voice in their free time. They can watch it as many times as needed. After that, students do the self-assessment task and send feedback to the teacher. Formative assessment technique(s) used in this activity: Answer the following questions: Why do we use passive voice? How do we form passive voice? How do we ask questions in a passive voice? Criteria to pay attention to: if you don't hesitate when you give answers, you've mastered the introduction. If you need to think a bit – watch the video again. If you are not sure about one or more answers – watch the video several times until you don't hesitate when you answer the questions. Next to the questions, write your process of giving answers according to the given criteria.

The teacher congratulates students who did well and suggests others to watch the video again until they have the impression that they have mastered the presentation. At this point, the teacher does not give any explanations.

C. Practice - bring into action what you have learned

Time: 10 minutes.

Role of the teacher: Finds an appropriate online exercise (e.g. https://learningapps.org/display?v=prw1k9jet20) or creates one of his/her own. Along with the video/text, the teacher gives the formative question and sets the criteria.

Description of the activity: The students do the exercise: to decide if each of 10 sentences given are in the active or in passive voice (level of recognition i.e. application of the newly acquired knowledge about the passive voice). The exercise shows the exact number of correct sentences, but it does not show which ones are correct.

Formative assessment technique(s) used in this activity: Questions for formative assessment: How well did you do? Criteria: 10, 11, 12 correct answers – excellent; 8, 9 – very good; 7, 6 – pass; 5 or less – needs improvement. If you are not satisfied with your result, answer the question: What do you still need to know in order to score better?

The teacher congratulates students who did well and replies to the students' answered questions. The teacher will re-teach crucial points, if necessary (50% of students or more did not pass).

D. Investigate - compare concepts

Time: 10 minutes

Role of the students: Do the exercise. Send feedback to the teacher for formative assessment.

Role of the teacher: Finds an appropriate exercise online (e.g. https://learningapps.org/watch?v=p5ojosev520) or creates one of his/her own. Along with the link to the task, the teacher gives the formative question and sets the criteria.

Description of the activity: The students do the exercise: to choose an appropriate answer (multiple choice). Do self-assessment online.

Formative assessment technique(s) used in this activity: Traffic light: Answer the question: Was the exercise difficult? Criteria: red – yes; yellow – not much; green – no. Think and answer the question: What can you do to improve?

The teacher congratulates students who did well, suggests others to revise and do the exercise again until they are satisfied with their result. The teacher will analyze the feedback and re-teach only the points which are not clear, if necessary.

E. Construct

Time: 10 minutes

Role of students: Do the exercise. Send feedback to the teacher for formative assessment.

Role of the teacher: Finds an appropriate exercise online (e.g. http://static.digischool.nl/en/grammar/hotpot/passive/tegenverltijd.htm) or creates one of his/her own. Along with the link, the teacher gives the formative question and sets the criteria.

Description of the activity: The student does the exercise: to write in the appropriate answer (put together the necessary elements and write them on the line in appropriate order and form).

Formative assessment technique(s) used in this activity: Send feedback to the teacher about how difficult this was: thumb up, thumb down or smiley with flat mouth. Analyze what was your greatest problem. Ask the teacher for additional explanation.

The teacher congratulates students who did well, answers the questions and analyzes the feedback. At this point, the teacher will work individually because this is a higher-order thinking exercise and not many revisions are expected.

F. Create a quiz or an exercise

Time: 35 minutes

Role of the students: Create a quiz with a peer. Send feedback to the teacher for formative assessment.

Role of the teacher: Gives instructions to students how to create a quiz or exercise.

Description of the activity: The teacher discusses the criteria of a successful exercise with students (3-4 clear ones). The teacher can do that by using a discussion forum on a platform or through an online survey or in some other way. Students create exercises for other students (5 questions). The form needs to be familiar to the student i.e. something already used. It can be an online resource (like Quizizz or learningapps.org) or it can be done in a word document or PPT or similar, depending on the ICT skills of the students. Students can use online communication channels to agree on questions, possible answers, form of their work etc. Each quiz is uploaded and posted for all other students to click the link/download and do.

Formative assessment technique(s) used in this activity: Each student sends feedback to the teacher on the following: Write a short summary about passive voice – what have you learned? What else would you like to learn? Students assess each other's work according to the pre-set criteria.

The teacher congratulates students who did well, answers the questions and analyzes the feedback. The teacher analyzes peer assessment and gives feedback i.e. formative assessment to each student (a short narrative plus recommendations about future work).

VI. CONCLUSION

Online tools in formative assessment are widely used, practical and interesting for students. In online education, they are essential. For that reason, the forms of assessment should be various, in order to cater for the needs of all types of learners. Polls and quizzes created with Quizizz, Socrative, Gimkit, Google Forms are user-friendly and not too time-consuming for both teachers and students. In primary school, where learning techniques are still being developed, it is advisable to have a range of different techniques and keep the assessment interesting, short and to the point.

The presented techniques for formative assessment in online education settings are suggestions from the practice of teaching English as a second language in a primary school. The methodology behind them is Bloom's taxonomy, which has been in use since the mid fifties, and Laurillard's communicative framework, which was developed in 2002.

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Project Planning Support for Waterfall Software Project Management Simulations

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Abstract – Management is the important factor of success of software projects. When focusing on software project management education, one must present the processes from both managers' and managed persons' point of view. Thus, a combination of more teaching subjects is required. Managed persons need to work in a managed team on software development tasks to gain the required experience. Managers must plan and manage software projects to gain management experience. In this paper, we focus on this second type of experience. The use of simulation software empowers teaching (and learning) of management in our case too. We focus this paper on estimation and planning of software projects for the waterfall software lifecycle model. We present and discuss our technique and prototype tools. After the planning, participants can faster identify and react to changing situations during the simulation.

I. INTRODUCTION

All areas of life need specific software to facilitate work and speed up the required results so that all parties can benefit from it. In the field of software development, there are different categories, including analysts, developers, and testers, as well as the project's beneficiaries.

With the rapid development of software as well as the requirements of users, as developers, we need to deal quickly and effectively in software development. To speed up work, we must follow an effective software management methodology to help us in the process of planning and development correctly and effectively. Therefore, even the field of software management is constantly and rapidly developing.

There are many methodologies any developer can rely on in software development. These methodologies have been developed continuously due to growth in the requirements of the required programs and work environment. Each method, whether traditional project management or agile project management, has strengths and weaknesses. For example, the difficulty of choosing the appropriate methodology that matches the quality of the requirements that we need to develop, or the team's focus on a method that they always rely on in their work style, can lead to a failure in the development process.

The first methodology heavily relied upon during work was the Waterfall in it, as it is known to work sequentially during software development; this was a problem in the advanced stages of development in case of a change in requirements, for example. So, it was developed into more than one-run version, but it was not always of the quality required.

In this paper, we focus on the planning phase of such waterfall software development model, taking into consideration its selected extensions as mentioned above. First, we present the various waterfall models, then we present the AMEISE (A Media Education Initiative for Software Engineering) simulation tool and its methodology. Our approach is defined in the description of suggested improvements for the tool and teaching/learning process. We point out the need for using modern technologies and design as well as the benefits of game-like presentation of results.

II. THE WATERFALL SOFTWARE DEVELOPMENT MODEL

The waterfall development model is one of the oldest software project models. It is a structured software development methodology that can be frequently quite solid. The software development process is divided into phases. All phases of project development, such as [1]:

1. Software Requirement Analysis,
2. Preliminary Design,
3. Detailed Design,
4. Coding and Unit Testing,
5. Integration, and
6. Testing

are completed once.

This model is best suited for projects with clearly defined requirements, for which we do not expect any change.

A. Advantages and Disadvantages of Implementation

The waterfall model is straightforward, its implementation is easy. Another advantage is in simplicity of the phases, that it is known in

advance when a transition to the next phase will occur, and, that the next phase is always the same. Phase distribution used to be 20-30-50, meaning 20% of time spent on the first two phases, 30% of time spent on the second two ones, while the remaining time is spent for integration and testing.

Disadvantages arise when the first phases are insufficient to cover most requirements, or, if these are frequently changing, as clients do not exactly know what they want for the software.

Disadvantages are used as tool to advocate other software development methods [2] and models over the waterfall model. However, there exist several modifications introducing real improvements to this model, such as Royce's final model [3], Peter DeGrace's "Sashimi model" (waterfall with overlapping phases), waterfall with subprojects, and waterfall with risk reduction.

B. Planning for Waterfall Software Development

The main advantage of implementing the waterfall software development model is that planning is relatively straightforward as well as it is true for the model structure. Considering the 20-30-50 distribution rule, one can set up an initial effort distribution across the phases. Assigning the best and top fitting team members for the tasks of the first phases is critical, but in general manageable. Next phases are planned according to conditions stated by the model. Testing and documentation are the heaviest phases, even that the quality of the product is coming from the first phases. Depending on the model applied, quality assurance is implemented as well.

The reasons for choosing the Waterfall methodology [4] are the small size of the team, the clarity of requirements, and the lack of continuous change. This relies on selecting a project that is not directed to a specific party, meaning it can control the requirements through the team and the supervisor.

C. Advantages and Disadvantages in Teaching Software Project Management

Simplicity of planning and implementation as well as clarity in the model's terminology make an ideal model for learning basic management principles. On the other side, waterfall development is applicable for medium-size and large projects, where the 20% of time used for only requirements is accurate.

As there are 1 or 2 following phases for each phase, simple conditions allow analyzing all "what if" situations.

Simulators [6,7] relying on a rule-base, heuristics or statistical evaluation might be implemented to simulate project activities and prepare model situations the players (learners) could be trained in project management based on.

We already mentioned, and it is an important notice, that the waterfall software development model is hard to implement with tiny or small projects. Many involved learners become part of teams, which are organized a different (mostly agile) way. For them, the clash of terminologies only hardens teamwork, their benefits from learning based on the waterfall model are minimal if any. On the other hand, this also applies for the opposite situation. Waterfall should be taught in connection to agile development [5] to prepare the learners for both worlds, the best and worst from both worlds, including management issues and strategies.

III. THE AMEISE TOOL

AMEISE (A Media Education Initiative for Software Engineering) simulation tool and its methodology offer the environment where the project can be simulated following the waterfall methodology with overlapping phases ("Sashimi model"). The main idea is to let small groups plan for each simulation, then let them react on simulated events during a simulation run with the aim to achieve as many as possible partial goals, such as budget, length, and selected product quality indicators.

A. The Normal Flow of Planning in AMEISE

The normal way how to produce the plan relies on the discussion between the small group of students. Each individual studies the available material on conditions for execution and characteristics on available human resources. Then while discussing, the fields of the plan are being filled with estimations of costs, effort and its distribution. The effort needs to be distributed between potential developers, managers and the customer. All that across the phases of the waterfall model, including quality assurance (review, test, repair) and allowing up to 50% overlaps.

B. Advantages

An excellent opportunity is given for teamwork of managers. Based on employee (software developer) characteristics focusing on technical skills and abilities, they are planning for each phase of the waterfall project and assigning developers to task according to specific limitations,

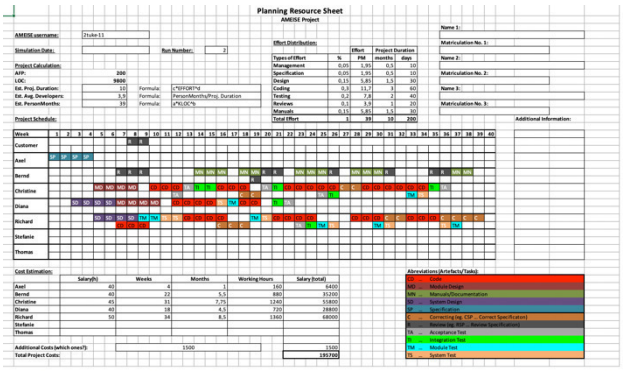

Figure 1. AMEISE waterfall project estimation – old tool

such as no employee can be involved in more than two tasks at the same time.

C. *Critiques*

The 20 years old tool also comes with an outdated way of required cooperation – using paper for planning. An improvement can be done by sharing a computer while filling the electronic form of the plans (Fig. 1). All these are limiting time of planning for the students, which, in specific cases, introduces inequity into learning the software management process. All parallel feedback is limited by the oral nature of main coordination, evaluation of plans is a kind of (very) late feedback. Running the simulation game produces partial feedback, which is given by the services included in the tool implementation.

IV. SUGGESTED IMPROVEMENTS

A. *Preparation for the Planning*

The task definition includes the estimated product size in function points (FP), one of the planning tasks is to estimate project effort, duration and count of developers involved.

An improvement in the simulation preparation phase – still before starting planning for the simulation game run, – could be a group of estimation calculations for different projects, where all relevant requirements are known. This way, FP analysis and its results will be more familiar to students. As the game preparation continues from FP through LOC (lines of code) until effort, duration and developers' count are calculated, the suggested improvement is about to start with requirements and estimate FP along with LOC in selected programming languages then applying the COCOMO model for waterfall estimation. These calculations produce the requested project properties as stated above.

Our example in Fig. 2 aims to point out several properties of such improvement.

First, the count of calculations each student performs. Behind each line in the output, the work needed to estimate unadjusted FP and the value adjustment factor, and calculation of estimations of Basic and Intermediate COCOMO are present. When considering possible locations for an error, such as forgotten round-up to nearest integer (LOC – lines of code; P – people count), this task is not that trivial at all. Initial calculations and additional corrections are planned for two labs, allowing the students to discuss the topic.

Second, the similarities and differences between the used models can be spotted, which might improve the selection of the most accurate model for the planning template on Fig.1.

Third, the project content is not new to the students. They estimate project properties for programming assignments they completed during their previous studies. Thus, they can select the right programming language, and they might compare estimations to real number of lines of code. Time could be also saved here, as the functionality assignments are known much better than with any starting project. Evaluation and estimation aspects can be learnt better, if the vision of the product is clearer.

We do not state the limitation on systems under estimation, selecting of already done assignments is some advice only. Any textual functional definition can be used here.

The basic calculation workflow is:

1. Get the textual description of the required functionalities.
2. Calculate UFP estimation
3. Calculate VAF (value adjustment factor)
4. Calculate AFP
5. Select two programming languages and

zadanie			FPA a odhad LOC (2. cvicenie)					Basic COCOMO (3. cvicenie)			Intermediate COCOMO (3. cvicenie)			
sk. rok	predmet	c. zadania	UFP	VAF	AFP	LOC - jazyk C	LOC - OO jazyk	E	D	P	EAF	E	D	P
2020/2021	KP	Block Puzzle	26	0,99	25,74	3294,72	772,2	1,829479	3,145028	0,581705	1,223332	2,984082	3,787635	0,787848
2020/2021	OS	Copymaster	21	0,74	15,54	1989,12	466,2	4,940891	4,587605	1,077009	1,148109	7,563573	5,393321	1,402396
2020/2021	OS	IPC	23	0,73	16,79	2149,12	503,7	5,359015	4,731429	1,132642	1,157109	8,267952	5,578934	1,481995
2019/2020	PVJC	Mastermind	20	0,74	14,8	1894,4	444	4,694145	4,49916	1,043338	0,843738	5,280839	4,705081	1,122369
2019/2020	PVJC	K	7	0,69	4,83	618,24	144,9	1,448526	2,878008	0,503308	0,983046	1,898624	3,189678	0,59524
2019/2020	PVJC	Top Secret	10	0,68	6,8	870,4	204	2,074513	3,298892	0,628851	1,041917	2,88196	3,737846	0,771022
2019/2020	ZAP	Hangman	7	0,71	4,97	636,16	149,1	1,492643	2,911007	0,512758	0,9706	1,93168	3,210668	0,601644

Figure 2. Project estimation preparation improvement – results

calculate LOC for them

6. Use one of the LOC data for Basic COCOMO, try Organic development first
7. Calculate EAF (effort adjustment factor)
8. Use the same LOC data for Intermediate COCOMO, use Organic development mode as well

The more focused ones will round up some values in their calculations.

After such a preparation, the normal flow of AMEISE planning could be implemented (as of Sec. III.A).

B. Online Cooperation

As stated above, the digital versions of plans could be shared via any common tool for cooperative editing. These tools usually also offer text, voice and/or video communication between people sharing the same plan.

Advantage is that there are no quarantine limitations, one of the disadvantages might be timing of actions. In this case, we cannot fully state that online is always better than in-person communication. Especially when considering teacher's involvement in the discussions.

Known tools used in practice of our students are Microsoft Teams, Google Meet, Skype and Webex. These tools offer similar but also different cooperation and work sharing possibilities.

After setting up the tools for online cooperation, the normal flow of AMEISE planning could be implemented (as of Sec. III.A).

C. A New Tool to Come

Distributing work across different technologies might not complain with every student's capability. To ensure equity over equal chaotic possibilities of self-selection, and to support centralization of teacher's feedback as well, a tool supporting the basic planning along with its tunable improvements would be appreciated. Without an aim on completeness, we present a prototype on it. This prototype could turn to a system of systems later as it is with the current version in use. Then, an improved configuration of those tools will be required.

After creating such a support tool, the normal flow of AMEISE planning could be implemented using that tool(set) (as of Sec. III.A).

A cooperative tool first needs the ability to create teams of members who cooperate. A draft process of creating such teams (small groups of student users of the system) is depicted in Fig. 3. This naïve representation assumes the existence of user in the system. If it is a single user without any associated group, (s)he might want to join a team using an invitation, or (s)he might want to lead a team by inviting others.

In this generic approach, any size for a team is acceptable, but with our examples, there should

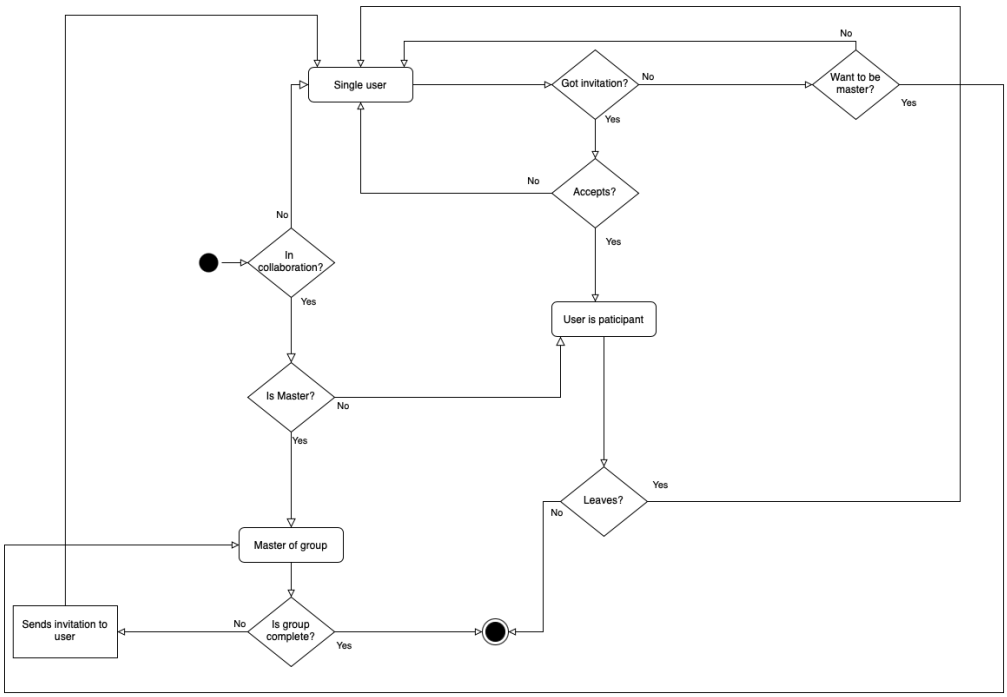

Figure 3. Team building workflow for waterfall project planning – proposed tool

each user separately successfully calculate 3 or more project estimations (FP and COCOMO) and only then will be able to start or join a group. Team/group size for AMEISE planning varies between 2 and 3. As a future extension of the prototype, a bit larger small teams of 4-6 users

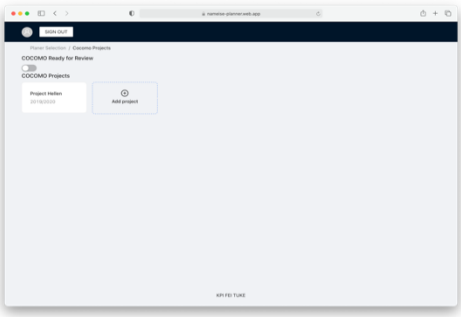

Figure 4. Project menu for estimations – proposed tool

would be used in agile planning.

Individual part of the work will require the execution of the steps described earlier in Sec. IV.

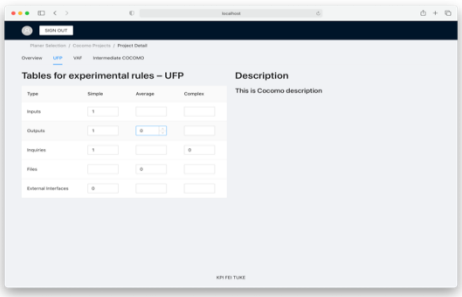

Figure 5. UFP estimation – proposed tool

Textual representations of required functionalities might be accessible based on subject selection, to eliminate searching and make the start easier (Fig. 4).

To support step 2, Fig. 5 shows the proposed form of the UFP calculation including the feature classification table.

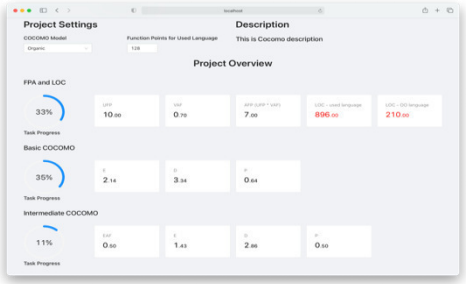

Figure 7. Estimation overview – proposed tool

The calculation overview might get also improved within project information as shown in Fig. 6. Such a support would improve the memorizing effect for visual learning type students. No need for custom Excel charts is present, all results are presented in the same coherent form.

This feature closes the list of digital improvements for the planning preparation process.

For planning, the proposed improvement would check the user's qualification for the planning round based on project estimation results. Then, the 2-3 member teams can be formed based on student, teacher or mixed strategies. It is not included, but a random distribution could be also considered.

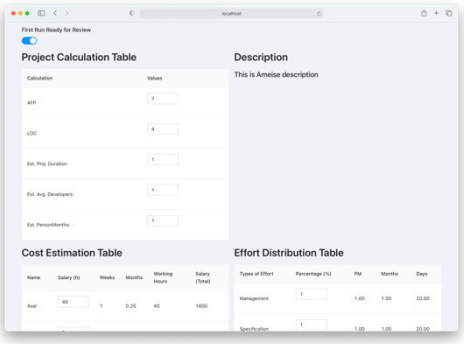

Figure 6. Estimation overview for project planning – proposed tool

Planning for the "big project" starts by studying selected materials, which ones could be integrated with the proposed tool to achieve a more coherent user experience.

The overview of the first stage of planning – the estimations, could be displayed as shown in Fig. 7.

To integrate editing for the plan for the 40 weeks of the selected project, a more complicated tabular system is needed. This must allow simultaneous parallel editing by the 2-3 team members, when considering this size for the managers' team.

The above presented tool prototype gets complete by Fig. 8, the visualization of planning. Here, names of developers can be found on the left, while the task assignment is done in the fields of the tabular.

V. CONCLUSION

Planning is essential in project preparation, management and execution, even that some claim that plans might be of littler importance.

Within this contribution, we presented the key aspects why we still use the AMEISE system in

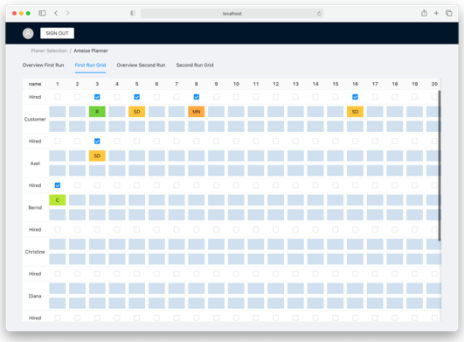

Figure 8. Project planner for waterfall projects with overlapping phases – proposed tool

teaching software project management. This legacy simulator comes with technical support and material that is prepared for use.

We pointed out our experience and presented first improvement for the planning preparation phase, which is focusing on experience-based self-evaluation of selected software project estimation methods. Here, the learner can compare her/his own results to the estimated ones (first implemented, then estimated – this is the order to make reuse of learner experience). In order to achieve this experience, the students are asked to collect textual descriptions of completed tasks and realize the estimation procedures over them.

At this point, the classical procedure of planning can be started as it comes with the tool. We used more likely the digital form than the paper based one. The disadvantage is the less conversation, which is hard to balance by any tool used for cooperation. A kind of cooperative distance planning could be implemented by using the Excel document, a document sharing system and text, voice or video messaging systems.

Later, we presented a proposal on a more complex tool that would support assessment of pre-project calculations and planning as well. This proposal is based on mainly oral feedback from planning sessions addressing the low compatibility of the system in use as well as the outdatedness ("retro feeling") of it.

When considering a suitable architectural decision for implementation, it would be not that hard to re-organize or introduce several occurrences of calculation tasks in the workflow. A good architecture would also cope with the requirement to have a multi-user task-sharing parallel-processing system.

Such as a MMORPG, where the playable characters are the managers, and the developers are the non-playable ones. It would be more like a chess game where 2-3 players play white with the same team of figures on the same board: focusing on accepting the others' decisions. But that would require the integration of AMEISE as well.

Another use case scenario for the presented prototype would make it used as starting case for a hackathon. There is a plenty of combinations of technologies for game and web application development that could be applied there. Our prototype was based on TypeScript, React, and Google Firebase.

After implementation, the most probable extensions would go towards incremental (spiral with COCOMO II) and agile project management methods (agile estimations, retrospectives).

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Analysis of Student Achievements in Teaching Matrix Using Geogebra Software

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Abstract - The achievement of students after completion of teaching process in each subject is what is quite important for both professors and students. This research deals with the analysis of students' achievements for the topic matrices, in a "traditional" way and teaching enriched with free software. The introduction of software in the teaching process as "modernized" approach to teaching aims to increase student activity, to raise the teaching process to a higher level, to raise a student's achievements and to motivate students to learn more independently.

I. INTRODUCTION

The interest in studying at technical faculties has tended to decline in recent years. It is a result of the general opinion that studying at a technical faculty is not easy. To change the current situation, analyzes must be made for the way in which the teaching process will be carried out to find a solution for greater motivation for learning, achieving better results and increasing the number of students at the mentioned faculties. This paper is also derived from the idea of finding the most appropriate way to perform teaching to achieve better results in mathematics subjects. Here, we investigate the results achieved by students for the topic matrices before and after used free education software. The aim of this paper is to compare the results of students for the topic matrices after classical teaching and after teaching with free education software. The students are from the Faculty of natural and technical science at Goce Delchev University - Stip. In this paper the results of the students' achievements will be listed so that the results of the students achieved during classical learning will be shown first, and then the results of the students after learning with software. Between the results of the two tests several solved examples of matrices using Geogebra will be listed. Also, applets have been created for some of them, for which links are given, with which help students can solve similar tasks. Also, for some calculations required in the given examples, commands are given which is used to obtain the solutions. In the end a conclusion from the results of both tests will be drawn.

The educational software that we decided to use is Geogebra. Everything we need to know about Geogebra software can be found in [9] and [10]. Here we can find more mathematics problems solved using Geogebra software from different mathematical topics.

Free softwar Geogebra in [5] is use for visually presenting the shape of which are calculate the volume. In that way the students can calculate the volume of the shapes and at the same time, they can present the shape visually and see what they calculate. The topic of [4] is to use computers in the lesson of Calculating the surface of a flat figure – the application of definite integral. The purpose of [4] is to master the same school program in two different methods: the first is the traditional method and the second is using computers, or more precisely, the Geogebra software. In [3] author shows how in a simple and interesting way the function flow in the Geogebra program package is examined.

Application of modern digital technologies in teaching has changed teaching methods. [1] is based on forming a teaching model in order to improve the level of ICT knowledge and skills of students applicable in the area of technical sciences. The purpose of [2] 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.

There is more research in which the main goal is to see the importance of ICT in the teaching process in mathematical subjects. Like that, paper [6] is the research in which there are two groups of students, from two Universities: Mother Teresa Skopje and Goce Delchev Stip. In the paper are process mathematical content in two different ways (some with Geogebra and on a computer, and others without visualization and Geogebra). Then the testing is done, the results is compared, and a conclusion is drawn.

Many high school teachers face questions from their students about the applicability of mathematical contents. For that reason, in paper [7] authors try to answer students question related to linear programming problems and solved them using Geogebra. The article [8] describes the observations of the experimental teaching conducted in the high school in Košice, where Geogebra was used. Geogebra was used for the first time in students' lives for solving a linear optimization word problem.

II. MAIN RESULTS

Matrix is a topic that is very important for students of technical faculties because its application is large. The importance of its application in most areas of technology and engineering, as well as other disciplines of mathematics on the one hand, the growing tendency of the number of weaker students from year to year on the other hand were reasons to find a solution to increase the motivation to learn. We decided to achieve our goal by introducing the Geogebra software in the study of some matehematics topic. We decide that to be topic matrices. To see how much the Geogebra software will help us in achieving our goal, we will analyze the student's achievement after classical learning of the given topic and learning with software. The results of the testing will be presented, and the conclusion will be drawn.

First, after studying the topic of matrices in a traditional way, we did a test on a group of 23 students from the Faculty of natural and technical sciences to see if the results were satisfactory. The test consisted of 6 tasks. Tasks are shown below:

1.Calculate 2A-3B if

$$A=\begin{pmatrix}1 & -1 & 2\\ 3 & 0 & 1\\ -1 & 4 & 1\end{pmatrix}, B=\begin{pmatrix}0 & 1 & 0\\ 0 & 0 & -1\\ 0 & -1 & 0\end{pmatrix}$$

2. Calculate 2AB+C if

$$A=\begin{pmatrix}5 & -2\\ -3 & 1\\ 2 & 0\\ 0 & 4\end{pmatrix}, B=\begin{pmatrix}3 & 4 & -1\\ 0 & 2 & 0\end{pmatrix}$$

$$C=\begin{pmatrix}0 & -1 & 2\\ 2 & 0 & 1\\ 2 & -2 & 3\\ 0 & 8 & 0\end{pmatrix}$$

3. Calculate $(AB)^T$ and B^TA^T if

$$A=\begin{pmatrix}1 & 0 & 1\\ 0 & 0 & 2\end{pmatrix}, B=\begin{pmatrix}2 & 1\\ 0 & 0\\ -1 & 1\end{pmatrix}$$. What do you conclude?

4. Find the inverse of $A=\begin{pmatrix}0 & 1 & -2\\ -1 & 2 & 3\\ 0 & 2 & -1\end{pmatrix}$.

5. Calculate A^3, if $A=\begin{pmatrix}1 & -2 & 0\\ 3 & -1 & 2\\ 0 & 4 & -3\end{pmatrix}$.

6. Find the rank of the matrix $\begin{pmatrix}0 & 1 & 3 & 0 & 1\\ 1 & 1 & 5 & -1 & 0\\ -2 & 0 & -2 & 3 & 1\end{pmatrix}$.

Each test task carries 5 points.

Information about the group of tested students is given in the following table

Table 1. Information about students

Variables		N
Group		23
Age	18-21	20
	other	3
Gender	F	15
	M	8

The results of the testing after the lessons conducted in the traditional way in which the topic matrices was studied are:

Table 2. Students' achievements after learning in the traditional way

Number of students	23
Number of students who scored over 15 points	12

Number of students who scored below 15 points	11	
student achievements	Tasks	Number of students who solved it completely correct
	1	20
	2	15
	3	11
	4	10
	5	17
	6	2

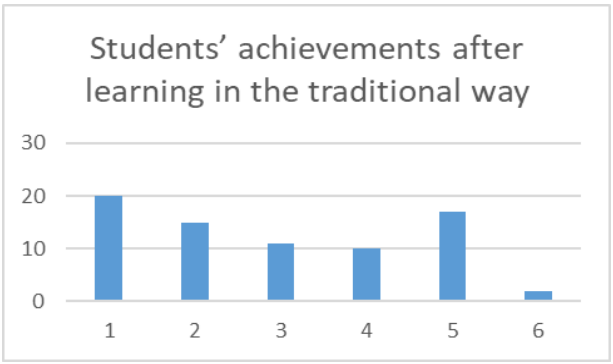


Figure 1. Result of testing after learning in the traditional way

Since the topic is very important for the students of the technical faculties, and the results were not the satisfactory, we decided to introduce changes. The changes were aimed at re-studying the topic with the application of ICT. The educational software which we decided to use was Geogebra, primarily because it is free and on the other hand it is easy to use.

In that way, in the following we will state how in Geogebra we can calculate the sum of matrices, the product of matrices, the determinant of a matrix, the inverse of a given matrix and the transpose and rank of a given one. For some calculations, we will also put links to applets that we are created in Geogebra to help students to learn.

Solve the problems with the help of Geogebra software:

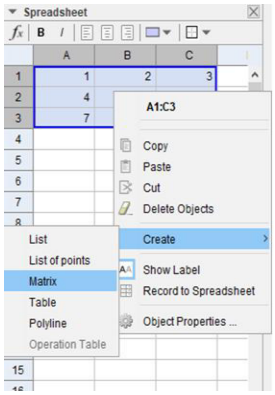
Example 1. Calculate A+B and B+A if it is possible for the following matrixes:

a) $A=\begin{pmatrix}1&2&3\\4&5&6\\7&8&9\end{pmatrix}, B=\begin{pmatrix}3&4&5\\1&9&5\\4&7&9\end{pmatrix}$

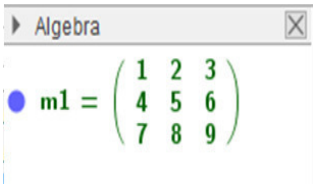
b) $A=\begin{pmatrix}1\\4\\7\end{pmatrix}, B=\begin{pmatrix}1&-1&0\end{pmatrix}$.

Solution. a) In Geogebra we write the elements of the first matrix, in the previously given sum in the same order as in the matrix, in the table which we get by selecting View → Spreadsheet. We select the cells and right click on them.

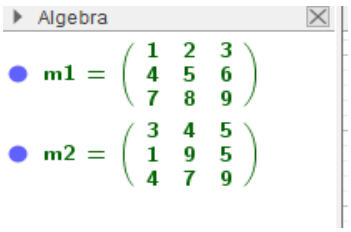
Then we choose Create →Matrix.



A matrix will be created in the algebra window:

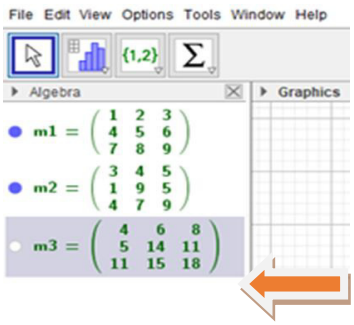


We can see that the matrix has been given the tag m1. We create the matrix B in the same way. That matrix also appears in the algebraic window with tag m2:



In the input field we enter:

Then we press Enter from the keyboard and the result appears in the algebraic window



To find B+A in the input field we enter m2+m1 and we get the same result.

b) In the same way as example 1 a) we enter the matrices into Geogebra. For the result from adding A+B and B+A we get in the algebra window

$$m1 = \begin{pmatrix} 1 \\ 4 \\ 7 \end{pmatrix}$$

$$m2 = \begin{pmatrix} 1 & (1) & 0 \end{pmatrix}$$

$$l1 = \{\}$$

from which we can see that the sum A+B cannot be found. Also and the sum B+A.

Example 2. For matrices in example 1 find products AB and BA if it is possible.

Solution: a) To find product AB in the input field we enter Input: m1*m2 and in the algebra windows we get matrix m4 which is the resulting matrix:

$$m4 = \begin{pmatrix} 17 & 43 & 42 \\ 41 & 103 & 99 \\ 65 & 163 & 156 \end{pmatrix}$$

Product BA we calculate so in the input field we enter m2*m1 and we get matrix m5

$$m5 = \begin{pmatrix} 54 & 66 & 78 \\ 72 & 87 & 102 \\ 95 & 115 & 135 \end{pmatrix}$$

b) In the same way as a) for the product AB we get matrix m3 in Geogebra

$$m3 = \begin{pmatrix} 1 & (1) & 0 \\ 4 & (4) & 0 \\ 7 & (7) & 0 \end{pmatrix}$$

And for product BA matrix m4:

$$m4 = \begin{pmatrix} (3) \end{pmatrix}$$

Example 3. To multiply the matrix $\begin{pmatrix} 2 & 3 & 4 & 5 \\ -1 & 2 & 5 & 9 \end{pmatrix}$ by ½.

Solution: In the input field in a new Geogebra window, we enter the given matrix, which is taged automatically with m1, then we enter

Input: 1/2m1

and in the algebraic window the matrix m2=(1/2)m1 is obtained:

Algebra

$$m1 = \begin{pmatrix} 2 & 3 & 4 & 5 \\ (1) & 2 & 5 & 9 \end{pmatrix}$$

$$m2 = \begin{pmatrix} 1 & 1.5 & 2 & 2.5 \\ (0.5) & 1 & 2.5 & 4.5 \end{pmatrix}$$

Example 4. Find the inverse matrix of $\begin{pmatrix} 3 & 4 & 5 \\ 1 & 9 & 5 \\ 4 & 7 & 9 \end{pmatrix}$.

Solution. We are working in the previous Geogebra window in which the matrix given in this example was entered and was tag with m2. To find the inverse of m2 in the input field we enter:

Input: Invert(m2)

At the same time, in the algebraic window, we get the matrix l1 which is the inverse of m2.

$$l1 = \begin{pmatrix} 1.24 & (0.03) & (0.68) \\ 0.3 & 0.19 & (0.27) \\ (0.78) & (0.14) & 0.62 \end{pmatrix}$$

With https://www.geogebra.org/m/bnfqen2r an applet is given which students can be used to calculate the inverse of a 3x3 matrix. Command that is use in Geogebra for find inverse matrix is *Invert(<Matrix>)*.

Example 5. Find the transpose matrix of $\begin{pmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{pmatrix}$.

Solution. In the input field we enter

Input: Transpose(m1)

because the given matric in this example get automatically tag m1 after entering it in the spreadsheet. In the algebra windows we get matrix m6:

$$m6 = \begin{pmatrix} 1 & 4 & 7 \\ 2 & 5 & 8 \\ 3 & 6 & 9 \end{pmatrix}$$

which is transpose of $\begin{pmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{pmatrix}$.

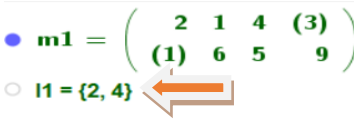
So, the command that is use for finding transpose matrix is *Transpose(<Matrix>)*.

Withhttps://www.geogebra.org/upload/633546b449cd9/?lang=mk an applet is given that can be used by students for calculate the sum and the product of two 3x3 matrices and the transpose of a 3x3 matrix.

Example 6. Find the number of rows and columns of the matrix $\begin{pmatrix} 2 & 1 & 4 & -3 \\ -1 & 6 & 5 & 9 \end{pmatrix}$.

Solution. In the input field of a new Geogebra window, we first enter the given matrix, which is automatically taged with m1, then we enter the command *Dimension(m1)*:

and in the Algebraic windows we get



Just below of the matrix m1 in the algebraic window we get the number of rows and columns of the matrix m1.

Example 7. Find the determinant of the matrix $\begin{pmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{pmatrix}$.

Solution. We find the determinant of a matrix with the command *Determinant(Matrix)*. We write the command in the input field using the keyboard. So, for matrix m1 in the input field we enter

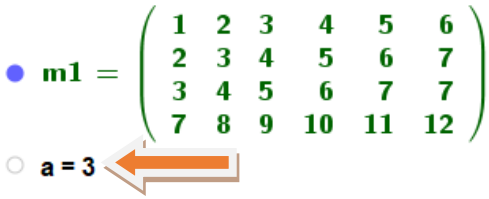
And in algebra windows we get

which means the value of the determinant is zero.

Example 8. Find the rank of the matrix

$$\begin{pmatrix} 1 & 2 & 3 & 4 & 5 & 6 \\ 2 & 3 & 4 & 5 & 6 & 7 \\ 3 & 4 & 5 & 6 & 7 & 7 \\ 7 & 8 & 9 & 10 & 11 & 12 \end{pmatrix}.$$

Solution. Rank of the matrix in Geogebra we can find with the command *MatrixRank(<Matrix>)*. So we enter the given matrix in spreedsheet and then in input field we enter MatrixRank(m1) becouse the entered matrix got tag m1 and we get in Algebraic windows:



Rank of the 4x6 matrix can be find with applet given with https://www.geogebra.org/m/daxep5wu .

After the classes in which tasks were solved with the help of Geogebra, listed above and in which to the students were sent links from the applets also listed above and many others created by us, we again conducted testing on the same group of 23 students. In the new test, the students had to solve the similar tasks as in the first test but now with the help of Geogebra. Solving time in the first test was 90 minutes, and in the second 60 minutes. Results of the second test are given in table 3:

Table 3. Students' achievements after learning with Geogebra

<table>
<tr><td>Number of students</td><td colspan="2">23</td></tr>
<tr><td>Number of students who scored over 15 points</td><td colspan="2">21</td></tr>
<tr><td>Number of students who scored below 15 points</td><td colspan="2">2</td></tr>
<tr><td rowspan="7">student achievements</td><td>Tasks</td><td>Number of students who solved it correctly</td></tr>
<tr><td>1</td><td>23</td></tr>
<tr><td>2</td><td>22</td></tr>
<tr><td>3</td><td>20</td></tr>
<tr><td>4</td><td>23</td></tr>
<tr><td>5</td><td>21</td></tr>
<tr><td>6</td><td>19</td></tr>
</table>

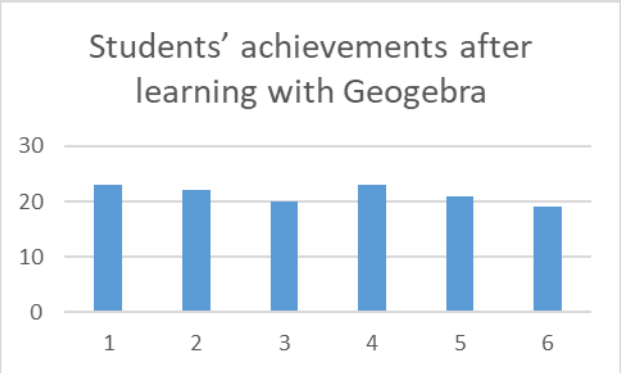


Figure 2. Results after learning with Geogebra

From table 3 and figure 2 we can see that the results are much better than the previous ones given in table 2 and figure 1. Students get better results after applying Geogebra software because the software helps them to get the correct solution in a very short time, the software helps them to check their obtained solution manually, to see what is the final solution and get a direction how to solve and what is most important with the application of the software are encouraged to solve independently.

III. CONCLUSION

From the table 2 and table 3 we can see that the application of ICT in the teaching of mathematics subjects is very important. The results confirm the general opinion that it is very important for students to have help in learning (in this case from the software). This is the only way they will get a greater desire to work, a greater interest in solving problems and thus achieve better results. How greater are the students' knowledge, the greater will be the chances that they will apply it in practice. From the table 2 and table 3 we can see also that the time required to solve is not so important when students know how to use and use software when solving.

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Apache HTTP Server as Forward Proxy Server

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Abstract - A server is a specialized computer for running utility software. If we want to protect our data while using Internet, we use a proxy server. In this paper we will talking about proxy server, types of proxy servers and at the end about Apache http serves as forward proxy server. Apache can be also used as reverse proxy server, but that will be discussed in some next paper.

I. INTRODUCTION

When talking about what a server is, it can be stated from two points of view. In the first place, when talking about a physical machine that contains information or data that is needed to solve a situation; and as a second point, the program that resides in a computer, either through hardware or software, is mentioned.

A server is a specialized computer (workstation) for running utility software. Its job is to perform a series of appropriate program services that usually determine the purpose of a given device.

Translated from English, the word "serve" means - "to serve". Based on this, we can think of the server as a kind of large office computer. It is worth noting that, server also refers to the hardware of a regular computer. That is, "charging" a computer, without a mouse, monitor and keyboard.

There is also such a thing as a web server - special software. However, in any circumstances, be it a utility computer or utility software, the utility runs autonomously, without human intervention.

From the outside, a server can look exactly like a system unit. Such units are often found in offices to perform various office tasks (printing, data processing, file storage, etc.)

It is important to note that the size of the server (block) directly depends on the tasks assigned to it. For example, a site with a lot of traffic requires a powerful server, otherwise it simply will not withstand the load. Based on this, the size of the server can be increased tens or even hundreds of times.

Any response offered by the server through the software is available to the user based on his utility. All this relationship remains on the web permanently, so that all users of electronic messages, cyber sites or web browsers can access it without difficulty according to their needs.

With this boom in technology and the virtual world, the emergence of servers was essential, which can be useful to be able to store and present a gallery of data and information in an infinite way. In some cases that can be in the virtual space, where you can consider an internet server, such as any computer at home or even at office, that are structured to stay on 24 hours a day, all year round.

More simply, when you turn on your computer and you can navigate through multiple sites like Opera, Chrome Edge, Firefox and others on the same computer, you are running multiple programs at the same time, that is what is meant by running several virtual programs at the same time; to be able to collect data requested by users or customers over the web through the existing HTTP (Hypertext Transfer Protocol) protocol.

II. PROXY SERVER

Every Internet user should protect their privacy and data. We all want to keep personal information safe and the internal network safe from dangers and unwanted attacks. That's why so many people use proxy servers.

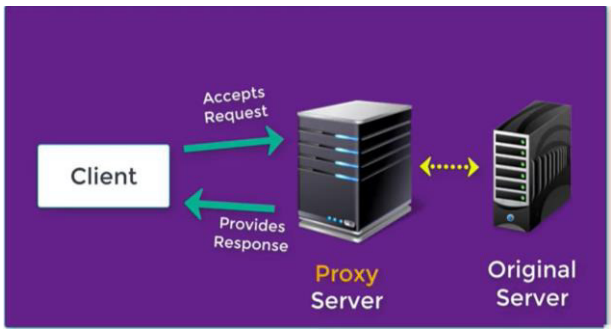

Figure I. Proxy server (accepts request and provides response)

Each request from a personal computer represents a submission of our data to return the correct information. The request always comes to an intermediary - a complex of computer programs that processes the request and sends the client to the address. Access to network resources is not possible directly from the client-server system, but an intermediary connection is required. So, Proxy is an intermediary between the client - computer and the internet systems - servers.

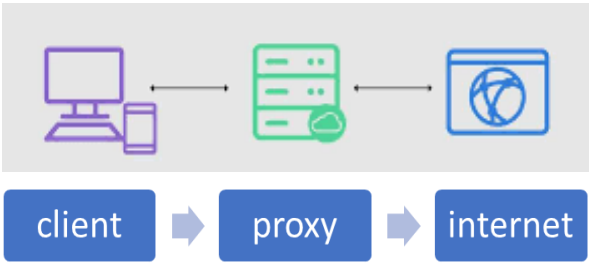

Figure II. How proxy server works

A proxy server is basically a computer connected to the Internet that is equipped with its own IP address. Instead of the user connecting directly to the intended website, the user sends their request to a proxy server that evaluates the request and then completes the request. Proxies function as a method to simplify or manage complex requests and provide an additional layer of security, privacy, and encapsulation structure. Proxies have the potential to mask the identity of the requester from the recourse server.

Hardware proxies are located somewhere between our network and the internet where they receive, evaluate, send, and forward requests. Software proxies are usually provider-hosted or exist in the cloud. Software proxies can be installed sometimes for free or for a fee.

A proxy makes networking much easier and provides anonymity to the client browser. Proxy helps to get around IP blocking, visit restricted site, search internet site in accelerated mode. The basic concepts of the proxy server principle bring user skills to a new level. Before a proxy server can be used, it must first be configured correctly.

III. TYPES OF PROXY SERVERS

There are several types of proxy servers. Some of them are briefly described in the following text.

Forward proxy

• This type of proxy is used to transfer data to groups of users in an internal network. When a request is sent by the sender, the proxy server evaluates the data to decide whether it should proceed and establish a connection.

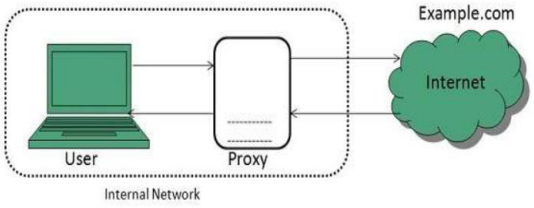

Figure III. Forward proxy

Public proxy

• Public proxies are available to anyone and work by providing their users with their IP address to hide their identity. This proxy, while cheap and readily available, leaves users more at risk of having their data breached.

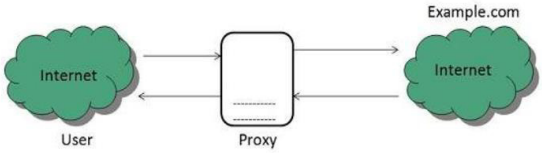

Figure IV. Public proxy

Residential proxy

• This proxy gives the user an IP address that can be traced to a specific physical device where all requests are evaluated and redirected.

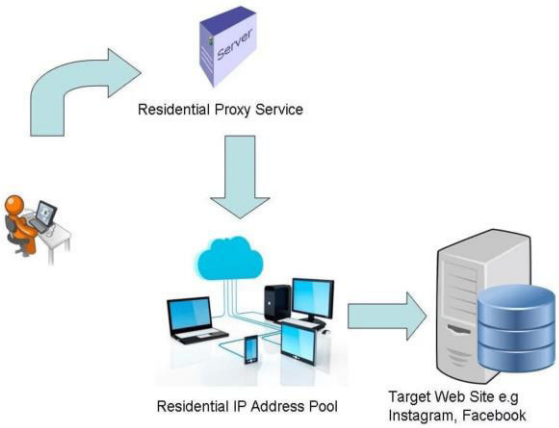

Figure V. Residential proxy

Shared proxy

• This proxy allows multiple users to engage with this proxy at the same time, providing users with a shared IP address.

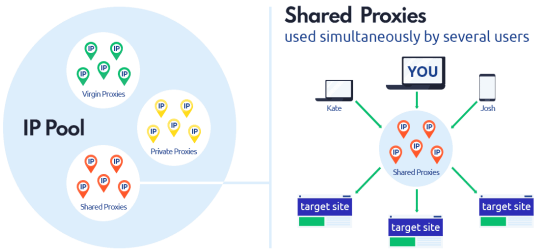

Figure VI. Shared proxy

Anonymous proxy

• Anonymous proxy servers aim to mask internet activity by evaluating a user's request while hiding their identity.

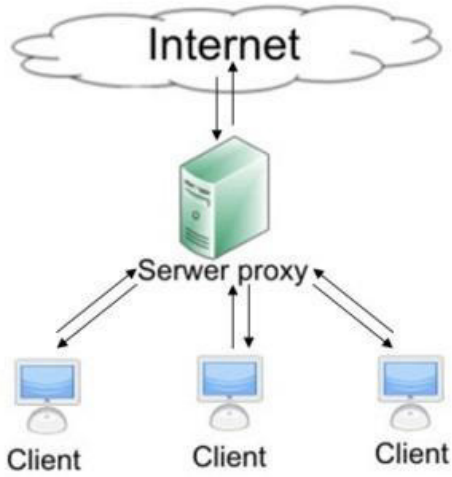

Figure VII. Anonymous proxy

High anonymity proxy

• This proxy is basically an anonymous proxy that takes an extra step to hide the identity of the user. This is done by deleting the user's information before the proxy attempts to connect to the target site.

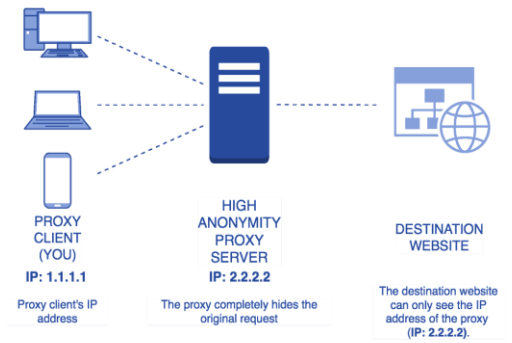

Figure VIII. High anonymity proxy

Transparent proxy

• Transparent proxies can be used to remain hidden from those to whom it is applied. This type of proxy is useful for organizations that want to implement a proxy without making the employee aware that they are using it. Transparent proxies are more vulnerable to specific security threats such as SYN attacks.

• SYN is a form of denial-of-service attack in which an attacker quickly initiates a connection to a server without finalizing the connection. The server must spend resources waiting for half-open connections, which can consume enough resources to make the system unresponsive to legitimate traffic.

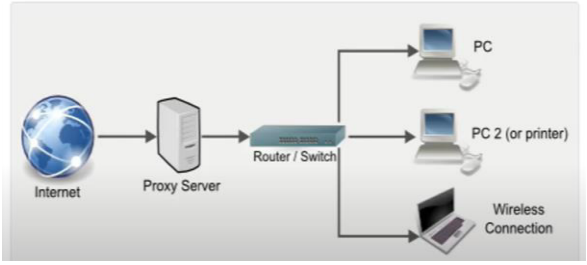

Figure IX. Transparent proxy

Data center proxy

• This proxy server may be physically located in a data center where user requests are evaluated and routed. It is not connected to an internet server, but a separate organization through the data center.

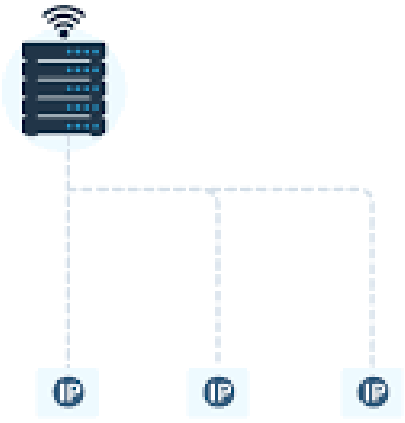

Figure X. Data center proxy

Rotating proxy

• Rotating proxies assign a different IP address to their users, an address that is different from the device that was previously connected to it.

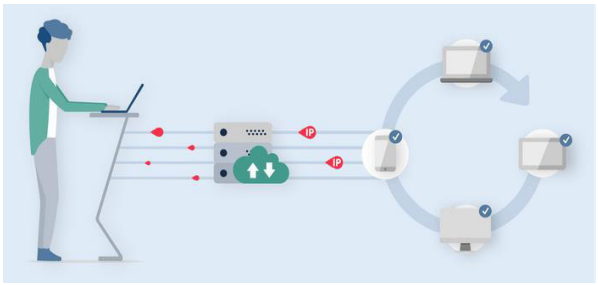

Figure XI. Rotating proxy

Reverse Proxy

• Instead of being placed "in front" of users, a reverse proxy is fixed in front of web servers that evaluate and route requests from the browser to the web server. A proxy server receives requests from the user at the network edge of the web server and then redirects the request received from the original server.

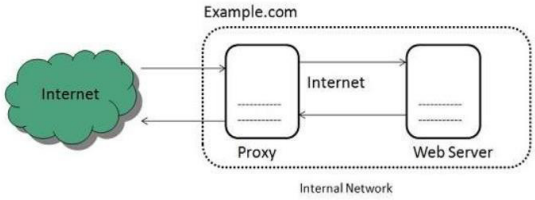

Figure XII. Reverse Proxy

SSL proxy

• SSL Proxy (Secure Sockets Layer) encrypts data sent back and forth on both sides, providing enhanced protection. These proxies are the better option for organizations to have for further security.

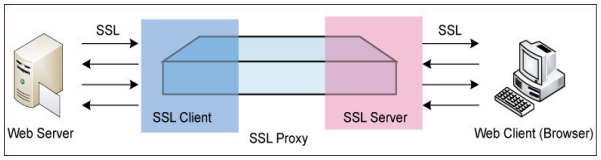

Figure XIII. SSL proxy

TOR proxy

• This proxy routes data through various globally available networks to mask the user's address. Data is encrypted in multiple layers to further protect privacy and when the data reaches its destination, each layer is decrypted to reveal the original data.

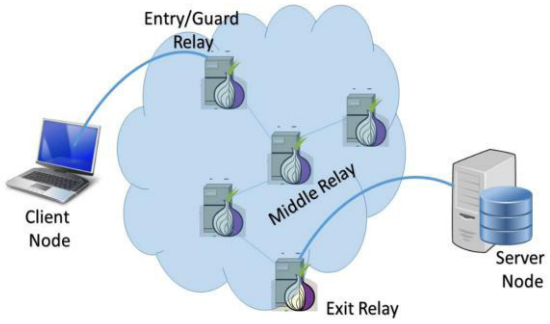

Figure XIV. TOR proxy

I2P proxy

• Like TOR proxy but improved.

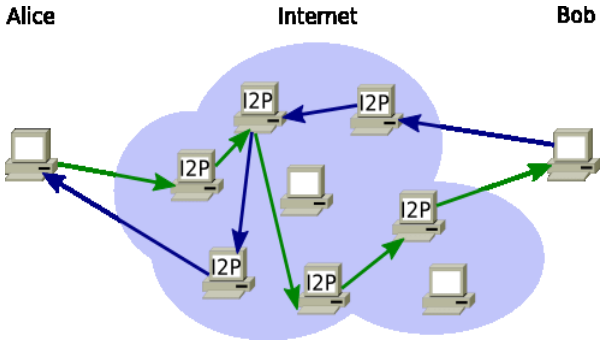

Figure XV. I2P proxy

Web Proxy Server

• This type of proxy forwards HTTP requests. This request is the same as HTTP requests; only URL is passed instead of path. A request is sent to which the proxy server responds. Examples of such proxies are Apache, HAPProxy.

• Proxy client-server autoconfiguration protocol solves the problem of multiple proxy servers.

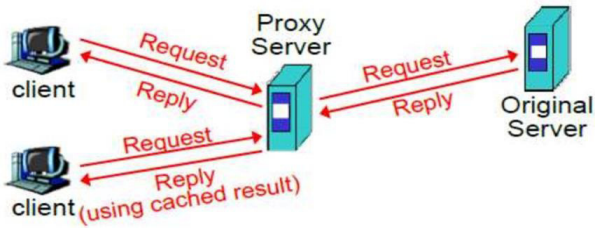

Figure XVI. Web Proxy Server

DNS Proxy

• Unlike other proxies, this type of proxy receives requests in the form of DNS requests and forwards them to the domain server, where they can also be cached, and the flow of requests can also be redirected.

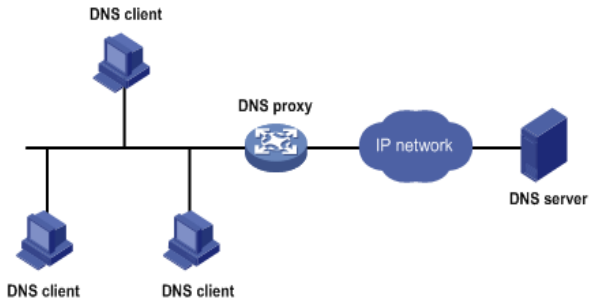

Figure XVII. DNS Proxy

CGI (Common Gateway Interface) Proxy

• This type of proxy is developed to make web pages more accessible. It works by accepting requests for targeting URLs using a web form, processing them, and returning the result to the web browser. It's less popular because of VPN and other privacy policies, but it still gets a lot of requests. Its use is reduced due to the excessive traffic that can be caused to the website after local filtration has passed, leading to collateral damage to the organization.

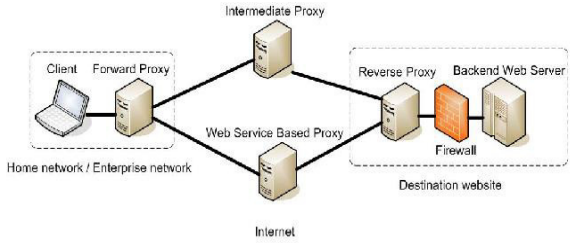

Figure XVIII. CGI (Common Gateway Interface) Proxy

IV. APACHE HTTP SERVER AS FORWARD PROXY SERVER

Apache Friends is a non-profit project to promote the Apache web server and is home to the XAMPP project. XAMPP is an easy-to-install Apache distribution that includes MariaDB, PHP, and Perl. The goal of XAMPP is to build an easy-to-install distribution for developers to enter the world of Apache. To make it convenient for developers, XAMPP is configured with all features included. Currently XAMPP has distributions for Windows, Linux, and OS X. To set up Apache as a proxy server first on our computer we need to have XAMPP installed.

We download XAMPP from the official website and install the .exe file. After successful installation, we open the control panel and configure the Apache server to function as a proxy server.

From the Apache control panel, select Config and open the Apache (httpd.conf) file (Figure 19).

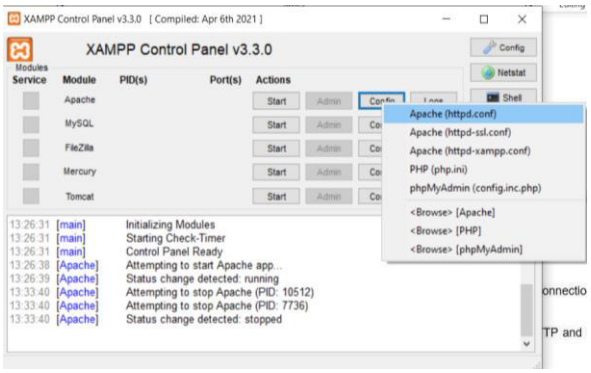

Figure XIX. XAMPP control panel

The file consists of several modules, some of which are enabled and others not. Our task is to enable the necessary modules in this file so that it functions as a proxy server. These are mainly the modules that contain the keyword proxy, but also several other basic modules. We enable modules by deleting the # sign in front of them. The necessary modules that we provide are the following:

- mod_proxy: The main proxy module for Apache that manages connections and redirects them.
- mod_proxy_http: This module implements the proxy features for HTTP and HTTPS protocols.
- mod_proxy_ftp: This module does the same but for FTP protocol.
- mod_proxy_connect: This one is used for SSL tunnelling.
- mod_proxy_ajp: Used for working with the AJP protocol.
- mod_proxy_wstunnel: Used for working with web-sockets (i.e. WS and WSS).
- mod_proxy_balancer: Used for clustering and load-balancing.
- mod_cache: Used for caching.
- mod_headers: Used for managing HTTP headers.
- mod_deflate: Used for compression.
- mod_lbmethod_byrequests: User for load balancer

After enabling the above-mentioned modules, we save the file. Then we go to the beginning of config and select browse Apache to make a few more configuration changes (Figure 20).

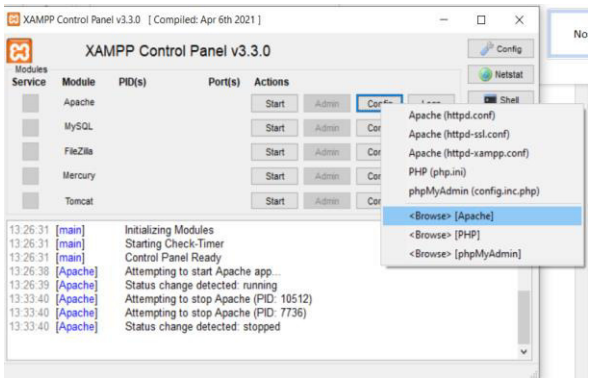

Figure XX. Control panel with selected browse Apache

Here we go to the configuration file (conf), extra and open the file httpd_vhosts.conf (Figure 21). At the end of this file, we will add 2 more virtual host configurations ProxyRequests on and ProxyVia on. We save the file and start the server.

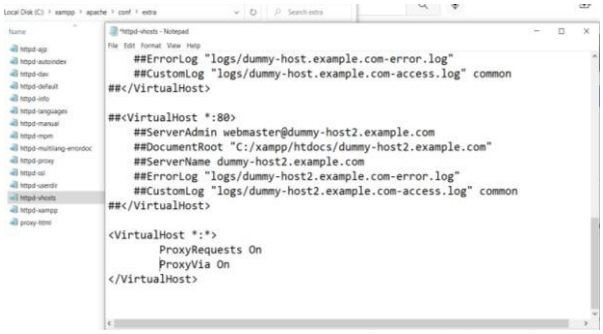

Figure XXI. httpd_vhosts.conf file

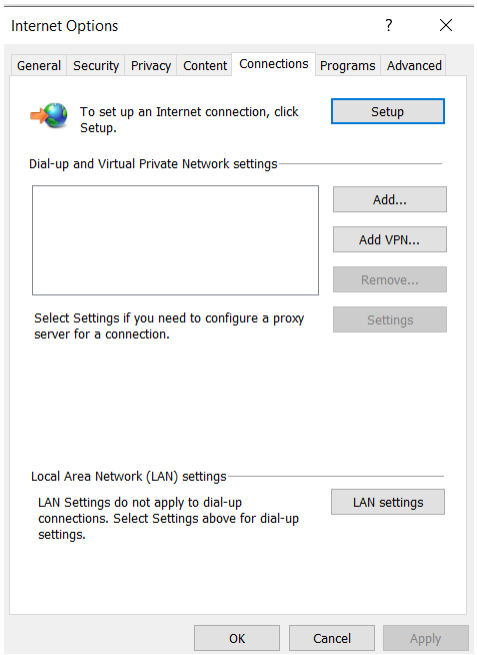

Figure XXII. LAN (Local Area Network) settings

Then open the Internet Explorer browser and select Settings from the upper right corner. From the settings, we select its Internet options (Figure 22). It offers several Internet options (General, Security, Privacy, Content, Connections, Programs and Advanced). From the options offered, we select the section with Connections and from there the local LAN (Local Area Network) settings. To use the browser as a proxy, we first check the box Use a proxy server for your LAN and in the address field we enter localhost and port 80 because Apache runs on port 80 as localhost. We choose ok and finish the settings (Figure 23).

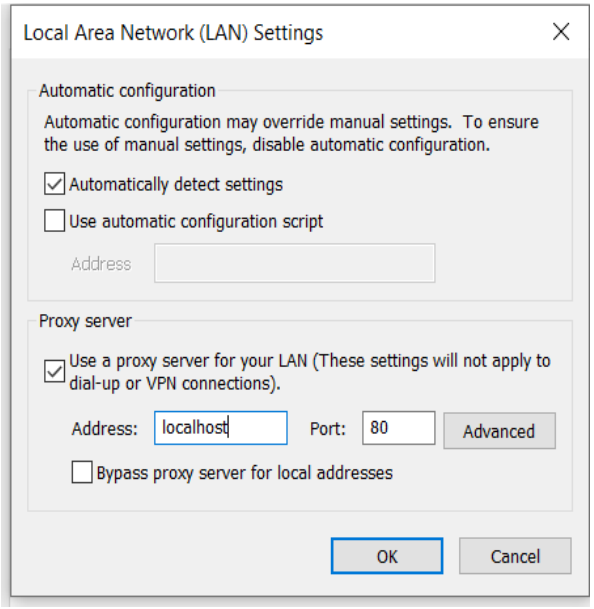

Figure XXIII. Proxy settings

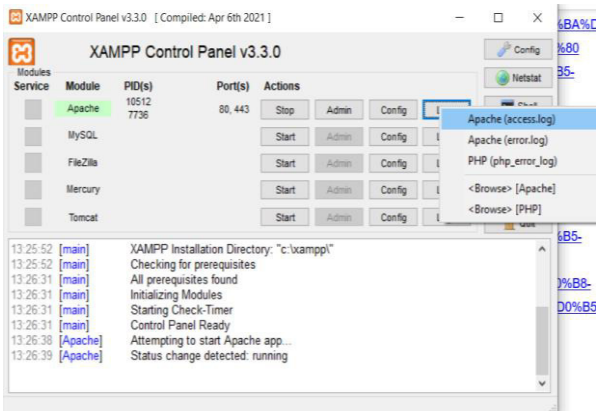

Figure XXIV. Apache (access.log)

Then we open any browser and randomly open several web pages and go to Logs in the XAMPP control panel. Here we open Apache (access.log) (Figure 24) and can see that there are no logs (Figure 25). It means that the settings are fine and the server is working as a proxy server.

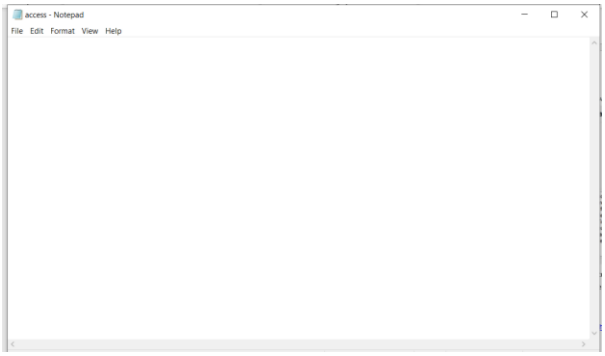

Figure XXV. access.log file

V. CONCLUSION

Proxies help with different types of anonymity needed at different levels, either as a client or as a service provider. They help to counter the information security of different users as well as the internal network. Different types of proxies are available, which follow different routing protocols and serve different purposes at different levels of anonymity.

Proxy servers act as a firewall and web filter, providing shared network connections and data caching to speed up common requests. A good proxy server protects users and the internal network from the bad things that live in the wild internet. Finally, proxy servers can provide a high level of privacy.

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Analysis of the Result of IT Project "Bandgrid Platform"

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Abstract – The paper presents the result of an information technology (IT) project, "BandGrid platform". The BandGrid platform consists of a website and web application. The purpose of the website is the promotion of the application and the possibility for users to access the application offers users the opportunity to view and follow music events of all kinds on the territory of the Republic of Serbia. Users can be visitors or registered users. The paper presents the characteristics and drawbacks of the web application and website, their differences and an overview of the front-end system of the web application and website.

I. INTRODUCTION

As a result of an information technology (IT) project, the "BandGrid Platform" is a project whose implementation involves the use of hardware, software and computer networks [1]. Taking into account the fact that this project is primarily a software project, two methodologies, intended for managing software projects, were used for its realization: kanban and scrum.

The BandGrid platform consists of a website and a web application. The purpose of the website is to promote the application and enable users to access the application and learn about its capabilities. The web application offers users the opportunity to view and follow music events of all kinds on the territory of the Republic of Serbia. Users can be visitors or registered users.

The idea to create a web application that allows users to view, monitor and, in a certain way, manage music events, came from the lack of similar information on the Internet. One of the problems is the non-updated pages of the clubs that organize these events, as well as the performers who are their main actors, where the BandGrid platform aims to promote them. In addition to promoting music events, the intention is to encourage clubs and performers to be more up-to-date with announcements about music events.

There are similar apps around the world, such as Bandsintown and Songkick Concerts. Both applications are available only on mobile devices, ie. Android and iOS operating systems. On the territory of the Republic of Serbia, there is currently no application that allows users to follow music events.

The paper describes, among other things: what is a web application and what is a website; why it is necessary to have both a web application and a website; features and disadvantages of the web application and website; key differences between a web application and a website; website and application architecture; an overview of the website's front-end system.

II. WEB APPLICATION AND WEB SITE

A web application is a software or program that can be accessed using any web browser (Figure 1 shows an example of a web application). Front-end, ie. the presentation part of the software is implemented using languages such as HTML, CSS, SCSS, JavaScript, i.e. languages supported by most web browsers. The back-end part of the software can be implemented using different frameworks that can be defined as a structure that the developer can follow. The framework mainly offers various libraries that, in addition to facilitating the creation of the project, significantly affect the time saving of its implementation. Unlike mobile applications, there is no separate Software Development Kit (SDK) for developing web applications. [2]

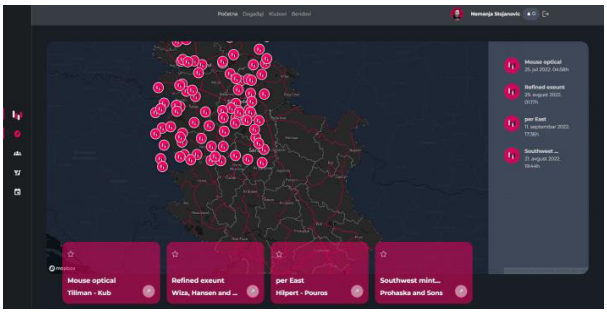

Figure 1. Example of a web application

Web applications use web browsers and web technologies to perform tasks over the Internet. A large number of businesses use the Internet as a cost-effective communication channel that allows them to exchange information with their target market and make fast, secure transactions.

However, effective engagement is possible if the company has the ability to collect and store all the necessary data, access the means to process that information and present the results to the user. Web applications use a combination of server-side scripts (eg PHP) to manage the storage and retrieval of information and use a combination of client-side scripts (JavaScript and HTML) to present information to users. Using these scripts allows users to interact with the company using forms, content management systems, shopping carts, and more. In addition, web applications allow employees to create documents, share information, collaborate on projects, and work on shared documents regardless of location or device. [3]

A website is a group of globally accessible, interconnected web pages that are under one domain (Figure 2 shows an example of a website). It can be developed and maintained by an individual, business or organization. All publicly available web pages make up the World Wide Web. It is sometimes referred to as a "web page", however, this definition is incorrect as a website consists of several web pages. There are sites of various types including educational sites, news sites, forums, social networks, e-commerce sites, etc. Web site pages are usually a mixture of text and other media such as images, video, and audio. [4]

It is possible to create a web page that contains only black and white photos or the word "cat", which is linked to another web page that contains the word "mouse". However, many websites follow a standard pattern of a home page that leads to other categories and content on the website. The home page is the main page of the website. Each page represents one HTML document, where all pages are connected by hyperlinks, i.e. links that are combined within the navigation menu for ease of use. The navigation menu is displayed on every page, not only on the home page, which gives users the ability to move faster through the site's contents. [4]

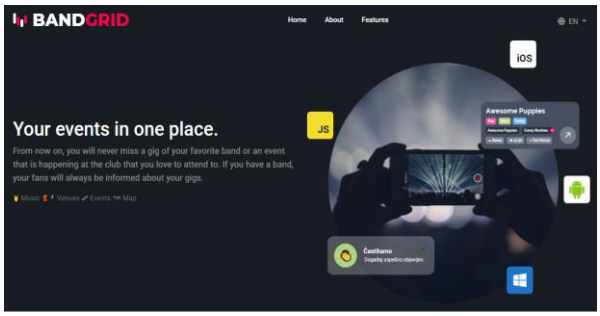

Figure 2. Example of a website

Web applications have a wide usage contributed by numerous features and advantages. Among other things, web applications can be said to be easier to maintain compared to desktop applications because they use the same code for the entire application and there are no compatibility issues. These applications are hosted on the Cloud, highly scalable and easy to test. Web applications can be used on any platform: Windows, Linux, Mac and are supported by all modern web browsers. The fact that web applications are accessed through a web browser means that there is no need to download and install the application. In addition to this, web applications do not require user updates and can be accessed 24 hours a day, 365 days a year from any computer or mobile device. Data access is not limited to a computer, data can also be accessed using a mobile device. Also, web applications are a cheaper option for any business. In comparison, desktop software licenses are extremely expensive.

Disadvantages of using web applications are, among other things, related to security issues. Security is not guaranteed as there is a possibility of unauthorized access. In addition to this, it is possible that the web application does not support different web browsers with the same priority, ie. some web browsers have higher priority than others. The web application has limited scope to access device features. Also, a web application is built exclusively for a specific operating system or operating systems. Due to this fact, the application cannot be discovered using an application store such as the GooglePlay Store for the Android platform or the AppleStore for the iOS platform.

On the other hand, a website is an effective method for displaying the products and services that are offered, helps in achieving business goals, in branding the business and provides support to users. Therefore, its advantages are related to high-quality and relevant content that is richly displayed and simple navigation that is convenient for users and web design. Also, the website can be found using a search engine such as Google.

The disadvantages of a website are:

• the possibility of a website crash, which can be a major disadvantage of an organization, institution, company or individual;

• the possibility of sending spam by the contact form located on the website;

• unreliability of information found on the website in case of non-updated site maintenance.

Summarizing the previously mentioned characteristics, the main differences between a web

application and a website can be listed, which is shown in Table 1.

Table 1. Main differences between a web application and a website

Parameter	Web application	Website
Created for	A web application is designed to interact with the end user.	A website mostly contains static content. It is publicly available to all visitors.
Interaction with the user	In a web application, in addition to reading content on pages, the user can also manipulate data.	The website contains visual and textual content that users can see and read, but cannot affect their functionality.
Authentication	Web applications require authentication because they offer a much wider range of options than a website.	Authentication is optional for informational websites. User can register for newsletter or to get additional options. These functionalities are not available to unregistered users.
Tasks and complexity	The functions of a web application are much more complex compared to the functions of a website.	A website displays the collection of data and information on a particular page.
Software type	Web application development is part of a website, but the application itself is not a complete website.	The website is a complete product that can be accessed using a web browser.
Compilation	The website must be recompiled before going live.	The website does not need to be recompiled.
Relasing	Any changes require the entire project to be recompiled and released.	Small changes never require a full compile and run. It is needed to update the HTML code.

III. BANDGRID WEBSITE ARCHITECTURE

The primary idea of the BandGrid website is to provide the user with all the functionalities offered by the BandGrid web application in a better and more detailed way. In addition to an insight into the functionality of the application, users can also stay up to date with all the happenings and news related to BandGrid. For this reason, the website has a newsletter and a contact form through which the development team can be contacted. In the future, the website will contain documentation that will enable more advanced use of the functionality of the web application, there will be a possibility to report errors, etc.

The website is live and can be accessed at https://www.bandgrid.com/.

Website architecture consists of:

- Front-End,
- Back-End,
- Database Server (database server),
- E-mail Server

The Front-End part on the website consists of several sections, such as: a brief description of the application, why users should register a profile on the platform, add-ons, i.e. functionality and the like. It consists of technologies that include TypeScript, SCSS, HTML5, Bootstrap and other modern technologies that are necessary for a visual overview of information [5-13].

The website is fully responsive, which means that the elements can be seen clearly on all devices - computer, laptop, tablet, phone...

The back-end part of the website is responsible for routing, validating data when filling out the contact form, signing up for the newsletter, and so on.

The database is only used to store contact information, ie. when the user fills out the contact form and sends it, in addition to the team members receiving an e-mail address with that information, it is also stored in the database.

IV. WEBSITE FRONT-END SYSTEM OVERVIEW

The idea was for the website to be single-page, that is, to contain one page where all the main sections are located. That is more or less achieved. The only section that is on the second page is the page that introduces the BandGrid team members (Figure 3) and the contact form.

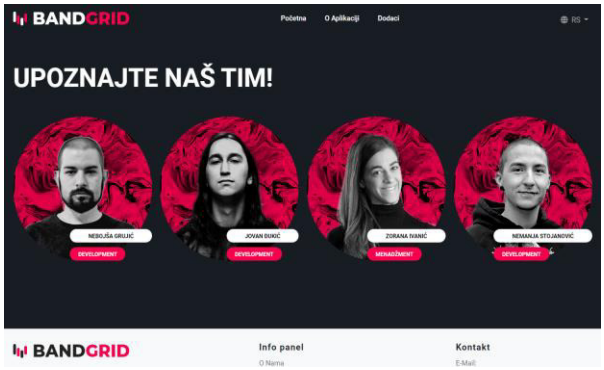

Figure 3. BandGrid team members page

The navigation menu consists of:

• BandGrid logo,

• A link that leads to the beginning of the home page,

• The link that leads to the "About the Application" section,

• The link that leads to the "Additions" section,

• The language that is currently active on the page.

Users can choose two languages: Serbian Latin/Cyrillic and English.

The next section contains a short text on why the user who is currently on the website, if he does not already have a registered account on the BandGrid application, should have one. The user is informed by the philosophy of the BandGrid team: if he follows a band or club, he will receive notifications for every event he creates.

The extras section, ie. functionalities briefly explains which functionalities will be available when the user registers and logs in to the platform.

Some of the functionalities are: creating bands, creating clubs, creating music events, receiving notifications (for example, when someone follows a band/club/music event created by that user), map (viewing the map of the Republic of Serbia where there are pins with music events) , data filtering (on the map, on the page for bands, on the page for clubs and on the page for music events).

Each tab can be expanded where the user can read a short text about that functionality. When the card is stitched, the + sign changes to a - sign to make it visually more realistic.

The last section contains a button that leads to the BandGrid Instagram profile where you can find posts from the marketing team as well as reactions from users who have had the opportunity to see some of the functionality of the BandGrid app.

The bottom of the page, the footer consists of: BandGrid logo, description, icon for Facebook and Instagram, Info panel containing "About Us" and "Contact", contact e-mail address, subscription to the newsletter.

The About Us page features members of the BandGrid team.

The contact page contains a form to be filled out. The fields that the form contains are: e-mail address, first name, last name and message.

It is necessary to enter data for each field on the form, and there is a predefined data validation that must be satisfied. If the user tries to send a message without filling in the fields on the form, he receives a notification that an error has occurred as well as an X mark in the fields where validation is not satisfied.

If the user satisfies the validation for certain fields, then instead of X there will be a mark for wacky.

When the user successfully sends a message, then the developers receive an e-mail at the contact address where they can see all the data that the user sent.

V. BANDGRID WEB APPLICATION ARCHITECTURE

BandGrid web application is a system for managing the content of bands, clubs and music events, as well as monitoring all music events in the Republic of Serbia. These events include all sets and subsets of alternative directions. The application aims to present the user as closely as possible all upcoming and active events in the form of dynamic lists or maps.

The architecture of this system consists of four main parts: Front-End, Back-End, Database server (database server), E-mail server.

The role of the Front-End part in this application is to enable the user to interact with the system and with the help of lists, graphs and maps current events are brought closer to the users. The Front-End part of the application consists of technologies that include TypeScript, SCSS, HTML5, Bootstrap and other modern technologies that are necessary for a visual overview of information.

The role of the Back-End part is to store and deliver all the necessary information to the user from and to the database. This is realized with the help of the REST API. REST API stands for Representational State Transfer and refers to the way/principles of API creation. Data is most often

transferred in JSON format, although it is also available in XML and YAML format. The API is based on the REST architecture and is very flexible and easy to understand.

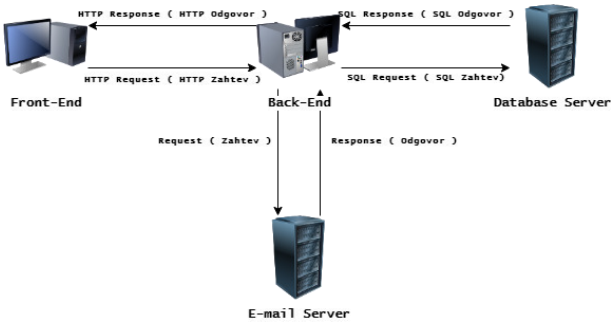

Figure 4. Architecture of the BandGrid system

The role of the database server is to store all outgoing and incoming information of the Back-End using technologies like SQL and NoSQL databases.

The role of the e-mail server is to deliver the right information to the registered user's e-mail at the request of the Back-End part. This system is used to deliver email notifications involving the web application and website.

VI. FRONT-END SYSTEM OVERVIEW

In order for users to use the application effectively, the front-end, ie. the user interface contains a navigation menu and a menu located on the left side. Some of the items found in the navigation menu are: Home (leads to the home page), Events (leads to a page containing music events), Clubs (leads to a page containing clubs) and Bands (leads to a page containing bands).

When the user is on a navigated page, that page will be marked as active in the navigation menu. For example, in Figure 5, it can be seen that the link on the home page is different from the other links. This means that the page is currently active, ie. that the user is on it. Accordingly, when the user is on the event page, that link will be active in the navigation menu.

Figure 5. Layout of the navigation menu if the user is logged in

In addition to the basic navigation items, there is also a user login button. This button leads to a page that allows the user to log in if they have a registered account.

If the user is logged in, then user information – name, surname and profile picture – appears in the navigation menu. Next to the first and last name, a new notification button appears. A user receives a notification for an event, band or club that he created and that another user followed. The user can access his profile by clicking on his profile picture or by clicking on his name and surname. There is also a user logout button on the navigation menu.

The navigation menu on the side contains links to the same pages. Compared to the previous navigation menu, it differs because it consists of icons. These icons also have an effect if the user is on a certain page, ie. the link is active.

If the user is logged in, then another button will be found on the navigation menu on the side. This button allows the user to filter events, clubs and bands using a number of different parameters.

Figure 6. The map – a visual overview of music events and the cities where they are held

The home page contains the most important functionality for this platform – the map (Figure 6.). With the help of the map, users have a visual overview of music events and the cities where they are held.

Users have the option to enlarge or reduce the map, which depends on their needs. This allows to see the city and the exact street of the club where a music event will be held.

The map has a section next to it that shows the four most recent music events that have been created. This allows for a quick and easy view of the latest content that has been added. The information that can be seen, related to the event, is the name of the event, the date of the event, as well as the logo. If the name of the event is clicked, then the user will be transferred to the same page where he can find all the necessary information.

In addition to that section, there are tabs below the map that also contain the four most recent events that have been created. In this way, the latest content created by a user is marketed to users in a nicer way. The information that users can see

inside the tabs is the name of the event and the club where it is held. By clicking on the arrow, the user will be transferred to the event page where he/she can find all the necessary information.

VII. CONCLUSION

"BandGrid platform" is the result of an information technology project. For the realization of this project, modern technologies were used, which aim to speed up and facilitate the development process. In addition to modern technologies, popular methodologies intended for software project management were also used.

There are many applications in the world that help users follow music events more easily, but there is no such application in the territory of the Republic of Serbia. Therefore, the development team came up with the idea of realizing an application that will provide users with all the necessary information. Users have the ability to create and update artists, clubs and music events. Currently, there is no control over who creates the profile of the performer on whose behalf, but there is intense discussion about the system that would be in charge of this.

ACKNOWLEDGMENT

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Quality Assurance System in Higher Applied Education

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Abstract - This paper aims to present the quality assurance system of higher applied education. Higher applied schools and academies of applied studies (hereinafter: the Institution) build an organizational structure for quality assurance. The system of internal quality assurance includes the preparation and implementation of appropriate documents, the definition of the quality bearer, the mechanism of its control, but also the implementation of corrective measures. During the external quality control and self-evaluation, the institution must provide evidence to the National Entity for Accreditation and Quality Assurance in Higher Education (NEAQA) that it has and applies a quality assurance system, as well as providing a critical review of the objectives; adequate design of processes and activities related to quality; but also for deciding on the achieved quality transparently. The standardization of the quality assurance system enables the improvement and improvement of the quality of the work of institutions in the territory of the Republic of Serbia with the simultaneous comparability of the results obtained with higher education institutions from the EU area. The result of achieving high quality is the membership of NEAQA in the European Association for Quality Assurance in Higher Education (ENQA).

I. INTRODUCTION

The system for ensuring the quality of higher education, and thus also for professional studies, is defined by the Law on Higher Education [1]. The quality assurance system of higher education institutions is regulated at the national level. The National Council for Higher Education is the highest authority in the system of control and quality assurance of higher education, whose competence is to [1]: monitor the development of higher education and its compliance with European and international standards; propose higher education policy; gives an opinion on the policy of admission to higher education institutions; proposes norms and standards of work of higher education institutions; establishes standards for self-evaluation and evaluation of the quality of higher education institutions; determines the standards and procedure for external quality control of higher education institutions.

National Entity for Accreditation and Quality Assurance in Higher Education (NEAQA) is a body established by the Government of the Republic of Serbia to perform accreditation work, checking the quality of higher education institutions and their constituent units, evaluating study programs and ensuring quality in higher education [1,2]. The Commission for accreditation and quality control is an expert body of NEAQA, which carries out the accreditation procedure of higher education institutions and study programs and the procedure of external quality control of higher education institutions, by the Law on Higher Education [1] and the prescribed procedure and standards for accreditation, self-evaluation and external quality control [3,4,5]. The verification of the fulfillment of the obligations of the higher education institution in terms of quality is carried out by national standards and according to the national procedure for the external quality control of higher education institutions, based on a self-evaluation report.

The national quality control and assurance procedure are harmonized with the international framework, ie with the quality system established by ENQA [6].

The national procedure for checking the quality of a higher education institution (and thus of higher vocational schools) according to the Law on Higher Education [1], has two levels:

1) Self-evaluation is a procedure that a higher education institution carries out in the fourth year after the accreditation of the higher education institution, or study programs, for the period of the previous three years, as well as during the preparation of the re-accreditation of the higher education institution, or study programs, for the period of the previous three years. In the self-evaluation process, students' grades are also considered. Self-evaluation is carried out in the manner and according to the procedure prescribed by the general act of the higher education institution, by the act on standards for self-

evaluation and quality assessment of higher education institutions and study programs [1,4]. The report on the procedure and results of the self-evaluation, as well as other data of importance for quality assessment, is publicly published by the higher education institution on its official website and submitted to the body called NEAQA, in the process of External Quality Control (but within the documentation for the accreditation of study programs/higher education institutions in the accreditation process).

2) External quality control of a higher education institution is a procedure carried out by the Commission for Accreditation and Quality Control, appointed by NEAQA, regularly: in the fourth year of the accreditation cycle and during the accreditation of a higher education institution, and may also be extraordinary, as well as at the request of the Ministry or the National Council for Higher Education. The regular external quality control procedure is based on the self-evaluation report submitted by the higher education institution. As a rule, the process of external quality control of a higher education institution is initiated by the Commission for Accreditation and Quality Control [1,3,4]. The report on the performed external quality control of the higher education institution is submitted by the body called NEAQA to the higher education institution and published on our official website.

According to the above, the introduction and strict implementation of the National system of quality assurance in the college of applied studies and academies of applied studies (hereinafter: Institution) is a key parameter of the ranking of these higher education institutions on the domestic and international market of education.

This paper aims to present the types of documents that make up the quality assurance system in a college of applied studies. The paper will also give a brief presentation of the Quality Assurance Strategy [7], in the sense of the selected strategic document for analysis, from which a set of operational documents for quality control in the concerned Institution is derived.

II. PRESENTATION OF THE QUALITY ASSURANCE SYSTEM ON THE EXAMPLE OF ONE COLLEGE OF APPLIED STUDIES

The quality assurance system in the selected college of applied studies consists of the following set of documents [7]:

- Quality Policy,
- Mission and Vision,
- Quality Assurance Strategy,
- Subjects and measures in quality assurance,
- The Rulebook on standards and procedures for ensuring and improving the quality of work, self-evaluation of the Technical College of Applied Science in Zrenjanin, and self-evaluation of study programs,
- The Action plan for the implementation of the Quality Assurance Strategy of the Technical College of Applied Science in Zrenjanin.

The Quality Policy [7] represents the starting document from which the Mission and Vision [7] derive as a principle document. The documents are publicly available [7].

A. The Quality Assurance Strategy

By its Mission and Vision, the subject Institution has determined the Quality Assurance Strategy and promotes it within the Institution and in the public [4].

The Quality Assurance Strategy is the basic document in the quality assurance system and is the starting point for managing certain processes of the Institution. It defines the strategic orientations, plans, and directions of activity of the institution in ensuring the quality of higher education by the standards in the area of quality prescribed by the National Council for Higher Education [7]. The strategy starts from the sustainable development goals of the society, the Mission and Vision of the Institution in achieving the goals of higher, primarily vocational education and represents the basis for the development of quality assurance action plans that should be fulfilled in a certain period [7]. The strategy defines the Institution's quality assurance goals. Achieving the set goals implies defining the general quality assurance requirements [7]:

- The Institution has established basic tasks and goals that determine the further development of activities and the process of planning and control of work;
- The Institution plans and controls its work based on the analysis of the current

situation, i.e. internal and external factors that affect its work;

- The Institution regularly and systematically controls the fulfillment of its basic tasks, giving priority to the achievement of educational goals;
- The bearers of the planning process are precisely defined through the Quality Assurance Committee;
- Long-term planning is done at intervals of at least three years, and short-term once a year, through the adoption of the Institution's Work Plan;
- The Quality Assurance Committee implements the quality control mechanism of all segments of the Institution's work, identifies deficiencies and problems, undertakes activities and implements measures to eliminate deficiencies, and proposes concrete ways to improve quality. The control of the fulfillment of basic tasks and goals is carried out by the Quality Assurance Committee at planned intervals which prepares appropriate reports, action plans, etc.

The Quality Assurance Strategy is a public document that contains [7]:

- The determination of the Institution to continuously work systematically on the improvement of the quality of study programs and to harmonize them with the best EU practice and National standards for accreditation;
- Quality assurance measures;
- Quality assurance entities;
- Areas of quality assurance;
- Commitment to building an organizational culture of quality;
- Connection of educational, developmental, and professional activities;
- Internationalization strategy.

The Institution must continuously evaluate the Quality Assurance Strategy and compare it with its Mission and Vision.

Through its Mission and Vision, the Institution also defines its determination through the Quality Assurance Strategy [7].

Quality assurance measures are included in the Quality Assurance Strategy and include activities that improve quality [7]:

- Self-evaluation and assessment of the quality of study programs and Institutions by the standards of the National Council for Higher Education, in three-year intervals and, if necessary, more often;
- Respect and implementation of standards and procedures for ensuring the quality of study programs, teaching and working conditions, as well as the criteria prescribed in the general acts of the Institution, while creating a positive environment for the development of study programs;
- Continuous work of the Commission for Quality Assurance in terms of monitoring and controlling the quality of the Institution's work;
- Respecting the criteria for the selection of teachers and associates prescribed by the Law on Higher Education and the Minimum conditions for selection as a teacher at applied studies Academies and applied studies colleges [8];
- Constant training of teaching staff to improve the teaching process;
- Constant investment in literature, development of electronic teaching material, as well as in workspace and equipment;
- Establishing permanent cooperation with the National Employment Service, employers, and alumni students, to receive feedback on the quality of the study program, the competencies they have acquired, and the application of the acquired knowledge in practice;
- Provision of human resources and infrastructure for the collection and processing of data important for the analysis and assessment of quality and degree of success in achieving set goals and objectives;
- Provision of work conditions for student representatives in the process of evaluating the teaching process;
- Publication of quality evaluation results;

- Provision of other conditions that promote a culture of quality.

One of the most important segments in the scope of the Quality Assurance Strategy [7] is the definition of quality assurance entities.

Subjects of quality assurance of the work of the Institution [7] are the employees of the Institution, students, the Director, professional bodies, and the Council. [7,9]:

- Commission for Quality Assurance;
- Advice;
- Director;
- Teaching-professional council;
- Collegium;
- Teachers;
- Associates;
- Non-teaching staff;
- Students Parliament;
- Students;
- All parties who complete certain tasks in the Institution.

All entities in quality assurance have the right and obligation to participate in quality assurance and improvement, and the responsibilities of individual entities are defined by the Statute of the Institution [9] and other acts from the field of quality assurance of the Institution itself.

The Quality Assurance Strategy in the Institution [9] defines the aspects of quality assurance and self-evaluation procedures.

Quality assurance standards and procedures are established separately for each area [7]:

- Quality assurance standards and procedures;
- Quality assurance system;
- Quality of the study program;
- Quality of the teaching process;
- Quality of scientific research and professional work;
- Quality of teachers and associates;
- Quality of students;
- Quality of textbooks, literature, library, and IT resources;
- The quality of the Institution's management and the quality of non-teaching support;
- Quality of workspace and equipment;
- Financing;
- The role of students in self-evaluation and quality control;
- Systematic monitoring and periodic quality control.

The Institution's quality assurance strategy [7] defines the flow of documents and procedures for their adoption. Quality assurance procedures are determined separately for each area and are publicly announced.

The Rulebook on standards and procedures for ensuring and improving the quality of work, self-evaluation of the Technical College of Applied Sciences in Zrenjanin, and self-evaluation of study programs [10] determines the jobs and tasks of teachers, associates, non-teaching staff, students, and the Commission for Quality Assurance in adopting and implementing the Strategy for Quality Assurance [7], quality assurance standards and procedures.

Through the Quality Assurance Strategy [7], the institution defines a clear and unequivocal commitment to building a quality culture and connecting educational and professional activities.

The Quality Assurance Strategy must be continuously evaluated and supplemented by the so-called umbrella documents from the field of quality assurance in the Institution.

B. Action plan

For the implementation of the Institution's Quality Assurance Strategy [7], the Quality Assurance Commission draws up an Action Plan that specifies the measures and activities with deadlines, as well as the entities responsible for the implementation of those measures.

III. CONCLUSION

By examining the Quality Assurance Strategy in a higher school (college) of applied studies, it was determined that the above-mentioned document is the basic strategic development document in the area of quality assurance in that institution. The Quality Assurance Strategy

defines the basic priorities of the observed college of vocational studies, vocational higher education in general, and other activities in the field of quality assurance and improvement, as well as the way of their realization. Promoting the culture of the quality of work of the Institution is also one of the priorities of the strategic determination.

According to the above, the considered Quality Assurance Strategy in the selected higher school of applied studies has a very important role and importance for the implementation of the established quality assurance system in the observed Institution. The Institution clearly stated that the Quality Assurance Strategy is aligned with national standards for quality assurance in higher education, but also that it is a permanent document, which will be periodically reviewed and changed, i.e. supplemented.

The further course of work may also include the analysis of other documents from the field of quality assurance (primarily operational) in the same higher school of applied studies, etc.

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Example of FCM Application in Subjectively Oriented Problems

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Abstract - Since subjectively oriented problems are very hard to be presented and defined, and especially hard to be analyzed, it is the fuzzy cognitive mapping (FCM) that helps us do exactly that. In this paper, it will be presented how to build a fuzzy cognitive map and what are the implications and requirements needed for a successful implementation of an FCM. The work in this paper is not only based on existing examples and works but also has a creative new example of FCM usage. Our work on the example was supported and finished by using computer programs FCMapper and Pajek.

Key words: fuzzy, cognitive map, FCM, causalities, concepts

I. INTRODUCTION

FCM is a semi-quantitative and dynamic knowledge structuring method that aims to capture a person's perception of a particular issue in a diagrammatic format. FCM graphs provide the creator and the respondent with an informal structured process that has the ability to show additional connections, provide insights and concepts about a particular domain. It provides information on how changing one question affects other answers. FCMs have the ability to represent quantitative and qualitative information obtained from the opinions of stakeholders, overcoming the lack of quantitative data reliability due to uncertainty. They are suitable for illustrating the effects of changing factors for the whole system although they are not able to make quantitative predictions. They predict the effects of policy undertaken in a "what-if" scenario, assuming that because the real world is complex, knowledge can be gained from the perceptions of people involved in a particular issue.

FCM can also be presented as a graphical representation of the system, which depicts cause-and-effect relationships between nodes. Nodes represent concepts and arcs represent observed relationships between these concepts. These relationships in FCM are logically imposed by connecting concepts through semantic or otherwise meaningful directional links that show causality between them.

FCM can also be viewed from the point of view of neural networks and Fuzzy logic. Experts decide which learning techniques and algorithms to integrate, with stakeholders first providing feedback before extracting knowledge. Through the process of defuzzification, all linguistic variables are transformed into numerical values, which enables the extraction of knowledge. The process produces a set of concepts denoted as Ci (i = 1, 2, … n) (graph nodes) with their mutual relations denoted as wi (directed edge graph). After defuzzification, concepts are assigned a value within the range [0, 1] and weights are assigned a value within the range [−1, 1] to see negative and positive causality. A positive value of the weight wij indicates that an increase or decrease in the value of the concept Ci leads to an increase or decrease in the value of the concept Cj. Similarly, a negative weight wij indicates that an increase (decrease) in the value of concept Ci leads to a decrease (increase) in the value of concept Cj, while a zero weight indicates no relationship between concepts Ci and Cj.

Then, the formation of the appropriate connectivity matrix is performed. Each concept Ci in the graph has a value Ai that expresses the amount of its corresponding physical value derived after the previously described defuzzification. The value Ai of Ci is calculated at each step of the simulation. It indicates the influence of all other concepts Cj on Ci (inference). The most popular inference rules are:

- Koskov's reasoning,
- Modified Kosko's reasoning
- Resize inference

II. FCM DEVELOPMENT USING HUMAN KNOWLEDGE

To develop an FCM, people can use their knowledge of the area being studied by identifying the main concepts involved. Then, indicate the

cause-and-effect relationships between these concepts. The last step is to calculate the strength of causal relationships using either clear numerical values in the range [−1, 1] or using linguistic variables and values that are later converted to numerical values. Experts can improve the existing FCM by collectively analyzing the key features of the system under study and re-evaluating the structure and interconnections of the graph, using conditional statements or fuzzy rules. The algorithm used to develop the FCM is shown below:

Step 1: People choose the concepts Ci that make up the FCM graph.

Step 2: Define cause-effect relationships between any two concepts, if any (positive, negative, neutral).

Step 3: A careful determination of the value of the relationship between the two concepts is carried out.

Step 4: Causal influences are then described using linguistic variables, such as 'low', 'medium', 'high', etc. The sign of each weight (- or +) represents the type of influence between the concepts. There are three types of interconnections between the two concepts Ci and Cj:

- wij ≥ 0 means that increasing or decreasing the concept Ci causes the same result in the concept Cj .
- wij ≤ 0 means that increasing or decreasing the concept Ci causes the opposite result in the concept Cj.
- wij = 0 means that there is no connection between the terms Ci and Cj.

The degree of influence between two concepts is indicated by the absolute value of wij. During the simulation, the value of each concept is calculated using the following rule:

$$Ai(k)=f(k1Ai(k-1)+\sum j=1, j\neq iNwji \times Aj(k-1))$$

III. LEARNING PROCESS IN FCM

In some situations, FCM cannot be created for the following reasons:

- There is no expert or stakeholder with a direct interest in defining FCM.
- Experts' knowledge is different - they draw drastically different FCMs or even FCMs with minimal overlap of concepts.

There are a large number of concepts and connections between them, which cannot be drawn without errors (occurs in problems of high complexity).

For such cases, a systematic way of constructing the FCM was developed using a learning process, to automatically determine the weights of the FCM, which best fits the decision-making and forecasting problems. Various learning methods have been proposed by many researchers and are based on the same techniques used to train neural networks. There are three basic types:

- Hebbian based- requires the data to be used together with a learning formula that governs the weight adjustment of the cognitive map
- population-based - use evolutionary strategies to learn FCMs from data
- hybrid- use both the efficiency of Hebbian learning and the global search capability of evolution-based algorithms.

In the case of population-based algorithms, the basic idea is to use available input data sets to discover models that mimic the input data. This method uses an objective criterion or a function to be optimized, which makes the method computationally intensive. The primary objective is to find a near-optimal weight matrix based on the functional characteristics of the FCM.

IV. THE NEW EXAMPLE OF FCM APPLICATION IN SUBJECTIVELY DEFINED PROBLEMS

Given that FCM can be effectively used to solve dilemmas concerning subjective issues and problems, this paper presents the application of FCM in one such case. Subjective questions and problems are included in topics from the most diverse spheres of life: in which people have already successfully applied both ordinary cognitive and fuzzy cognitive maps (maps) in the previous period. However, in order for the topic to be adequately described, it needs to be understood and presented as a system consisting of various interconnected elements (ie. factors, concepts). Some of the more notable applications are in the fields of medicine, ecology, economics, engineering...

In this work, cognitive mapping was used in order to, first of all, create and then present and view the most significant part of unquantified factors related to the quality of life and standard of living. As previously established [4], gathering data to form concepts and arcs (factors and interrelationships) can be done in several ways. However, in this paper, the factors are primarily based on the consideration of many possible factors, which were then reduced to groups that

were compared with those that appeared most frequently through a free Internet search. In order to avoid situations that lead to the impossibility of creating FCM, and as it was stated in earlier works dedicated to FCM and its application: new concepts (and therefore arcs) do not increase rapidly in number when interviewing several subjects, we concluded that the factors collected to describe this problem will be sufficient. Also, since this is only a demonstrative example of FCM use and not a scientific research, it made it easier to decide for us. The term "unquantified factors" does not mean that their causality is equal to zero, but rather their subjective nature, i.e. to the fact that they were not obtained from numerically (statistically) determined sources.

Issues of quality of life and standard of living can be understood in several ways and there are several ways in which organizations and institutions perceive and calculate them (for instance: https://www.numbeo.com/quality-of-life/indices_explained.jsp). The calculation systems they use include easily measurable and accessible data. However, sometimes for the presentation and understanding of the needs and problems faced by citizens, it is much more important to look at their opinion and personally assessed needs, criteria and priorities. This is precisely why we used and successfully applied FCM, whose procedures and results will be presented in more detail in the following chapters.

V. FCM CREATION PROCEDURE

A. *Matrix of concepts*

To create any FCM, it is first necessary to define and describe the problem. After that, it is necessary to look at the factors of that problem, where the problem should be viewed as a system consisting of components or factors that make it up. After that, the values that describe the interdependencies of the system components are determined and formed into a matrix. Arguably, the matrix is the most important part of the FCM. While calculating interconnection values, it is evident that there may be a potentially big problem in the form of disparity in opinions regarding the names and grouping of the concepts (components) themselves, as well as their mutual connection (-, 0, +). Basically, since the procedures for collecting information and successfully forming the matrix have already been described in the previous chapters, it is time to present the matrix from our example (Figure 1).

Figure I. Matrix of concepts

	Leisure a	Access to	Access to	Affordab	Educatio	Employm	Environm	Housing	Infrastru	Political	Safety	Traffic,tra	National	Law enfo	Family a	Pension s
Leisure, culture and recreation	0	-0.1	0	-0.1	-0.1	0	0	0	0	0.1	-0.1	0	0	0	0	0
Access to and potential of obtaining more material g	0.2	0	0	0	0	0	0	0	0	0	0.2	0.2	0	0	0.2	0
Access to food and water	0.3	0	0	0	0.1	0	0	0	0	0	0.1	0	0	0	0.7	0
Affordable healthcare	0.2	0.1	0.1	0	0.1	0	0	0	0	0	0.2	0	0.2	0	0.7	0
Education	0	0.3	0.5	0.5	0	0.5	0.1	0.2	0.1	0.2	0.2	0.2	0.3	0	0.1	0
Employment	0	1	1	0.7	0.2	0	0	0.9	0.3	0	0.4	0.5	0.2	0	0.9	0
Environment	0.4	0.1	0.5	0	0.1	0.1	0	0	0	0	0.1	-0.1	0	0	0.1	0
Housing	0.1	0	0.2	0.2	0.3	0.2	-0.2	0	0	0	0.3	0	0	0	0.4	0
Infrastructure	0.3	0.2	0.3	0	0.5	0.4	-0.3	0.5	0	0	0.2	0.3	0.1	0	0.1	0
Political and religious freedom	0	0	0	0	0	0	0	0	0	0	0.1	0	-0.1	0	0.1	0
Safety	0.1	0.1	0.2	0	0.1	0.1	0	0.2	0.1	0	0	0.1	0	0	0.2	0
Traffic,transportation and freedom of movement	0.3	0.5	0.5	0.5	0.4	0.8	-0.1	0.5	0.3	0.1	0	0	0	0	0.1	0
National economic and political stability	0	0.9	1	0.6	0.4	0.5	0.2	0.4	0.4	0	0.4	0.3	0	0	0.2	0.7
Law enforcement and justice institutions	0	0.1	0.2	0.3	0	0.1	0.3	0.2	0.1	0	0.6	0.1	0.3	0	0.2	0.3
Family and social interaction	0.2	0.1	-0.1	0	0.5	0	0	0.1	0	-0.2	0	0	0	0	0	0
Pension system	0.1	0.2	0.3	0.3	0	0	0	0.1	0	0	0.1	0	0.1	0	0.1	0

The selected example is complex but at the same time suitable for the application of FCM because it requires the monitoring and examination of a large number of causalities: the number of potential connections is 162. If it were an even more extensive example (and there certainly are examples that indeed are), the qualities of the fuzzy cognitive maps would reach even greater expression.

At first glance, when looking at the parameters of the matrix, it may be insufficiently clear clear how the parameters ie. factors influence each other.

B. *Values calculation and FCM presentation*

For this and subsequent steps (up to the presentation of the map itself), a tool based on MS Excel software called FCMapper was used. The tool itself is free and available at the following link (M. Bachhofer, M. Wildenberg: FCMapper - our Fuzzy Cognitive Mapping Software Solution. http://www.fcmappers.net/joomla/index.php). The first step that must be done is to calculate the base value of each concept. The values obtained during simulations and after applying the formula serve us to describe the properties of each individual concept. By the property of a concept is meant whether it is a "receiver", a "transmitter" or a "ordinary" one. This is determined on the basis of connections (arcs) that flow into it or flow out of it. Figure 2 shows the parameters of the specific example.

Density	Hierarchy Index	Total Nr. Factors	Total Nr. Connections	Nr. Transmitter	Nr. Receiver	Nr. Ordinary	Nr. NoConnecti	Nr. SelfLoops	Nr. Regular Connections
0.5078125	deactivated by author	16	130	1	0	15	0	0	130.0
			1						
Concepts	Outdegree	Indegree	Centrality	Transmitter	Receiver	Ordinary	no connection		
Leisure, culture and recreation	0.50	2.20	2.70			1		-2.3	
Access to and potential of obtaini	0.80	3.70	4.50			1		-2.3	
Access to food and water	1.20	4.90	6.10			1		-2.2	
Affordable healthcare	1.60	3.20	4.80			1		-2.2	
Education	3.20	2.80	6.00			1		-2.1	
Employment	6.10	2.70	8.80			1		-1.9	
Environment	1.50	1.20	2.70			1		-2.2	
Housing	1.90	3.10	5.00			1		-2.2	
Infrastructure	3.20	1.30	4.50			1		-2.1	
Political and religious freedom	0.30	0.60	0.90			1		-2.3	
Safety	1.20	3.00	4.20			1		-2.2	
Traffic,transportation and freedor	4.10	1.80	5.90			1		-2.1	
National economic and political st	6.00	1.30	7.30			1		-1.9	
Law enforcement and justice insti	2.80	0.00	2.80	1				-2.1	
Family and social interaction	1.20	4.10	5.30			1		-2.2	
Pension system	1.30	1.00	2.30			1		-2.2	

Figure II. Calculating the centrality of concepts for their display

After that, an analysis of those characteristics is available to us, which can be obtained in the form of statistics. The most important factors can already be guessed from the statistics. Of course, since the nature of FCM is descriptive, it is not possible to determine precisely how much a change in any of the factors can exactly affect any of the other factors, but it can certainly guide us and indicate which factors are of greatest importance. In the concrete example, most of the factors contain the feature of centrality, ie. arcs come in and out of them, which means that these factors are neither strictly receiving nor strictly transmitting ones.

In order to finally present the concepts in the best possible way, they can be grouped. Within each group, it is necessary to select the concepts that belong to it, as well as the shape and color of symbol through which they will be displayed. In addition to the mentioned options, there is also a button to help us verify the groups - it serves us to count members (in case we have omitted a member - concept - we will not be able to complete this step).

The last step is to create a list of nodes and arcs, which is very easy because the tool itself generates a new Excel sheet with the necessary values which can be changed as desired. After that, the network is created, however, to display it, it is required to download an additional software that supports reading files with the .net extension. One such program is Pajek (A. Mrvar, V. Batagelj: Pajek – Program for Large Network Analysis. http://mrvar.fdv.uni-lj.si/pajek/), which is recommended by the FCMapper community. The Pajek program enables the manipulation of the cognitive network in various ways, although the most important thing for us is its basic ability to, simply, present them.

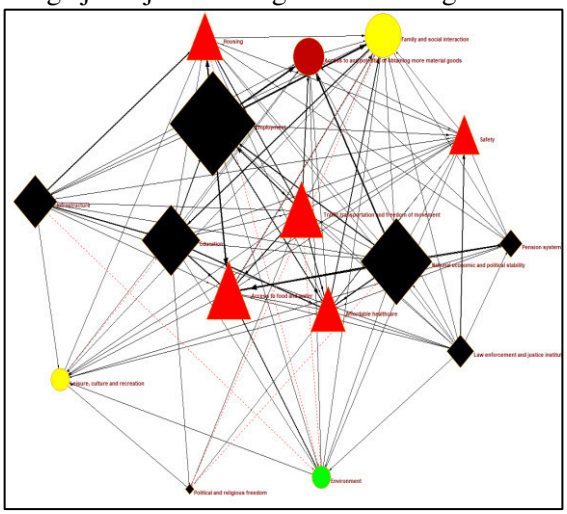

Figure III. The appearance of the fuzzy cognitive map

VI. CONCLUSION

From the final image (Figure 3) of the fuzzy cognitive map, it is concluded that employment (as well as employment opportunities) is the basis for all other factors. Along with employment, the

economic and political stability of the state is also very important, because it is clear that only in a stable state (a state not subject to sanctions, wars, conflicts of any nature) can the conditions for a normal life worthy of man and his basic rights be realized. Basic needs in the form of basic foodstuffs, general security, and an affordable healthcare system also stand out as very important factors. Their mutual connection is very clear and easily explained even from examples from everyday life. You should especially look at the far right side of the map where traffic (transportation/movement) is located as another important factor. The map in this example with the parameters estimated in this way shows that political and religious freedoms are on a lower scale of connectivity compared to the other parameters. Its "weight" is logical because different state systems in the world restrict people in these rights in different ways yet people still have their basic life needs met. The only transmitter node is the law enforcement node and the judicial system node. Its successful application has a positive effect on at least 10 other spheres. Nature (environment) is the concept that is easiest to negatively influence. Another node that clearly stands out is education, which is the basis for the rest of the nodes.

Such a detailed conclusion could perhaps be obtained by looking at the FCM matrix or by collecting a large number of questionnaires. However, by creating such a map, subjectively selected parameters that are formed according to the opinion of experts or regular people are very easily visually observed – much easier than through other data presentations. It is well known that a picture speaks more than 1,000 words, so this type of data presentation is very suitable for use in various magazines, books, flyers, web presentations... It is important to note that the creation of fuzzy cognitive maps requires a certain knowledge level of logic and computer technology (software), but only a good power of observation is enough to interpret and perceive them.

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Training and Utilizing a General-Purpose Sound Classification Model Using TensorFlow Lite and Flutter

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Abstract - Machine learning branches such as image classification, object identification, and speech recognition are now more widely employed in current-day devices than ever before. Most smartphones introduced in the last five years include at least one feature that is dependent on one of the above fields. Google now allows users to submit a query based on speech input that is translated to text, cameras on both iOS and Android smartphones have object and face identification built in, and gallery applications can automatically organize images based on their contents. Speech recognition is a subset of audio classification, which also includes music genre classification, song identification, automatic audio equalization, voice-based identification, and others. This paper discusses the fundamental processes of training a general audio classification model that can predict a limited number of unique sounds, as well as the methodologies used in training any sound classification model, independent of its intended use.

I. INTRODUCTION

Audio classification uses many ideas and techniques that stem from various fields like signal processing, statistics, psychoacoustics, and others [1]. In addition, in machine learning, the phrase "sound classification" can refer to a variety of topics ranging from speech recognition to speech-to-text, voice recognition, music genre classification, and so on, while the method of implementation and application of these subjects may also vary. Models for music genre categorization, for example, often include convolutional neural networks (CNNs) in their designs [2], [3], whereas models for voice recognition employ recurrent neural networks (RNNs) [4]. The first steps in developing any sound classification model are practically always the same in all sound classification methodologies and reflect the answers to a few important problems that occur during the development of these models.

This paper is organized in the following manner: Section 2 introduces the terminology relating to the digital representation of sound; Section 3 describes how to extract an audio file; Section 4 outlines the process of developing a generic audio classifier – a model that can distinguish between a limited number of sound classes; Section 5 gives a practical example of sound classification; and finally, in Section 6 conclusions are presented.

II. SOUND DIGITAL REPRESENTATION

Sounds are defined as compression waves produced by periodic oscillations of a sound source that affect the pressure of their surroundings or medium [5], and the information carried by them may be represented as an analog signal. As input, classification models use tensors which contain numbers that represent information about the sound in question. Due to the sound waves being represented as analog signals, first they need to be converted into a digital form that can be interpreted by the model.

The process of converting a continuous, analog signal into a discrete, digital representation by recording the signal amplitudes at set intervals and assigning the recorded amplitudes a value from a finite range of integers is known as signal sampling [6].

The sampling frequency or sample rate is the number of samples in one second, whereas the range of possible values for a sample reflects bit depth or resolution [7]. The sampling rate and bit depth of CD-quality audio files, for example, is 44100 Hz and 16 bits, respectively [8]. In other words, the audio stream is sampled 44100 times per second and the samples can have one of 16 distinct values. In general, the higher these numbers are in audio files, the higher the accuracy and quality (Fig. 1).

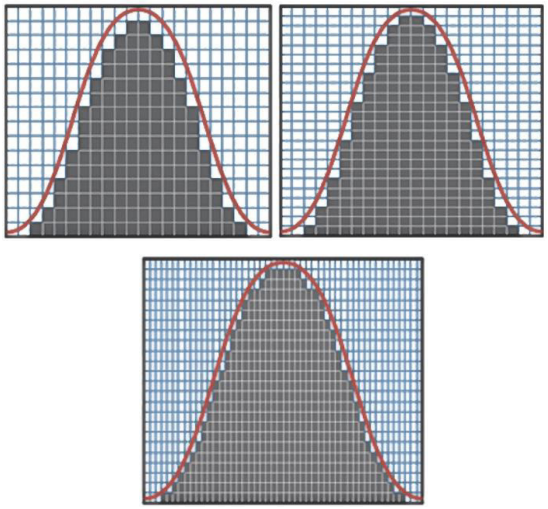

Figure 1. Comparison of different sample rates and bit depths (a) 44kHz, 16-bit, (b) 44kHz, 24-bit, (c) 96kHz, 24-bit)

III. EXTRACTION OF AUDIO FEATURE

When it comes to the digital version of an audio signal, it first needs to be concluded how its characteristics, which contain information that may be utilized to categorize it, can be extracted. In other words, what distinguishes an audio signal, which of its characteristics give it its "identity", and how those properties can be utilized in order to classify it, all need to be understood first.

Any physical signal, according to the Fourier analysis, may be decomposed into a finite number of discrete frequencies [9]. The sum of these frequencies represents the original, complex signal. The spectrum of a function is represented by this collection of frequencies, and it illustrates the amplitude of each frequency contained in the signal.

Fig. 1 depicts the sampling process of an audio signal in the time domain, demonstrating how its amplitude varies over time. Similarly, the amplitudes of all the component frequencies of a signal at a given time (Fig. 2) are also represented. The frequency domain, often known as the spectrum, is used to describe this [10].

Because a signal can create a variety of sounds over time, its component frequencies and, as a result, its spectrum can both change. A spectrogram is a visual representation of how the spectrum of a signal changes over time (Fig. 3).

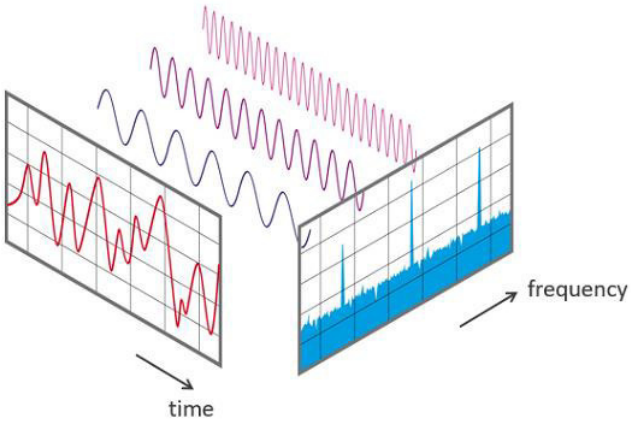

Figure 2. The time and frequency domains of a signal

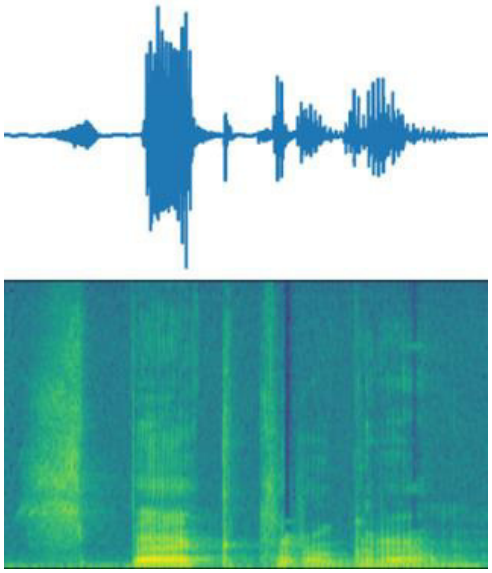

Figure 3. A signal's waveform and spectrogram

Each segment of the graph reflects the frequency domain and energy distribution of the signal at a specific point in time, while the brightness of a color on a spectrogram denotes the amplitude or intensity of a frequency at that point in time. In essence, a spectrogram is a "picture" of a signal that contains characteristics and properties that are unique to that complex signal, which the model may use to classify it into the appropriate category.

IV. TRAINING A CLASSIFICATION MODEL

This section outlines how to create a generic audio classifier, which is a model that can discriminate between a set of sound types (Fig. 4):

1. Reading audio files in the proper format
2. Creating spectrograms from audio files
3. Audio or spectrogram augmentation

4. Extraction of feature maps
5. Using the extracted feature map, predicting the score for all supported classes in the model for the supplied signal.

To begin, all of the input data is transformed into the proper format, which is commonly a PCM (pulse code modulation) encoded .wav file – an uncompressed bitstream with one channel (mono), a bit depth of 16 bits, and a sample rate of 16 kHz. Sample rates greater than 16 kHz are rarely required, as features may be clearly detected and retrieved from spectrograms of even lower frequency samples. When two spectrograms at 16 and 48 kHz are compared, Fig. 5 shows that the brighter regions of the spectrograms (which frequently indicate features) stay constant regardless of the sampling rate.

When it comes to the training dataset, it needs to be vast and varied in order for the final classification model to be accurate in its predictions. Differences in pause, silence, or noise length can have a significant, and frequently detrimental influence on prediction accuracy. As a result, training data is often augmented and edited to most accurately represent the features of the audio signal in question, employing techniques such as noise reduction, silence trimming, and others as needed [11], so that the key characteristics of each supported category can be clearly defined. This procedure can be performed either before or after converting the audio samples into spectrograms, and while not a requirement, it is a recommended step because excessive noise or silence can easily impair the model's accuracy.

After converting and importing the training data, the spectrograms can be produced; typically generated using the Fourier transforms [12] and most often computed by mathematical libraries. The classification procedure is quite similar to image classification, as the model classifies sounds based on their spectrograms. As previously stated, spectrograms can represent the "image" of an audio signal, and just as specific arrangements of pixels in an image contain information unique to a specific object, a collection of pixels in a spectrogram's image can also represent features of an audio signal, meaning that when implementing image and sound classification models, the methods used are very similar. A convolutional neural network with a linear classifier is the most utilized architecture for the models in question [2], [3], [13].

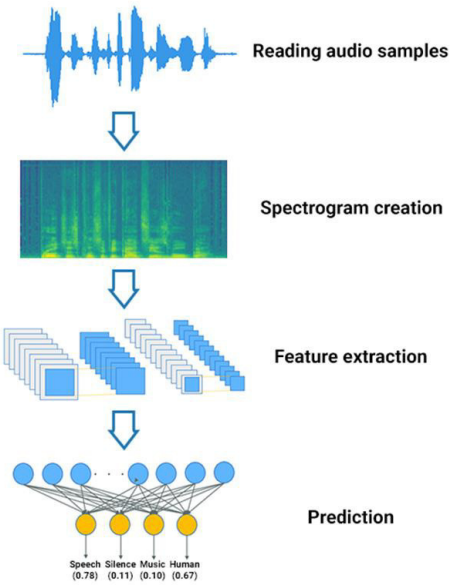

Figure 4. Steps of training a model

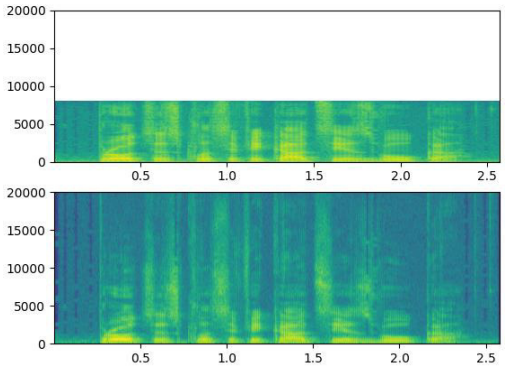

Figure 5. Comparison of spectrograms of audio signals with a sample rate of 16 and 48 kHz

The neural network creates another tensor that contains the activation or feature map of the provided signal by passing a tensor of a specified rank and dimension with the data that makes up the spectrogram of the audio signal through the convolutional layers of the network. The information within this tensor is processed by individual neurons based on the contents of the feature map and the receptive fields of the specified neurons [14]. A fully connected layer, or linear classifier, is one of the last layers in a neural network, and it is where the classification itself occurs [15]. In other words, this is the layer that produces the model's prediction scores for each supported category for the input audio. Following this process, the prediction scores can optionally be passed through a loss function [16], similar to the sigmoid function, which computes the "cost" of incorrect predictions — this information is then used to improve the model's accuracy. Finally, for

the given input signal, the model returns an array of prediction scores for all classes.

V. A PRACTICAL EXAMPLE

The sample program was created by using the TensorFlow package for Python, which can classify seven different types of sound. The first step in constructing a classification model is to gather training data. As previously established, the dataset should ideally be wide and diverse, and the training samples should approximate the ideal version of the sound in question, with little noise and sufficient length. The data for this model was gathered from YouTube and Kaggle, a website where users can obtain a variety of pre-defined datasets for training and other purposes [17].

This application's model can distinguish between the sounds of a car, a truck, a cat, a dog, as well as human speech, noises of a crowd (conversation, a number of people talking), and silence. The dataset that was used is small, and includes the following information:

- Car – 104 samples
- Cat – 164 samples
- Crowd – 105 samples
- Dog – 113 samples
- Human – 206 samples
- Silence – 71 samples
- Truck – 107 samples

The dataset has a total of 870 samples, implying that the model might not be particularly accurate, given that typically, thousands of unique samples are utilized as training data for a classification model. For example, Google's YAMNet sound classification model is trained on the basis of almost 2 million unique audio samples, leading to the conclusion that this model is lacking in data, however sufficient for demonstration purposes. First, these samples need to be converted into a .wav file with a sample rate of 16 kHz and a bit depth of 16 bits. Although Kaggle datasets are typically in this format, if any data needs to be converted, tools like ffmpeg can be used to batch convert multiple files at once [17].

It is important to distinguish between three kinds of datasets during the model training process: training datasets, validation datasets, and testing datasets. A training dataset is a set of data that is used solely for training the neural network; the weights and biases of the model are adjusted based on the contents of this dataset. [18]. On the other hand, a validation dataset is made up of randomly selected samples that are used to detect and correct errors in predictions during the training process. These samples are not utilized to train the model [18], [19].

The number of borrowed samples can vary depending on the size of the training dataset, but typically 20% of its samples are used in the validation dataset. Finally, a test dataset is generally a separate dataset, used to evaluate the final model when training is complete, and does not contain any samples from either of the previously discussed datasets [18]. After the model training is complete, a confusion matrix may appear (Fig. 6), showing how accurate the model is in predicting samples from the validation dataset.

The actual application was made using the Flutter framework, which is a cross-platform framework for application development that can target multiple platforms including Android, iOS, Windows, Linux, macOS and web-based [20]. This application, however, only targets the Android operating system, versions 5.0 and above. Flutter also offers a wide range of official and community-made packages and plugins through the pub.dev platform in order to achieve functionality that otherwise would not be available directly out of the box. The application in question does use a few such helper packages [21], [22] in order to invoke calls to the earlier created TensorFlow Lite model and read its output.

As mentioned previously, the model takes a file that contains a stream of bits which represent audio. In order to achieve classification in real-time, the model needs to consistently and continuously output the prediction scores for every class for the given input signal. The steps in the implementation of this process are as follows:

1. Record a fixed-length chunk of audio using the device microphone
2. Invoke the classification model with the recorded chunk as the input
3. Sort the resulting prediction list
4. Refresh the UI and display the top few highest scoring classes
5. Repeat

In short, while the application is active, it continuously records audio using the device microphone, and from that audio it takes fixed-length chunks to be used as inputs when calling the model. The model then returns a list of prediction

scores for all possible classes, after which this list is sorted in a descending order, and finally the results are shown in a manner that is easily readable for the user (Fig. 7). It should be noted that the model is not constantly invoked, rather it is automatically called after a fixed period of time, for example, 1000ms. While this greatly improves application performance, it also provides enough time for the recorded chunks to be long enough to contain features that the model may be able to detect – in contrast, chunks that are too short in length may not contain any information that can reliably be used to infer the contents of the recorded sound, which may result in actually decreasing the model's perceived accuracy.

Apart from being able to view prediction results classified in real-time, the user can also modify certain parameters of the model and the application, such as the number of results displayed, how many times the model is invoked per second, the sample rate of audio recording, etc. (Fig. 8)

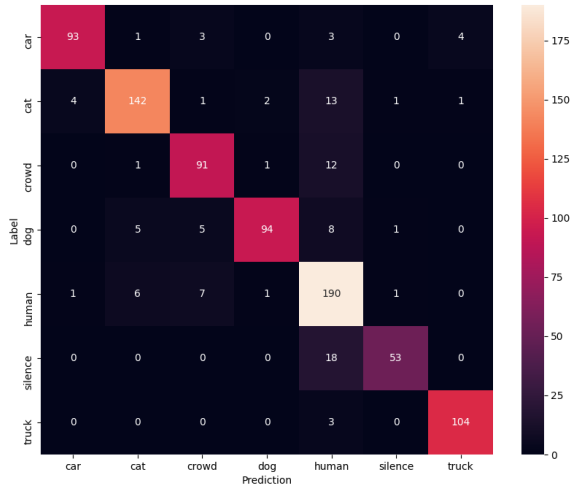

Figure 6. The confusion matrix for the predictions made during training

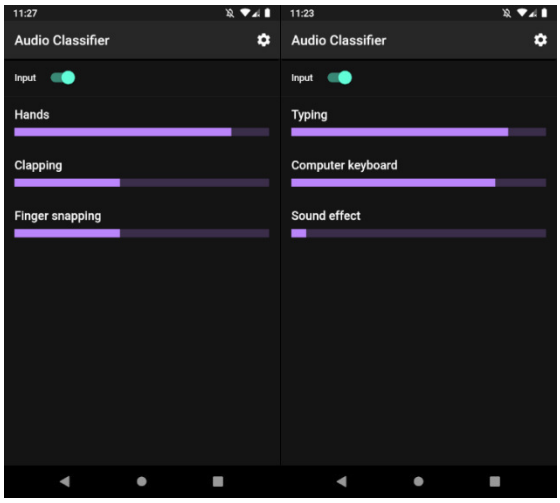

Figure 7. The example application's main screen

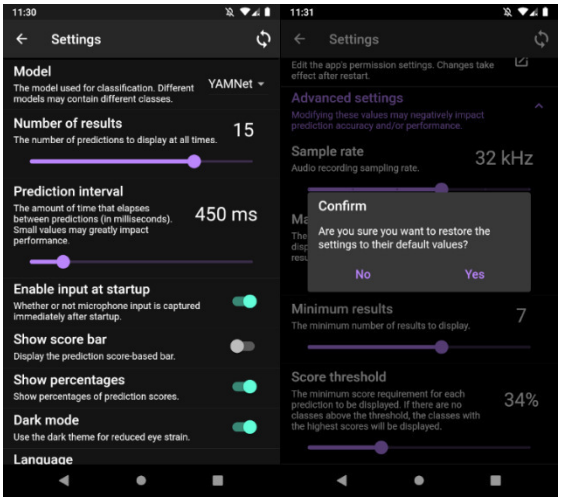

Figure 8. The application's settings screen

VI. CONCLUSION

Currently, sound classification models are most often utilized for speech and music recognition. Aside from that, they might be employed in devices like IP cameras, many of which can nowadays distinguish human forms or silhouettes, and perform certain activities based on what they "see", such as triggering alarms or illumination systems, which is enabled by image classification algorithms. Similary, sound classification models can be used to activate certain functionalities based on what the microphone "hears" but the camera cannot instantly "see", such as the sound of glass breaking, or a loud noise exceeding a given threshold.

Sound classification has the potential to be used in natural environments as well. For example, it can be used for detecting illegal deforestation operations [23] or tracking the activity of difficult-to-see wildlife such as insects in their natural habitats. By tracking the sounds these animals may produce, it is possible to determine which hours of the day they are most active, how they interact with each other and other wildlife, how they react to different weather conditions, and so on [24].

Most common machine learning frameworks, such as TensorFlow and PyTorch, may also be used to create a sound categorization model following the fundamental techniques presented in this paper. They are easily adjustable, and the models may be tailored to a variety of applications. The number and sequence of neural network layers, tensor rank and dimensions, loss functions, and datasets themselves all have an

impact on the prediction accuracy and quality of the final model.

The method presented in this paper, on the other hand, is primarily used to train a general-purpose audio classification model that can categorize a few different types of audio. When implementing a model for a different use case, such as speech recognition, the neural network architecture may differ – for example, the data at the end may pass through multiple RNN layers rather than a fully-connected layer or a linear classifier – however, the core principles of digital audio representation and discerning the inherent attributes of an audio signal through feature extraction rarely change when implementing a sound classification model.

ACKNOWLEDGMENT

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School and Community Collaboration

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Abstract - Educating children represents a complex process, composed by series of different factors. Very often, school is seen as one of the most important factors, along with family, which takes the leading role in one's character development. However, beside school and family, impact of immediate surroundings, such as peer environment, environment where child spends its free time and environment where interests are being born and deepened further, cannot be overlooked. Each of given factors can be perceived singularly, yet these factors are shaping the overall surroundings where child is developing by forming correlations. Given correlations can be formed in a way where one factor can affect an outlook on another factor, resulting in different positive or negative attitude towards responsibilities in school. As an institution with high responsibility in children education, school should be open towards the rest of the community and develop adequate integration strategies for collaborating with other development factors in community.

I. INTRODUCTION

Modern educational tendencies are oriented towards integration of many different educating aspects. Schools are encouraged to be open for collaboration with community, ready to consider parents ideas and viewpoints, as well as guide parents through the process of upbringing children.

Motivating parents to cooperate with teachers and take active part in their child's education is one of the key points in achieving optimal educational environment.

Partnerships with other social communities do have a great potential for improving school environment, tending to students interests and increasing their motivation for reaching higher academic and civic goals. All aspects of collaboration between school and any other institution or public congregation should be pointed towards the same goal – enhancing school education.

Following empirical research is conducted anonimously with 80 teachers and is focused on types and levels of collaboration between schools and public communities as well as collaboration between schools and parents.

II. THEORETICAL BACKGROUND

Improving school institution and achieving high-quality program can be strongly accelerated through partnerships with public institutons, organizations and governmental structures, where would formed partnership revolve around curricular and extra-curricular activities. According to Meleville, 1998, school and community functioning is not and should not be perceived as independent functioning with opposite goals. On the contrary, these two entities are interconnected with complementary relations. Initiatives from these two different standpoints ultimately result in unique ideas and strategies in solving problems in teaching and upbringing students.

Cooperation of school and community can be based on procuring necessary equipment for classrooms, it can be based on partnerships with correspodent local business for expanding practical education or school can form partnerships with other academic institutions aiming to increase students motivation and deepen their interests and curiosity.

Meleville (1998) finds that there are five key areas with obvious positive response to collaboration between school and community:

1. Increased parent involvement
2. Improved atmosphere in schools
3. Enhanced non-academic policies in schools
4. Enhanced teaching methods
5. Higher diversity and quality of teaching plans.[1]

A. Overlapping Spheres of Influence

Three main contexts where students are learning and growing, are family, school and social circle. Each of given areas are forming specific relations and are directly affecting development and understandings of each student. „The model of school, family, and community

partnerships locates the student at the center. The inarguable fact is that students are the main actors in their education, development, and success in school. School, family, and community partnerships cannot simply produce successful students. Rather, partnership activities may be designed to engage, guide, energize, and motivate students to produce their own successes."[2]

B. Priciples and Focus Types in School-Community Collaboration

Epstein & Sheldon (2006) are proposing 7 principles for establishing collaboration between schools and community:

"1. School, family, and community partnerships is a better term than parental involvement to recognize that parents, educators and others in the community share responsibility for students' learning and development

2. School, family, and community partnerships are multidimensional concepts

3. A program of school, family, and community partnerships is an essential component of school and classroom organization

4. Programs of school, family and community partnerships require multi-level leadership

5. Programs of school, family and community partnerships must include a focus on increasing student learning and development

6. All programs of school, family and community partnerships are about equity

7. Methods of research on school, family, and community partnerships must continue to improve"[3]

According to ETOS, guide for self-evaluating and evaluating school published by Ministry of Education and Sports, important factor in evaluation is a role of school in given local environment, considering collaborations with other educational institutions, cultural, sports and other institutions and requires certain level of participation in humanitarian, cultural, ecological and similar activities.[4]

III. RESEARCH METHODOLOGY

A. Research topic and research problem

Research subject are types and levels of cooperation of schools with community. The research problem is underlined by question – to what extent are social communities involved in student education and functioning of schools.

B. Research goal and task

Research is aiming to empirically determine degree of cooperation between school and community, through analysis of respondents viewpoints, attitudes and experience.

C. Main hypothesis and sub-hypothesis

The main hypothesis: Primary and secondary school teachers have a positive attitude towards collaboration of school with the rest of community.
The sub-hypothesis: Cooperation of school with community is improving diversity and quality of school education program.

D. Research methods

Methods used in conducted research are descriptive and experimental. The technique used involves the analysis of the gathered data from research participants.

E. Research Sample

Research sample consists of 80 teachers with different years of experience, mainly working in primary schools in Vojvodina, Serbia, as it is represented in Table 1.

TABLE I. RESEARCH SAMPLE – YEARS OF EXPERIENCE

	Years of experience
Less than a year	7(8,75%)
1 – 5 years	15(18,75%)
6 – 10 years	9(11,25%)
11 – 15 years	8(10%)
Over 15 years	41(51,25%)

IV. EMPIRICAL RESEARCH RESULTS AND DISCUSSION

Results of conducted research are indicating that schools in Vojvodina are open for collaboration with community. 43.8% of respondents declared that the school they worked in is „very open for collaborations", as it is represented in Figure 1.

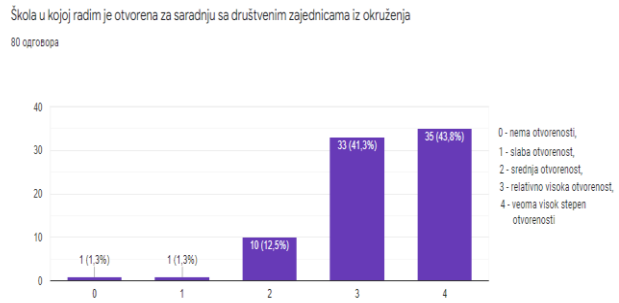

Figure 1. Degree of school openess according to respondents

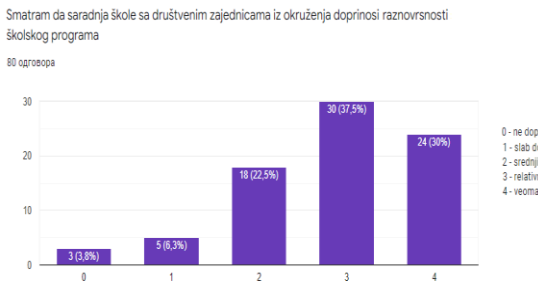

Figure 2. Impactfulness of collaborations on school program diversity

Statistically, the most of respondents said their schools are ready to cooperate with community. To this question, most frequent grade is also the highest one, while standard deviation is the lowest in this case. However, the highest standard deviation is noticed in respondents impression regarding schools taking parts in public competitions for upgrading the institution and equpment.

Figure 2. represents the respondents opinions regarding the level of impact collaborations between school and community has on diversity and interactivity in school program and classes. An average score is 2.84 on scale 0 – 4, while modus is 3 (relatively high impact) and standard deviation is 1,04873.

Regarding quality and impact of collaboration between schools and community, responses are predominantly positive when it comes to diversification of school program and frequency of school involvement in public activities in local surroundings, but when it comes to involvement of local communities in school activities and actions, responses are less positive. This would raise a question – are the two to sides in given collaboration

Figure 3. is showing correlations between types of ognaizations schools collaborate with, frequency of collaborations and school program and classes. Out of 153 relations, using Pearsons correlations coefficients, 104 in total are moderately positive, with only 7 negative correlations in total. All of the negative correlations are regarding obstacles in planning

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	18	19
1	1.00																	
2	0.69	1.00																
3	0.69	0.82	1.00															
4	0.52	0.68	0.66	1.00														
5	0.48	0.64	0.59	0.69	1.00													
6	0.51	0.65	0.63	0.72	0.79	1.00												
7	0.58	0.63	0.63	0.70	0.74	0.85	1.00											
8	0.46	0.64	0.62	0.58	0.59	0.71	0.72	1.00										
9	0.49	0.63	0.56	0.58	0.64	0.69	0.65	0.71	1.00									
10	0.47	0.63	0.62	0.69	0.59	0.62	0.55	0.62	0.65	1.00								
11	0.46	0.52	0.54	0.54	0.66	0.68	0.59	0.62	0.77	0.74	1.00							
12	0.44	0.64	0.60	0.67	0.72	0.68	0.60	0.66	0.65	0.71	0.72	1.00						
13	0.56	0.77	0.75	0.78	0.68	0.70	0.65	0.69	0.72	0.75	0.70	0.82	1.00					
14	0.27	0.45	0.45	0.49	0.54	0.55	0.58	0.47	0.61	0.46	0.53	0.48	0.58	1.00				
15	0.46	0.63	0.63	0.71	0.71	0.66	0.62	0.62	0.68	0.63	0.73	0.79	0.83	0.66	1.00			
16	-0.20	-0.07	-0.19	0.08	0.12	0.11	0.17	0.15	-0.01	-0.06	-0.05	0.09	-0.04	0.06	0.03	1.00		
18	0.03	0.20	0.15	0.27	0.30	0.33	0.27	0.20	0.37	0.27	0.43	0.32	0.35	0.38	0.34	0.12	1.00	
19	0.29	0.40	0.34	0.61	0.41	0.38	0.42	0.33	0.45	0.41	0.43	0.42	0.51	0.39	0.52	0.20	0.30	1.00

Figure 3. Correlations – School and community collaboration impact on school program

and realization of collaboration. The strongest negative correlation implies that there are discrepancies between school openess towards communities and obstacles during collaboration process. The second, very important, negative correlation is regarding level the school empowers students to take a part in social circumstances and to fulfill their civic duties and rights.

The strongest positive correlation, with 0.85 coefficient, implies that schools are most frequently collaborating with cultural organizations as well as sports groups, which ensures enrichment in school program and classes.

V. CONCLUSION

In order to achieve an adequate and high quality education process for students schools have to be open, modern and transparent. It cannot be isolated entity with sole purpose to teach student predefined material, but it has to cooperate with other institutions and organizations, which eventually would elevate the school program and would empower students to take active participation in social context.

Research results are implying that partnerships between schools and community are beneficial for diversity of school study program.

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Student's Understanding Of Digital Literacy

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Abstract - The paper is a continuation of the research conducted in 2018 related to the student's understanding of digital literacy at the University of Mostar in Bosnia and Herzegovina. The development of information technology continuously offers different opportunities for its use in teaching and other processes at universities. The global COVID-19 crisis has shown that it is possible, thanks to IT, for universities to move online extremely quickly and raise the level of their own digitalization almost overnight. That is precisely what prompted the authors to repeat the research conducted before the covid-19 crisis in order to investigate whether and what has changed in students' understanding of digitalization. Although there are specific differences in students' answers in 2022 compared to 2018, the research from 2022 shows that students still mostly connect digital literacy with computers, then with the Internet. as well as with information and operations on them.

I. INTRODUCTION

The continuous development of information technology (IT) is constantly bringing new opportunities and challenges to every aspect of university's activities. The global COVID-19 crisis has shown that universities can move online extremely quickly and raise the level of their digitalization almost overnight. However, it was the COVID-19 crisis that confirmed the necessity of increasing the digital competencies of students, teaching and administrative staff. That is necessary in order to maintain and continue the university digitization process, which gained momentum and acceleration due to the COVID-19 crisis.

Long before the COVID-19 crisis, European Union (EU) recognized digital competence as one of the critical competencies for lifelong learning, which can ensure active participation in society and the economy [1]. This competence involves "the confident and critical use of Information Society Technology (IST) for work, leisure, and communication" [2]. In the Communication 'Strengthening European Identity through Education and Culture [3], the European Commission set out a vision for a European Education Area and announced a dedicated Digital Education Action Plan [3].

The digital transition at universities continued even more strongly during and after the COVID-19 crisis. In 2022 the EU launched two initiatives that go in this direction: a European Strategy for Universities and a Commission proposal for a Council Recommendation on building bridges for effective European higher education cooperation [4]. In its strategic vision, known as Digital Decade [5], the EU has set an exceptionally ambitious goal such as achieving that 80 % of EU citizens have at least basic digital skills and 20 million ICT specialists employed by 2030. The European Commission foresees various actions to achieve these goals [4]:

- The Digital Europe Programme (strategic funding) should support specialized education and training programs in cutting-edge digital technologies, especially for multi-disciplinary courses in artificial intelligence, cybersecurity, microelectronics and high-performance computing.
- The Commission encourages member states to support the development of digital skills of students of all ages, staff and researchers, the digital capacity of universities, as well as the crucial role of universities for innovation and new digital technologies, and universities to lead in the digital transition.

Paul Glister introduced the term digital literacy in 1997. In defining digital literacy, Glister focused on one's ability to understand, appreciate and use the information in multiple formats that the computer can deliver, as well as on the ability to evaluate and interpret the information [6]. Recently, researchers have viewed digital literacy as "a continuum, with progressive stages where the basic abilities are only the first step. The upper end of the continuum contains increasing levels of cognitive competence in using the literacy in question for tasks, learning, creating and expressing new ideas, and this involves issues such as attitudes and social and cultural aspects" [7]. Digital literacy is an umbrella concept

(UNESCO Institute for Information Technologies in Education) that includes the capabilities which fit someone for living, learning and working in a digital society and includes the following [8]:

- ICT proficiency (a set of useful skills that enable active participation in a society where services and cultural offerings are computer-supported and distributed on the Internet),
- Information, data and media literacy (the ability to locate, identify, retrieve, process and use digital information),
- Digital creation, problem solving and innovation,
- Digital learning and development,
- Digital communication, collaboration, and participation,
- Digital identity and wellbeing.

Bosnia and Herzegovina, as a transition country, just at the beginning of the European path, also recognized the importance of the development of IT and knowledge society. So, in 2004 the Council of Ministries in BiH adopted the document "Strategy of Information Society Development in BIH " [9]. However, the latest census of BiH, the 2013 census, collected data related to IT literacy for the first time. Unfortunately, the census showed that 38.7 % of persons older than ten were IT illiterate [10].

In 2017 the Council of ministers of BiH made a Decision on the adoption of the BiH Policy for Development of Information Society for 2017 - 2021 [11]. On its path toward EU membership, Bosnia and Herzegovina showed readiness to implement higher education reform by signing the Bologna Declaration in 2003. Universities in BiH, supported by different EU projects, have begun with necessary reforms in order to be prepared for inclusion in the European Higher Education Area [10].

In 2020, the COVID-19 crisis forced universities in Bosnia and Herzegovina to switch instantly to online teaching. That further emphasized the need for continuous investment in improving the digital competencies of students, teachers and administrative staff. All that motivated the authors to repeat the research related to the student's understanding of digital literacy at the University of Mostar in Bosnia and Herzegovina conducted before the covid-19 crisis in order to investigate whether and what has changed in students' understanding of digitalization.

II. METHODOLOGY

The empirical research was conducted in 2018 and 2022. The questionnaire was filled out by 215 students of the University of Mostar – 112 students in 2018 and 103 students in 2022. The sample was convenient, with voluntary participation in the research. The goals of the research and the way of data usage were explained to each participant of the research. After logical and technical control of questionnaires, two students' questionnaires in 2018 and one in 2022 were excluded. A total of 212 questionnaires were analyzed.

The same survey questionnaire (prepared by the authors) was used in both studies. The survey questionnaire covered questions related to the understanding of the term digital literacy and rating of personal digital literacy, usage of the Internet, the age of laptops and mobile phones, and statements about the importance and influence of digital literacy in education and business [10]. Questions were created in the form of closed questions or as Likert scale with five levels (1= strongly disagree; 2 = disagree; 3 = neither agree nor disagree; 4 = agree; 5 = strongly agree).

The gender structure of the sample shows the majority of women in both samples (2018: 31 males (28.2 %) and 79 females (71.8 %); 2022: 14 males (13.7 %) and 88 females (86.3 %) students). All students (in both years) were students of the first cycle of studies between the ages of 19 and 22.

The programs IBM SPSS Statistics 25.0 and Microsoft Office Excel 2016 were used for statistical data processing. The results are presented as absolute (N) and relative frequencies (%), mean (M) and standard deviation (SD) were calculated.

III. RESULTS

The Students' answers in 2018 and 2022 related to questions about understanding the meaning of digital literacy and aspects and activities that constitute digital literacy are shown in Table 1.

TABLE I. STUDENTS' UNDERSTANDING OF THE CONCEPT OF DIGITAL LITERACY, RESULTS FOR 2018 AND 2022

	N (%)	
	2018	***2022***
Digital literacy is the same as … *		
IT literacy	58 (52.7)	22 (21.6)
Computer literacy	63 (57.3)	14 (13.7)
Information literacy	21 (19.1)	12 (11.8)
Web literacy	33 (30.0)	24 (23.5)
Media literacy	26 (23.6)	12 (11.8)
Communication literacy	18 (16.4)	14 (13.7)
Neither term correspond/describe digital literacy	2 (1.8)	2 (2.0)
All offered terms can be "synonyms" for digital literacy	33 (30.0)	66 (64.7)
Digital literacy includes the following aspects of literacy *		
IT literacy	5 (52.7)	30 (29.4)
Computer literacy	54 (49.1)	24 (23.5)
Information literacy	24 (21.8)	24 (23.5)
Web literacy	46 (41.8)	32 (31.4)
Media literacy	27 (24.5)	16 (15.7)
Communication literacy	15 (13.6)	10 (9.8)
All listed	35 (31.8)	58 (56.9)
Digital literacy includes the following capabilities *		
Recognition of the need for information	24 (21.8)	14 (13.7)
Information retrieval and collection with the use of a computer	63 (57.3)	44 (43.1)
Analysis and evaluation of information	22 (20.0)	14 (13.7)
Usage (storing, creating and presenting) information using a computer	59 (53.6)	44 (43.1)
Publishing and sharing information via the Internet	47 (42.7)	34 (33.3)
Neither of the listed capabilities	1 (0.9)	2 (3.9)
All listed capabilities	29 (26.4)	48 (47.1)
* multiple answers		

The mean grade (self-assessment) of students' digital literacy in 2018 was 3.11 (SD=0.83), and in 2022 is 3.59 (SD=0.80). The mean grade of knowledge about information technology (self-assessment) in 2018 was 3.06 (SD=0.87), and in 2022 is 3.49 (SD=0.86). Computer usage time (hours per day) was as follows:

- study: 2018 – M=1.27 (SD=1.25); 2022 - M=2.54 (SD=2.96),
- entertainment: 2018 – M=6.77 (SD=6.02); 2022 – M=4.57 (SD=2.60),
- other activities: 2018 – M=3.38 (SD=4.08); 2022 – M=3.80 (SD=2.88).

The mean age of students' computers in 2018 was 4.10 years (SD=2.72), and in 2022 4.45 years (SD=3.40). In 2018 the students' mobile devices were "younger" than one year; they were mostly a few months "old", while in 2022 the mean age of students' mobile devices is 2.37 years (SD=1.70).

Table 2 shows descriptive statistics for 2018 and 2022 years related to statements about the importance of digitalization for business, education, and the competencies of the main stakeholders in the education process.

TABLE II. RESULTS OF EVALUATION OF STATEMENTS, RESULTS FOR 2018 AND 2022

	M (SD)		*Grade≥4 N (%)*	
Statement	***2018***	***2022***	***2018***	***2022***
Digitalization is the future of business	4.39 (0.83)	4.41 (0.78)	96 (87.3)	94 (92.2)
Digitalization is the future of education	4.17 (0.89)	4.20 (0.96)	85 (77.2)	82 (80.4)
Digital literacy enhances the quality of education	4.15 (0.91)	4.16 (0.95)	82 (74.5)	76 (74.5)
Digital literacy contributes to the quality of the teaching process	4.08 (0.86)	4.27 (0.96)	82 (74.6)	88 (86.3)
Digital literacy improves student competencies	3.97 (0.81)	4.25 (1.04)	79 (71.8)	84 (82.4)
Digital literacy affects the quality of a higher education institution	4.14 (0.80)	4.43 (0.81)	90 (81.9)	90 (88.2)
Digital literacy raises the competitiveness of a higher education institution	4.03 (0.89)	4.45 (0.76)	78 (70.9)	90 (88.2)
I am prepared to learn about new features of information technology	4.18 (0.99)	4.41 (0.94)	84 (76.4)	90 (88.2)
I am prepared to adapt myself to new technologies	4.36 (0.96)	4.33 (0.89)	92 (83.6)	86 (84.3)
I constantly observe technology and novelties in the IT sector	3.10 (0.99)	3.33 (1.16)	35 (32.2)	46 (45.1)
Digital literacy is the key factor in the digitalization of business	3.88 (0.90)	4.35 (0.77)	75 (68.2)	88 (86.3)
Digital literacy is the key competence for job finding	3.96 (0.89)	3.92 (0.98)	79 (71.8)	72 (70.6)
Digital competences are more important than others	3.32 (1.01)	3.08 (1.00)	44 (40.0)	30 (29.4)
Digital literacy improves the competences of teachers	3.79 (0.94)	4.08 (0.80)	72 (65.4)	82 (80.4)
Digital literacy facilitates information finding	4.52 (0.69)	4.59 (0.64)	102 (92.7)	94 (92.2)
Digital literacy facilitates information evaluation	4.14 (0.84)	4.49 (0.73)	88 (80.0)	92 (90.2)
Digital literacy facilitates the integration of information	4.33 (0.87)	4.57 (0.67)	94 (85.4)	96 (94.1)
Digital literacy facilitates the creation of information	4.48 (0.77)	4.73 (0.49)	99 (90.0)	100 (98.0)
Critical thinking fosters digital literacy	3.58 (0.93)	4.10 (0.85)	56 (50.9)	78 (76.5)
Creativity fosters digital literacy	3.93 (0.97)	4.12 (0.91)	77 (70.0)	80 (78.4)

IV. DISCUSSION

The first research results showed that although students use technology daily, they are not fully familiar with the meaning of digital literacy. The above can also be concluded based on the results of the research from 2022.

A more detailed comparison of the answers about the knowledge of the concept of digital literacy in these two surveys shows some differences.

Slightly more than half of the students in 2018 identified digital literacy with IT literacy and computer literacy, while less than a third of them linked all offered terms with digital literacy. The results for 2022 are different. More than 60 % of students state that all the mentioned terms can be equated with the term digital literacy, while 1/5 (and less) of students associate it with IT and computer literacy.

Concerning the capabilities which comprise digital literacy, only 26.4 % of respondents (slightly more than a quarter) linked all offered capabilities with digital literacy. In a repeated survey, the percentage rose to almost 50%.

The largest proportion of students in 2018 thought that being digitally literate means being capable of retrieving, collecting, and using information by computer. Although in 2022, compared to 2018, the shares of specific answers are smaller, in 2022, most students think similarly. In both studies, it was determined that students mostly connect digital literacy with computers, then with the Internet, as well as with information and operations on them. The stated results suggest that students only partially know the concept of digital literacy and are unaware that digital literacy is an extensive and comprehensive term.

The mean grade of personal digital literacy in both researched years is between 3 and 4 (more precisely between 3.1 and 3.6), with the grade for 2022 being slightly higher. Previous results and these mean grades confirm students' only partial understanding of the term digital literacy and indicate that students are aware that they do not understand it.

Comparing the mean grades of individual statements shows higher grades for most statements among students examined in 2022. Slight differences in favor of students from 2018 can be seen in the three statements "I am prepared to adapt myself to new technologies", " Digital literacy is the key competence for job finding", and "Digital competencies are more important than others".

However, not a single group of students showed an enviable knowledge of digital literacy as an imperative in everyday life and business, both today and in the future.

The importance of critical thinking for improving digital literacy, especially in education, is continuously stressed in the various UN, EU, and BiH documents. The previous implies that students, through their study experience, should become aware of the importance of digital literacy and the soft skills expected of educated people today.

But the results of the conducted research are only partially on that track. The mean grades show insufficient knowledge of the researched topic, but the student's willingness to learn about novelties in information technology and to adapt themselves to new technologies gives hope. On the other way, their readiness is questionable due to the fact that the mean score for the claim "I constantly observe technology and novelties in the IT sector" is 3.10 (in 2018) and 3.33 (in 2022). Continuous learning and gathering information concerning technology progress is an important component/activity in reaching and keeping a satisfactory level of digital literacy.

From the students' answers (both years), it can be concluded that digital literacy plays a vital role in enhancing the competitiveness of higher education institutions in the market. Still, in the context of the competence of students and teachers, it plays only a partial role.

Another contradiction in students' attitudes can also be read in the mean grades for the statements regarding digital literacy as a critical factor in the digitalization of business and the key competence for job finding. Digital literacy is an essential element when finding a job students recognize less than as an essential element for a modern and successful business.

In the context of these, partially agree, results are also results about the greater importance of digital competences compared to other competences. In fact, agreement with the statement related to the above is lower than with other statements related to digital literacy in the context of competencies. Of course, digital competences cannot take precedence over other soft skills such as communication, organization, teamwork, etc. Still, they gain importance with the development of digital technology and the continuous digital transformation of business activities. They must be at least at the same level as other competencies, not underestimated.

V. CONCLUSION

The findings of the research conducted in 2022, compared to 2018, show no important change in the student's understanding of digital literacy at the University of Mostar in Bosnia and Herzegovina. Although students use technology daily, they are not thoroughly familiar with the meaning of digital literacy. Both studies have confirmed that students mostly connect digital literacy with computers, the Internet, and information and operations. It suggests that students only partially understand the concept of digital literacy and are unaware that it is an extensive and comprehensive term.

However, both studies (2018 and 2022) show that digital literacy plays a vital role in enhancing the competitiveness of higher education institutions in the market. Still, in the context of the competence of students and teachers, it plays only a partial role. Amazingly, not a single group of students showed an enviable knowledge of digital literacy as an imperative in everyday life and business, both today and in the future. That may cause concern because the importance of improving digital literacy, especially in education, is continuously stressed in the various UN, EU, and BiH documents. Namely, all documents emphasize that students, through their study experience, should become aware of the importance of digital literacy and the soft skills expected of educated people today.

The respondents of this research are mostly the millennial generation, e.g., the generation that grew up with IT. Still, research findings show they are unfamiliar with basic terms like digital literacy. They are not fully aware of the IT features and influence of IT on their personal life, education, and business, what would be expected.

Further research should be focused on teachers, as well as on the comparison of opinions of students and teachers. The inclusion in the research of other universities from Bosnia and Herzegovina and beyond would contribute to the quality of the conclusions.

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Measuring Readability And Understanding Of Program Code Through Eye Tracking

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Abstract - The aim of the research is to analyze whether understanding the program code written in C is influenced by the style in which it is written. In this work the style of writing code refers to how the indentation is used (what is the number of spaces before the statement or instruction in the code). The use of indentation is recommended. The code writer should always indent the body of a statement with a uniform amount from the first character of the statement. The body of a statement is the action (or set of actions) that the statement controls. Statements that have bodies include loops, decision statements (if, if-else etc.) and functions. The authors aim to analyze the extent to which the number of spaces at the beginning of rows affects the understanding of code. The GazePoint G3 device was used in the research. It's a device that monitors eye movements and records the position and movement of both eyes based on optical tracking and light reflection. During the study, the student's eye movements were monitored as he/she tried to understand the program code and answer what the result of code execution will be. Data processing involves comparing how one student „looked" at the code with different indentation. Data such as the duration (time spent on visual analyzing the code), number of fixations, fixation/saccade ratio, average saccade length and average saccade velocity, may be directly related to readability and understanding of programs.

I. INTRODUCTION

The technique of eye tracking allows you to measure the direction of the view (where viewed) and to move the eye relative to the head. Researches related to eye tracking began at the very beginning of the last century. Eye tracking devices were then used primarily for medical purposes. The development of information communication technologies enable this type of measurement to be carried out outside the laboratory premises [1-6]. The development of the technology has also contributed to measuring these devices seamlessly and does not bother the user. Data collected in this way from the person is often better quality than, for example, from a questionnaire. Results such as where the person is looking, how long it retains its view of an item, the speed of change in fixing eye from one item to another begins to apply in other areas, such as in marketing, in application and software ergonomics, in product development. and of course in the use of assistive technologies, which deal with the development of aid for the blind and the low-sighted. [7-11]

II. MOTIVATION

Learning programming and acquiring algorithmic skills always begins with simple coding examples and tasks. In this learning period the source codes are read only by authors and rarely happen to be used in any subsequent and larger project and the code writing style has little impact on task solving and learning efficiancy. For a person who learns to write program codes periods that follow bring projects which are more complex and have more and more lines of code. There is also a change in the distribution of time spent with the source code: a significant part of a software's lifecycle is no longer about development, but finding errors, upgrading or maintaining the application [12].

For a developer to be efficiance in his work, for example in upgrading software with new features, the source code has to be in a well readable form, because it will shorten the time needed to understand what is written. Understanding the program code depends on many factors. The style of the code in the editor, in our case, how instructions are formated is just one of those. The world's big software companies have their own writing style recommendations. Adherence to these recommendations means writing in a style that will enable the code to be more easily analysed and understood [13]. These recommendations are not standards and vary from company to company. A description of how to use indent lines or how many empty spaces to be at the beginning of a line is different. For example, Microsoft's recommendations for writing programming code in C# state that one tab (8 spaces) is used for indentation, while others recommend using at from 2 to 8 spaces for indentation. The code readability importance is highlited in the software's developing phase, when many integrated development environments (IDE) contain an option for formating the code, for example: adjust alignment, comments, and/or parentheses that indicate a block. For Linux, there is an Indent application which can format the source code in many ways, all in order to make it easier to read [14]. The following diagram (Fig. 1)

shows the result of a query of how empty places a user leaves at the beginning of line [15]:

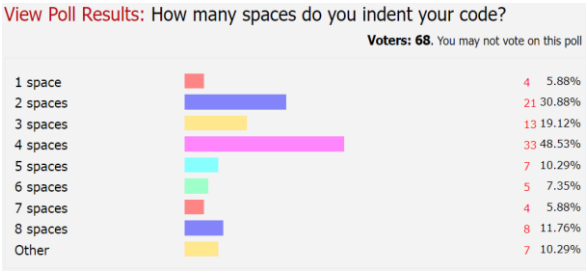

Fig. 1. Indent query result

In this paper, the authors explore how readability and understanding code are influenced by indentation of lines in cases where instructions belonging to the block are written. The research question can be defined as: Is there a relation between code readibility and how fast and easy the code is understand. The block is one part of the code, which contains instructions that are grouped based on the task's algorithm. Blocks are also used to define body of the function and control structures (cycles and conditions). All instructions in the block move/indent to the right and in this way visually emphasize that these instructions are related. Next figure (Fig. 2) presents the same program code with different indents (left with no indention, right with 4 spaces):

```
int x = 7;
while (x > 2) {
if (x%2 == 0)
x=x-3;
else
x--;
printf("%d", x);
}
```

```
int x = 6;
while (x > 0) {
    if (x%2 == 0)
        x=x-3;
    else
        x--;
    printf("%d", x);
}
```

Fig. 2. Program codes written in different indention styles

It must be emphasized that the indent, that is, the number of empty spaces at the beginning of the line is also related to the position of parentheses that indicate the beginning and end of the block. Including this parameter in the research would make it impossible to unequivocally display the impact of the alignment from the measurement results. This was the reason for the research to use a code that contained only a minimum number of brackets.

III. THE RESEARCH

The research was conducted in the winter semester of 2021/22 school year at Subotica Tech College of Applied Sciences in Subotica. Ten students from Informatics study programme participated in the survey. Those students from the second and third year of study had sufficient knowledge and programming skills from the C language to participate in the research.

Assumption in this research is that easy to read code can be understand more easily and quickly, and also, the programming code with minor line indentations, would be harder to read and understand. Short segments of the program code were used to prove the assumption. The students needed to understood the code segments and to gave answer what will appear on the output after program execution. Eight tasks/code segmenst were written for the research. The tasks contained algorithms with conditions, cycles, array functions, and so on. Two more sets of code segments were made from the origional 8 questions. Two set contains almost same questions. Small changes were made on the original questions, for example, the differnet initialization values were used, and where it was possible the conditions were changed. Such similar code segments from two sets are displayed in the previous picture (Fig. 2). In this way the tasks have the same logic, same algorithm but different execution result. This allowed the comparison of how one student handles "same" three tasks and to analyze if the used style have impact on the readibility and understanding of the source code. To summarize: three set of eight questions was used. Each set contained tasks with the same algorithm, but different indents were used for the writing style. In the first set of tasks, an eight space indent was used, in the second only one, while in the third set of tasks no indent was applied.

During the measurement, each student was supposed to solve 8 tasks from each set. At first occasion he/she got questions from the first set, next week from the second set and finally, after one more week from the third set. A week between the two measurements was enough to keep students from remembering the previous measurement or how a task was being solved. Because of the different initial values of variables in the program, the results for the same algorithm were different, reducing the impact of previous

measurements on the current one, because the program code had to be re-analyzed. The way the student analyzed the code was tracked with the Gazepoint G3 device. It's an eye movement tracking device (Fig. 3.) The Ogama[16] software package was used to process and visualize data.

Fig. 3. Gazepoint G3 eye tracking device [17]

The measurement method was rolled out in the following steps:

- The students sat in front of the monitor on which the Gazepoint device was mounted.
- For each student, a calibration device was performed (to make the measured data as accurate as possible).
- With the Ogama software package, the student was alternately shown tasks.
- By looking at the code on the computer screen, the student tried to understand the algorithm and answer what the result of the execution was. The analysis and understanding of the code was done in the head.
- After the task was resolved and answered, the student was given the next task.
- The measurement was done when the student answered all eight questions written in the same style.
- While observing the code, the device recorded eye movement data.

One measurement referred to eight questions whose style was the same. The procedure and method of measurement were the same in all three sets of tasks.

IV. RESEARCH RESULTS

While the student visualy analyzed the program code, the following parameters were measured: the duration in milliseconds, the number of fixations, the average saccade length in pixels and the average saccade velocity in pixel/sec. Because the goal was to compare is there any impact of the styles for a person, this section presents data comparation done for one student. In the research process his ID was 4. A detailed analysis of other students eye movements data and theire comparison with the other students' data, will not be presented in this paper. Because of measured data (see below), the relation of the used indents and the accuracy of the response the student gave will be discussed in some other research.

Before presenting the results, the following two expressions is need to be defined (Fig 4):

- Fixation is where the eye is directed at a specific target.
- Saccade is the movement of the eyes from one target to another.

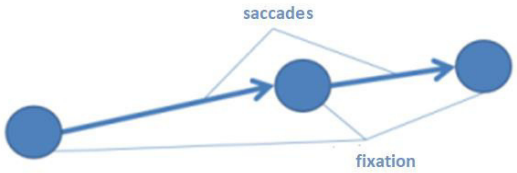

Fig. 4. Saccade and fixation

Duration in milliseconds

The measured data in the case of student (with ID 4) does not indicate that the code without indentation was viewed longer than the one that had spaces and was readable with it. The following diagram shows the time a student spent on assignments.

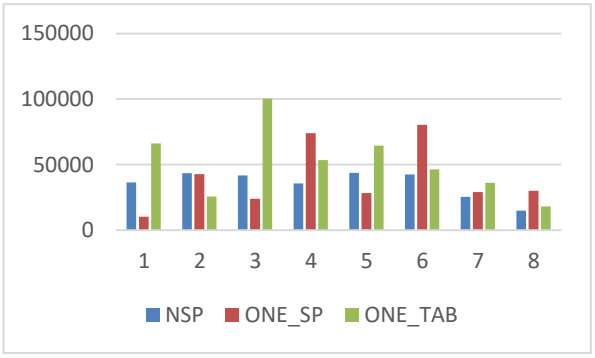

Fig. 5. Duration in miliseconds

The vertical axis is time in milliseconds, the horizontal axis refers to the task's number. Abbreviation meaning: NSP - no spaces, ONE_SP-1 space, ONE_TAB — 4 empty spaces.

Number of fixations

Measuring the number of points on screen (code) where student saw some inforamtion indicates that the code without space was "viewed differently." The number of fixations in poorly readable code was in many cases lower than in a program code that contained spaces and was readable (Fig. 6).

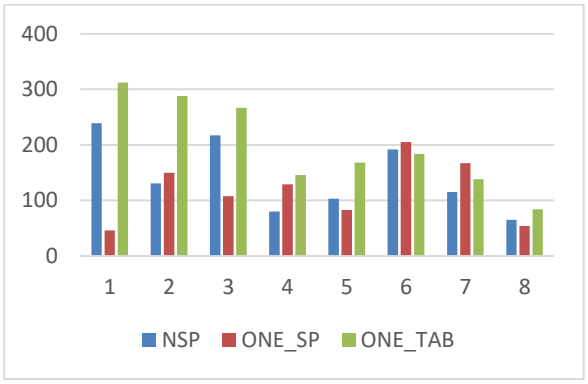

Fig. 6. Number of fixations

Interesting data is that there is a correlation between the number of fixations and the length of viewing (Fig. 7 and Fig. 8).

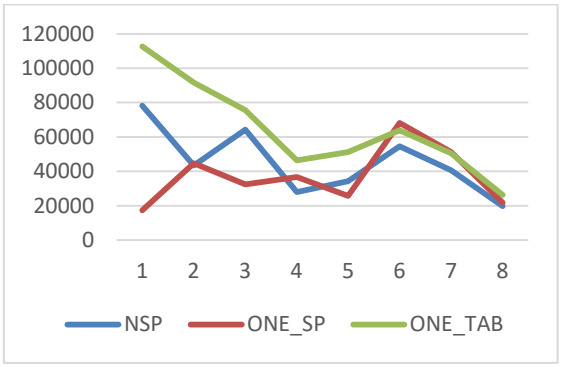

Fig. 7. Duration time in milliseconds

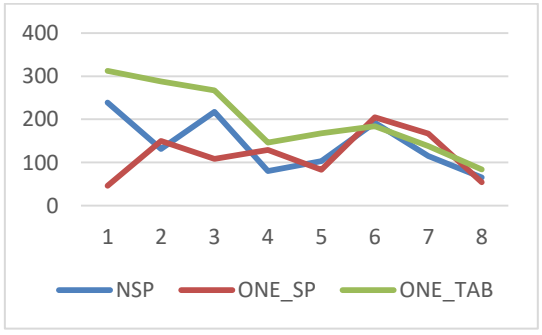

Fig. 8. Number of fixations

Average saccade length

The assumption that when using multiple spaces, the average length of the saccades will be more has not been proven.

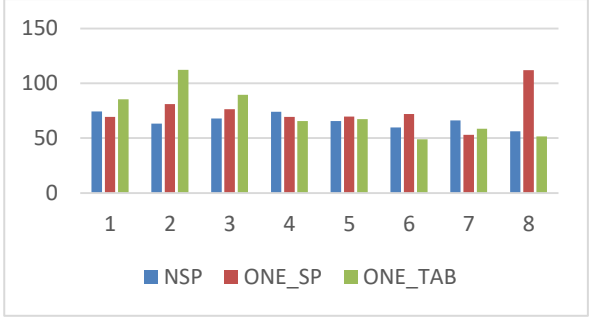

Fig. 9. The average saccade length in pixels

Average saccade velocity

The following figure shows the average rate of change of focus. The speed of change is, in most cases, lower when the student was looking at the code with fewer indents.

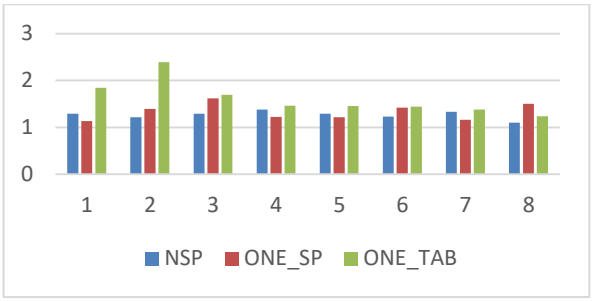

Fig. 10. Average saccade velocity in pixels/sec

V. CONCLUSION

The work presents research aimed to determining whether the readability of the program code is influenced by the use of different indent values. Literature[18][19] states that it is very important that the code be easy to read and that there are various recommendations on how to use code indentation. However, no exact and proven rules exist which is an optimal value to use, only recommendations that the number of indent's spaces should be between 2 and 8 spaces. A fewer space means densely written code, while for example with four spaces, visibility increases. Using multiple spaces also has its drawbacks: The developer sees fewer code on its screen, which again affects efficiency.

Using an eye movement measurement device, data was collected about how a student visualy analyzes the source code and tries to understand the implemented algorithm. Data from eye movement and data on whether the student has correctly solved the task or not may indicate the validity of the assumption that denser program code, with fewer indent gaps is being harder to read, and that will also affect the number of correct responses of the implemented algorithm.

This paper presents diagrams that apply only to one student. Data for that student could not prove any of the earlier defined assumptions. Lets summarize some of the results:

- Duration data suggests that it is easier to read code that is densely written (Fig 5). Which is the opposite of what's expected.
- The number of fixations also does not suggest that the multi-space indent code easier to read (Fig. 6). The first three tasks showed that the code with the most spaces had the most points of interest, that is, as if

the student needed more visual analysis of the code to understand the task, despite of assumption that this style is the most readable.

- The assumption was that the average length of the saccade will be shorter at the denser code. The results from Fig. 9 only partially support the assumption.
- The average speed of the saccade is the only measured data that supports one of the assumptions (Fig. 10). The data suggests that in most densely written code, the rate of eye change is lower. That's logical because objects of interest are close to each other.

Data from eye tracking device and the use of spaces for indents could not be examined with the efficiancy of understanding the code. The next table (Table 2) shows percentage of correct answers for all students.

TABLE 2. PERCENTAGE OF CORRECT ANSWERS

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8
NSP	33%	33%	22%	89%	0%	33%	89%	67%
ONE_SP	0%	0%	33%	100%	0%	0%	100%	78%
ONE_TAB	44%	11%	0%	0%	78%	22%	33%	100%

Some of the reasons for the poor results may be that the tasks in C language were too difficult for most students and also solving tasks in the head made problems for most. The Table 2 suggests that the percentage of correct solutions for the first three tasks is very low. The complexity of the algorithm probably influenced efficiancy. There is also a very high level of inconsistency in solving Q4 and Q5 tasks. Changing the style of the code and the initial values of some variables couldn't lead to a situation that in one case everybody knows the correct solution an in the other case nobody knows it. Further research is planned to detect reasons for this inconsistency and poor results. Authors plane to :

- Fewer the number of questions. It would reduce the time of measurement and load of students. In the current study, one measurement with eight tasks lasted an average of 10 minutes.
- Using easier and more general questions, without specific C language elements, so the student could focus only on the understanding of the algorithm.

With these impovements the research could focus only on factors that affect how the programming code is read.

ACKNOWLEDGMENT

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The Authority of Computer Science Teacher

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Abstract – This paper aims to show all aspects of the authority of informatics teachers - what it is based on, how much it is represented, and what is the relationship between informatics teachers and students. Within it, research was carried out, the subject of which is the self-assessment of one's own authority and work style of computer science teachers.

I. INTRODUCTION

The issue of authority is a topic that has always been discussed among teachers, students, and parents. The relationship towards authority is created in the family, after which the child goes to school, where he transfers the previously built relationship towards authority to the teachers, teachers, pedagogue and director.

In recent years, one gets the impression that teachers are losing their authority and that, due to numerous social changes, it is increasingly difficult to establish and maintain authority in teaching. The starting point is that every authority in the school is there to be questioned and none of them must be untouchable.

The informatics teacher has an important role in the implementation of quality education focused on the child, where education uses the potential of each child to the maximum extent possible to prepare him for life and work in modern society. The teacher is expected to be a moderator of learning, to direct and guide students through the learning process,motivate and encourage them to persevere in their work. The relationship between student and teacher becomes cooperative, where both sides try to achieve the common goal - knowledge - in the best possible way.

They most often recognize their computer science teacher as someone close to them, because the profession of computer science teacher is closely related to the interests of students growing up in the digital age. In informatics classes, teachers and students increase creativity and the possibilities of learning based on real projects that have led to the understanding of the subject being simpler and more applicable in practical conditions.

Effective use of authority requires the development and cultivation of one's own style.

II. THE CONCEPT OF AUTHORITY

Authority implies the expression of respect and appreciation of the one who, with his knowledge, behavior, abilities, experience, and position, deserves to have his opinion heard and accepted. đ most preschool and other educational institutions need this way of working. "The principle of authority is based on its voluntary acceptance, without external impact." [1]

The concept of authority is very close to the concept of power and they are often used in the same context. Power is the ability to influence other people, such as changing their opinions, thinking, attitudes, and behavior. However, authority can be defined as a way of using power.

The authority of a certain person is created based on his knowledge, his abilities and his emotional maturity. Also, the ability to build quality relationships of mutual respect and positive influence on other people is extremely important. Each teacher is an individual for himself and organizes his or work in his own way.

Setting boundaries and authority at an early age is necessary for the child's psychophysical development. Discipline is the first step that leads a child on the right path to build good relationships with people around him. The goal of discipline is for children to understand their behavior, take initiative, become responsible and respect themselves and others. In doing so, the teacher should assume the role of a guide, not an imposing authority.

III. AUTHORITY BASED ON FEAR

"Punishing authority values and develops obedience in children, which is based on the fear of punishment and the consequences that follow if the child behaves in a way that is not in accordance with the teacher's expectations." [2] Authority based on fear implies that being good means being obedient, and only what authority dictates is right. What the teacher rewards is good, and what the teacher punishes is bad.

The relationship between teacher and student boils down to the control of students by the teacher. The teacher punishes or rewards a student who is

passive to develop obedience and responsibility. The teacher clearly defines the rules and the sanctions that follow for non-compliance with those rules. Punishing as well as rewarding is a form of social control. In this context, socialization can be defined as the acceptance and adherence to norms and standards that apply in society, then it is clear that social control is necessary to ensure the applicability of norms and standards.

A computer science teacher who bases his authority on fear gives orders to students, expecting them to obey them without asking unnecessary questions. They believe that students should do what they are told, without asking for an explanation. In these situations, they use punishments such as additional tasks, test or oral answer, homework or refusal to repeat or further explain the material to the students.

"The problem with using this authority is that it weakens over time: as students grow up, they depend less and less on the teacher's rewards and punishments, i.e. the teacher has less and less available rewards with which he can motivate students, and less and less punishments with which he can intimidate them. " [4] This has become even more pronounced with the development of technology and the transition from a traditional society to a modern one, where the student is placed at the center of the teaching process.

IV. AUTHORITY BASED ON RESPECT

"Supportive authority values and develops children's independence, responsibility and critical attitude towards reality. It is an authority that fosters freedom of choice and self-discipline, i.e. develops internal motivation in children and internal locus of control." [2]

Supporting authority can be described by the statement - the child does not do what he wants,the child wants what he does. This means that the teacher managed to awaken intrinsic motivation in the students. Teachers' readiness for new challenges, creativity, curiosity and imagination trigger intrinsic motivation in students.

The teacher has the ability to control the conditions and the environment and thus defines the framework of permissible behavior within which children are allowed to choose and be responsible for the consequences of their choices. An informatics teacher who allows a student to choose, for example, the tasks they will solve, the projects they will be involved in, when he creates problem situations that students need to solve, their involvement in the teaching itself will be greater. They recognize every assignment of responsibility to a student as a privilege and a chance to prove themselves. Students' feeling that they have control and choice over what happens in class is one of the best ways to keep them engaged.

Building a good relationship with the teacher in students increases positive emotions towards the given subject, and makes the atmosphere in the class pleasant.

V. WORK STYLES OF COMPUTER SCIENCE TEACHERS

Work styles can be defined as a way of teaching. According to the behaviorist approach, leadership is understood as a form of managing people's behavior. The teacher becomes a leader - a person who creates goals and strategies for their achievement. Work style can also be defined as how the relationship between teacher and student is established. What can be said based on practical situations is that no style exists in its "pure" form, because each style of work depends on numerous subjective and objective factors. Each teacher is a personality of his own and has his own specific set of behavior in different situations in the class. In the literature of numerous authors, the following work styles are most often mentioned:

- authoritative work style
- authoritarian work style
- indifferent work style

"Authoritative teaching management style implies that the teacher helps establish rules within the group, i.e. the teacher as a leader involves students in establishing rules and is ready to discuss the rules." [3] Based on this, we can conclude that decision-making in the classroom is participatory and decentralized. The teacher encourages creativity and innovation in students. The basis of this style is interpersonal relationships, that is, the relationships that exist in the classroom. A teacher who has this style of work knows each of his students well and sets high demands accordingly, because he believes in them and that they can achieve them. He is always happy to communicate with students and respects the opinion of each student.

"The authoritarian work style of the teacher implies that the teacher sets firm rules and standards and does not want to negotiate with the students about the same." [3] There is order, work and discipline in the classrooms, without deviation from it. These teachers have a firm authority among the children, but due to the absence of warmth and closeness, this approach is similar to the military. The class is controlled, and the teaching is

determined by strict rules of behavior that all students must respect. Consequences and penalties are known if the rules are not followed. Communication between teachers and children is one-way: order - execution.

"The spontaneous or indifferent style does not establish or maintain rules, it does not set any boundaries or goals." [3] Students have freedom in their behavior. The teacher is very tolerant, does not interfere in matters related to students unless it is necessary and does not take the initiative. This style of work rarely occurs in continuing practice, only certain elements are present to a lesser extent. Its characteristics are reflected in indecisiveness and decision-making under pressure.

VI. THE NEW ROLE OF THE TEACHER

The computer science teacher is the most responsible person for providing a stimulating environment that will enable all students to learn faster and easier with the use of new technologies. The dynamic development of information technologies fundamentally changes the entire educational system, and therefore the role of teachers. New technologies require a new role for the teacher, new pedagogical methods and a new approach to teacher professional development.

The new role of the teacher is to be the student's guide through the learning process, not his only source of knowledge. The traditional teaching role in which the teacher relies on stating the facts that the students need to remember is increasingly suppressed, and the teacher becomes the organizer of independent learning. A teacher must be a versatile person, at the same time he is a student's teacher and friend. The student is recognized as an active researcher who comes to his knowledge through his research and activity. The teacher must be open to cooperation and be ready to understand and help the student who is now at the center of the teaching process. The goal is no longer to teach the student, but to teach him how to learn. The teacher must introduce new methods, teaching aids and forms of work into his work, which will constantly increase the innovation of teaching.

Teacher competencies refer to the knowledge, abilities, skills, attitudes and principles of professional ethics that are necessary for the implementation of teaching in schools. "Competences of informatics teachers refer to:

- Teaching area, subject and teaching methodology
- Teaching and learning
- Supporting the development of the student's personality
- Communication and cooperation" [4]

VII. THE CRISIS OF THE TEACHER AUTHORITY

The problem of modern society is the crisis of the authority of both teachers and other roles, which is closely related to the change in the system of values and morality. In the past, in less developed societies, authority was clear - it was a person who stood out for his qualities, experience and abilities to organize society and all activities in it well.

Some of the possible reasons for the teacher's authority crisis are:

- Changing the way children are raised
- Crisis of social values

Until they start school, the main role in the education of children is played by parents, later that role is also taken over by teachers. The problem arises when parents consciously or unconsciously give up their authority. That it later affects the child who goes to school, where rules of behavior and authorities are imposed on him, which he must respect, and before that he did not encounter it. In this way, parents deprived children of the opportunity to build a proper relationship with authorities.

The crisis of authority arises because of a broken system of values in society. In the social sense, social value is reduced to an indicator of what is desirable and acceptable for a certain social environment. Values are always re-examined and their expression carries with it a certain amount of conflict in relationships between individuals. Sociologists and pedagogues agree that the value system of young people is broken. The philosophy of young people is dominated by hedonism and a great desire to succeed with as little effort as possible. From an early age, they start looking for "shortcuts" that will make it easier for them to do their schoolwork, for example, they don't read textbooks, but look for paraphrased versions on the Internet. Because of such values, sometimes people are not sure whether authority is something good or bad.

VIII. SUBJECT AND IMPORTANCE OF RESEARCH

The subject of research in this work is the self-assessment of one's own authority and work style of computer science teachers. Bearing in mind that teacher's authority has been one of the most

important pedagogical topics since ancient times, it is important to determine what form of teacher's authority is present in schools. Previously, not much research has been conducted that deals with teacher authority and has mostly dealt with teacher authority from the perspective of students. Within this research, the emphasis is on teachers and their assessment of authority and their own work style. Informatics teacher is a relatively recent occupation, so not all aspects that make it up have been sufficiently examined.

Although current, this phenomenon has not been sufficiently examined, especially when it comes to Serbia and the region. The available information is linked to certain portal and scientific works.

The research that was carried out as part of this master's thesis is based on the research carried out as part of Marija Krešić's work Self-assessment of teachers on work styles and authority. With this work, it was made specific to teachers of computer science. The importance of this research is reflected in the fact that information will be obtained about the work style of computer science teachers, potential shortcomings will be observed and important conclusions will be drawn regarding the relationship between teachers and students.

IX. SAMPLE OF RESEARCH

The research was conducted on a convenient sample consisting of 111 computer science teachers in the territory of the Republic of Serbia, 64% (71) are women, while 36% (40) are men. All respondents answered all questions.

The largest number of respondents, half of them, 49.5% (55), are between 41 and 50 years old. 23.4% (26) of respondents are between 51 and 60 years old, 22.5% (25) are between 31 and 40 years old, 3.6% (4) are between 20 and 30 years old and the smallest percentage is 0.9% (1) is more than 60 years old. When it comes to years of service, the largest number of respondents are between 15 and 25 years old, 44.1% (49), 27.9% (31) have between 5 and 15 years, 16.2% (18) less than 5 years and 11.7% (13) more than 25 years of service. 63.1% (70) of respondents work in primary school. 29.7% (33) of respondents work in high school, while 7.2% (8) of respondents work in both schools.

X. RESEARCH RESULTS

Based on the obtained results, we can conclude that teachers assess their work style as authoritative (M=4,234) and authoritarian (M= 3,207) to the greatest extent, while they assess their work as permissive (M=2,504) to the least extent. The same hypothesis was proven in the research that was the basis of this one - "The results showed that teachers assess their style to the greatest extent as authoritative (M = 4,127), and to a lesser extent as authoritarian (M = 2,842) and permissive (M = 2,552). " [5]

Table 1. Computer science teacher work style

Work style	N	M	SD
authoritarian	111	3,207	0,106
authoritative	111	4,234	0,142
indifferent	111	2,504	0,105

The hypothesis turned out to be correct, because this style combines firm control and emotional warmth and therefore turned out to be the most effective work style. Such teachers have firm control over undesirable forms of behavior in students, and on the other hand, they give them the emotional support they need. Students who have such teachers display traits such as self-confidence, self-control, and responsibility.

Graph number 1 shows the correlation between the authoritarian work style of computer science teachers and their age (older than 41).

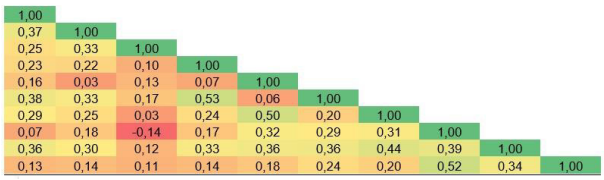

Figure 1. Attitude towards authoritarian style based on their age (older teachers)

Out of a total of 45 correlations shown, 44 are positive and one is negative. On the diagram, it can be seen that the largest number of correlations is weak. There are 4 moderate positive correlations (0.40, 0.75). There are 40 weak positive correlations (0.00, 0.40). There are 1 weak negative correlations.

The largest negative Pearson coefficient is -0.14 and indicates a weak negative correlation between the statement that the teacher does not allow students to question his decisions and that most problems in the school would be solved if teachers were stricter with students when problematic behaviors appear in class.

Graph number 2 shows the correlation between the authoritarian work style of computer science teachers and their age (younger than 41).

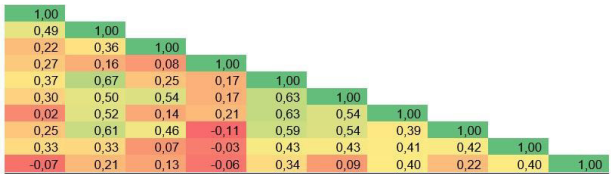

Figure 2. Attitude towards authoritarian style based on their age (younger teachers)

Out of a total of 45 correlations shown, 40 are positive and 5 are negative. The largest number of correlations is moderate or weak. There are 16 positive moderate correlations (0.40, 0.75). There are 34 weak positive correlations (0.00, 0.40). There are 5 weak negative correlations.

The largest negative Pearson's coefficient is -0.11 and indicates a weak negative correlation between the claims that the teacher leads all the activities in the class and presents arguments, and that most of the problems in the school would be solved if the teachers were stricter with the students when problematic problems appear behavior in class.

Based on the presented correlation diagrams, we can see that there are more moderate correlations among younger teachers than among older teachers. Older teachers have a higher number of weak correlations, while unlike younger teachers, there is only one negative correlation. Authoritarian leadership style is often associated with traditional teaching, so it is assumed that older teachers will assess that they use an authoritarian style of work in their work to a greater extent than younger teachers.

Table number 2 shows the foundations of the authority of informatics teachers.

Table 2. Foundations of the authority

foundations of the authority	f	%
power	0	0
knowledge	27	24,3
personality traits	18	16,2
good relationship	66	59,5
Ukupno	111	100

Based on the obtained results, the hypothesis that teachers primarily base their authority on subject knowledge turned out to be incorrect. More than half of the respondents (59.5%) believe that the teacher's authority is primarily based on a quality relationship with the student.

XI. CONCLUSION

From the perspective of developmental psychology, obedience to authority is a moment in the developmental path that is present in every individual. The new role of the teacher requires a different relationship between the student and the teacher, which leads to the teacher wandering in the path of finding the best way to respond to the needs of the students.

Further research could be based on the research of other factors that directly or indirectly influence the teacher's authority, which are theoretically described in this work. It is important to continue to examine why it seems that the authority of teachers has been increasingly lost over the years. In future research, it is necessary to include technology and its aspects of action on the teaching process and the role of the teacher.

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Learning Mathematical Contents Using Smart Educational Technologies

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Abstract - The subject of the research is training students with new mathematical content using Smart Educational Technologies (SET). Specifically, the research presented in the paper deals with the analysis of students' satisfaction with the mathematical content prepared in the GeoGebra software. During the lesson, the teacher uses SET as GeoGebru/HotPotatoes software and online tests while teaching and checking students' knowledge. This approach to teaching aims to increase the activity and engagement of students, but also to raise the teaching process to a higher level of efficiency, as well as to motivate students for independent learning. The public opinion of students about satisfaction with mathematical teaching content in the GeoGebra software was examined by means of a survey questionnaire. The questions of the survey questionnaire with the analysis and discussion of the results are presented in the paper.

I. INTRODUCTION

Since Information and Communication Technologies (ICT) are increasingly used in education, it is necessary to adapt the teaching process to it. The application of Educational Technologies (ET) in the teaching of mathematics can be very useful in explaining mathematical ideas, abstract concepts and evaluating knowledge. Smart Educational Technologies (SET) provide teachers with various software packages and technologies to facilitate their teaching [1]. An important role of SETs is that they enable the connection between graphic presentation and certain conditions, so that students can develop their knowledge [2, 3].

This study deals with the identification of students' satisfaction with the presented teaching content by mathematics teachers trained to use SET. The mathematics teacher training project called "E Mathematics Classroom" was implemented by the Pedagogical Institute of the Republic of Srpska, involving mathematics teachers in the Doboj Region, Bosnia and Herzegovina, in 2017. Mathematics teachers who participated in the project presented the same teaching content to the students, in the classic way and online in the educational software GeoGebra. In order to evaluate students' satisfaction with teaching concepts with/without the use of SET, a survey was conducted among students. The application of ICT as a segment of SET, in mathematics visualization skills and mathematics teacher education programs, is significant [4]. The survey questionnaire included a set of questions that show students' satisfaction with the use of ICT in teaching mathematics. With a questionnaire, students expressed their individual attitudes towards the use of ICT in teaching mathematics. We note that the way in which the learning process was organized encouraged students to use software packages to solve problems related to mathematics.

II. APPLICATION OF SMART EDUCATIONAL TECHNOLOGIES IN LEARNING MATHEMATICS

Mathematics is one of the subjects that students cannot avoid during university education. Therefore, teaching mathematical knowledge and skills should be carried out using multiple teaching strategies to optimize the learning process and increase student motivation [5]. The aim of this study is to use GeoGebra software as a SET. GeoGebra software was chosen because of the accessible way of presenting mathematical teaching content: graphic, algebraic and tabular presentation. The ways of representing mathematical teaching content are dynamically linked and automatically adapt to any change that occurs in any content representation, regardless of how the teaching content was created. The power of visualization can be used as a tool to develop the theoretical meaning of mathematical teaching concepts. GeoGebra software is convenient to use because it can be installed on a computer, or used in online mode [6].

GeoGebra's CAS (Computer Algebra System) view allows users to work with algebraic expressions, functions, equations, matrices, numbers, and data sets [7].

The GeoGebra CAS view allows solving equations, factoring polynomials, differential and integral calculus [8]. This GeoGebra option allows users to quickly find a solution to a problem or to check an existing solution.

III. LEARNING MATHEMATICAL CONTENTS USING GEOGEBRA SOFTWARE

Mathematical teaching content in GeoGebra software is interesting because it assesses the level and method of application and the unique characteristics of teaching mathematics and informatics with the aim of improving the general context of learning and improving students' ICT competences, i.e. it uses the advantages of this teaching system compared to the traditional system [9]. GeoGebra is a mathematical software that successfully connects geometry, algebra, analysis and other areas of mathematics [10, 11]. It is suitable for presentation and better understanding of mathematical content [12]. GeoGebra has three ways of representing mathematical objects: graphical, algebraic and tabular [13, 14]. All three ways of representing an object are dynamically linked and automatically adapt to any change that occurs in any representation, regardless of how the object was created. The power of visualization can be used as a tool to develop the theoretical meaning of geometric concepts. GeoGebra can be installed on a computer, or it can be used in online mode [15]. Using GeoGebra software teaching and evaluation processes, in addition to mathematical knowledge, they include students' ICT knowledge and skills [16].

IV. RESULTS AND DISCUSSIONE

The purpose of this research is to analyse students' satisfaction with mathematical content prepared in the GeoGebra software, i.e. using SET in mathematics lessons. The research was conducted at the University of East Sarajevo, teaching content of the Mathematics I curriculum, academic year 2019/20. 22 first-year students participated in the research.

The survey was conducted as follows:

- Students attending the Mathematics I curriculum were selected for the public opinion survey.
- 22 students participated in the survey.
- The survey contains 8 questions, and the respondents had the opportunity to fill out the questionnaires by answering the questions in online form.
- Students had 10 minutes to answer the questions individually.
- The survey was anonymous.

After the survey was conducted, the answers were analysed and presented in percentages, broken down by each question.

Question 1. Do you think that computers are necessary in learning mathematical content?

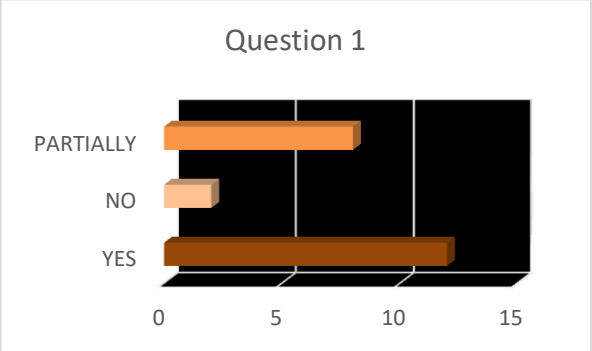

Figure 1. Student answers to Question 1

Most of the respondents, 54.5% of them, answered "YES", 36.4% said that computers are needed for entertainment "PARTIALLY", and 9.1% answered "NO", Figure 1.

Question 2. Are you satisfied with the mathematical teaching contents in which the GeoGebra software and online tests were used?

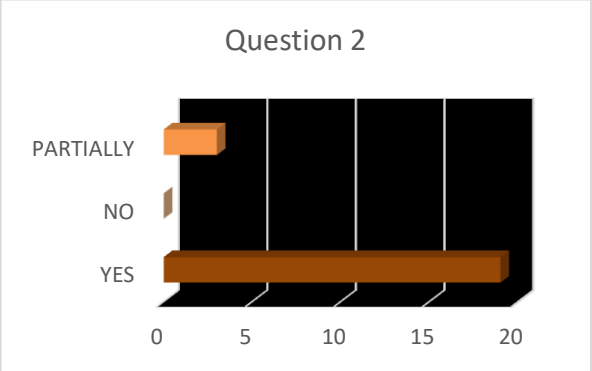

Figure 2. Student answers to Question 2

It is obvious that the students liked the teaching content prepared in the GeoGebra software. Out of 22 students, 86.4% gave the answer "YES", 13.6% said they were "PARTIALLY" satisfied, not a single student expressed dissatisfaction with the teaching content in GeoGebra software, Figure 2.

Question 3. Is your motivation higher when you learn through the teaching contents prepared in GeoGebra software?

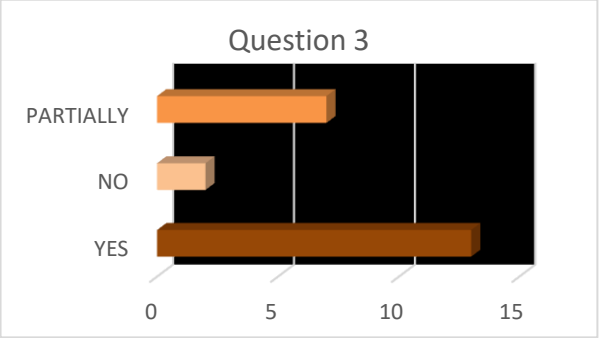

Figure 3. Student answers to Question 3

The majority of students, 59.1% of them, are more motivated to learn with the presented teaching content. 31.8% said they were partially more motivated. 9.1% of 22 students answered "No", which means that the students are not particularly motivated by the offered teaching content, Figure 3.

Question 4. Do you like the features of GeoGebra software?

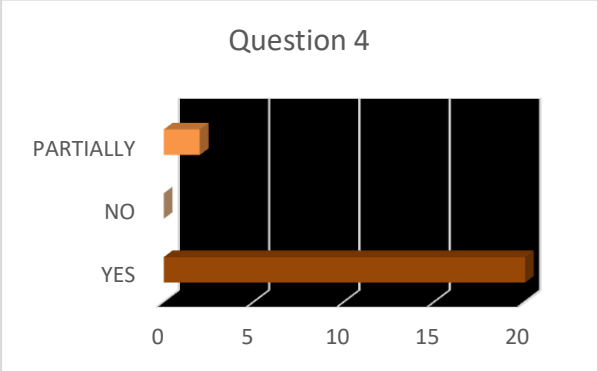

Figure 4. Student answers to Question 4

GeoGebra would gladly be used by 90.9% of the students, while 9.1% of them are not sure if they would like to do so, Figure 4.

Question 5. Would you be able to master mathematical content better with the help of GeoGebra software?

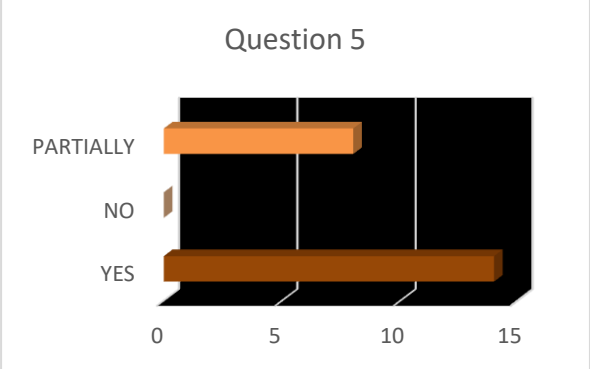

Figure 5. Student answers to Question 5

The most common answer is "YES", total of 63.6%, while the rest of the students 36.4% answered "PARTIALLY", Figure 5.

Question 6. Evaluate your activity during the class!

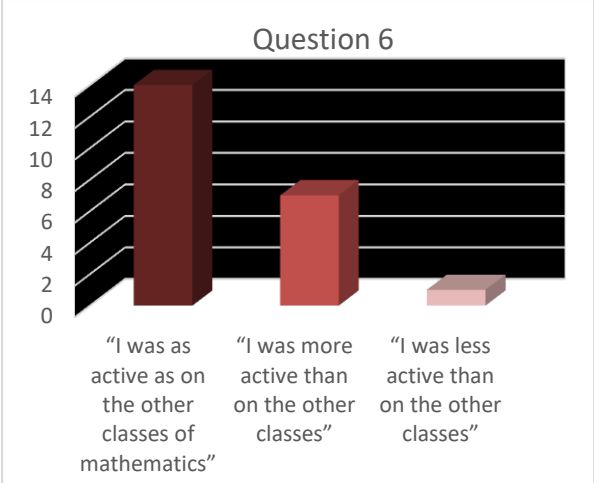

Figure 6. Student answers to Question 6

Majority of students, 63.3% of them, answered: "I was as active as on the other classes of mathematics". 31.8% of them answered: "I was more active than on the other classes". 4.6% of them answered: "I was less active than on the other classes", Figure 6.

Question 7. Did on-line tests help you in self-evaluation of your knowledge?

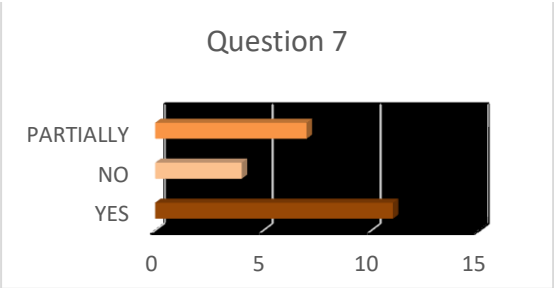

Figure 7. Student answers to Question 7

50.0% of the students think that on-line tests are helpful in self-evaluation, while 31.8% of them are not sure of it, and 18.2% of them don't agree with the statement, Figure 7.

Question 8. Evaluate mathematical teaching content in the GeoGebra software.

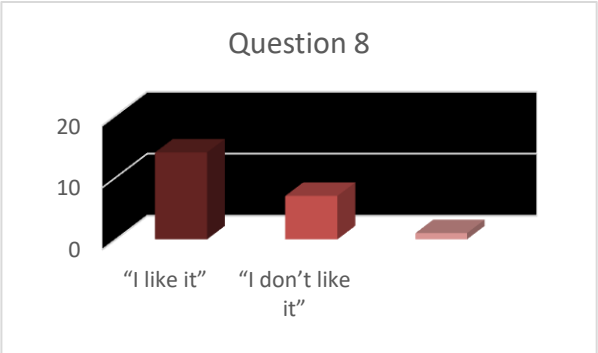

Figure 8. Student answers to Question 8

Answer: "I like it" was given by 63.6%, "I

don't like it" by 31.8% and 4.6% answered "I neither like nor dislike it", Figure 8.

According to the results of the research, it is noticeable that the students were satisfied with the use of GeoGebra software when adopting new teaching content. Unofficially, the students pointed out that this software was helpful in acquiring new knowledge and deepening the old ones in the field of Mathematics I. Also, the students stated that they would like to continue using this software in mathematics lessons.

V. CONCLUSION

Based on the analysis of the results obtained from the research, we can conclude that students are satisfied with the introduction of SET in the Mathematics I curriculum (Figure 1, Figure 2, and Figure 4). The use of SET (GeoGebra/HotPotatoes) in mathematical teaching content allows students to be more motivated to participate in the teaching process, express their views and suggestions for solving problems, investigate, and gain confidence (Figure 3, Figure 6, Figure 7, and Figure 8).

Students adapt well to the teaching content of mathematics. Therefore, students discover mathematical concepts and rules in them together with the teacher, but also independently investigate certain properties (Figure 4, Figure 5, Figure 6, Figure 7, and Figure 8).

With this approach to mathematical concepts, the teacher overcomes the limitations of classical teaching. At the same time, the teacher is required to have a creative and interesting approach to teaching, and must design and adapt the mathematical teaching content so that it best suits the students. It is necessary to use performance tasks as much as possible within the mathematical teaching content, and to develop students' ability to apply different techniques in solving these tasks. GeoGebra as a SET enables the fulfillment of most of the goals set in modern mathematics teaching, and it is easy to use for both teachers and students.

Further research could be developed in the direction of examining the achievements of students within the framework of innovative mathematical content.

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Using Educational Games for Learning Natural Science

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Abstract – The intrinsic connection between play and technology is becoming increasingly significant in early years education. This is especially true for children who belongs to the Generation Alpha. Gen Alpha generation is greatly influenced by technology, and they seek personalized and interactive education delivered through technology. Game-based learning offers a new way of learning, which conforms to the habits and interests of Gen Alpha. This paper provides an overview of a custom developed educational game and its applicability in the teaching of natural science and also investigates the outcomes obtained through game-based learning, in primary school children.

Keywords: game-based learning, educational games, natural science

I. INTRODUCTION

Technology use in education is not new. There have been many instances of technology-based games used to engage students at various skill levels (some popular examples from the 90's include: Math Blaster, Spyro The Dragon, Carmen Sandiego, Civilization, RollerCoaster Tycoon, SimCity etc.). The adoption of technology and its proper use, especially in early childhood education, is of global interest. We are living in an age where the technology used represent yet another environment in which children are expected to learn. This is especially true for children who belong to the Generation Alpha (Gen Alpha) - a term coined by social researcher Mark McCrindle [1].

Generation Alpha is composed of individuals who were born at the crossover of Generation Z and the new age, or to put it in another way - those born after 2010 [1]. In fact, their appearance coincides with the launching of iPad and creation of Instagram. The most important about this generation is the digital environment they are being born into.

Since technology is part of their everyday lives, it is natural for them to learn through technology [2, 3, 4, 5, 6]. The technology can support educators in their day-to-day activities and make it easier for them to bond with young generations [7]. Gen Alpha are digital natives that find gaming as an especially important part of their identity. According to them, games can make learning fun and provide them with educational content in a medium they understand and love. Game-based learning provides an opportunity for teachers and educators to incorporate active learning into their lessons, promote students' interest and engagement, increase motivation, and provide immediate feedback on performance [8]. The fun of gameplay is a critical part of why this method is so successful with children. According to educators, games can help disguise the learning of essential but challenging skills that kids might otherwise resist.

However, game-based learning environment do not set enjoyment and fun as its primary objectives, but rather its environment includes educational content in a challenging and enjoyable way which promotes active learning. Educational games are based on four main elements which are: engagement, autonomy, mastery, and progression [9].

Engagement takes place when students are actively involved in their learning. Sometimes educators might think that students are engaged because they are behaving well, however, engagement is much more than "passive" student participation. According to Schlechty, if the student sees the activity as personally meaningful and worthy of trying to get it right, it means that the student is engaged [10]. Engagement is closely related to motivation; higher motivation tends to lead to higher engagement and vice versa. Numerous studies have reported the increased level of engagement when students were involved in digital game-based learning [11, 12, 13, 14, 15], as well as students' high motivation when playing educational games [16, 17, 18, 19, 20, 21]. Educational games allow player to be more autonomous, to think critically, make decisions and take appropriate actions, based on those decisions. Mastery, as a characteristic in

educational games, is the degree of repeatability of players' specific actions in order to gain full control of the game. And finally, progression, refers to the reward players receive for their success. It includes, levels, stars, points, badges etc., that create a high situational interest. In fact, progression is the main motivation for players to accomplish the game's goals while learning at the same time [22].

In view of the variety of games, it becomes important to identify the effect of educational games on learning outcomes. This paper provides an overview of a custom developed educational game and its applicability in natural science teaching. It also explores learning outcomes in the game-based learning context.

II. NATURAL SCIENCE EDUCATION IN PRIMARY SCHOOL

Rapid technological development, scientific advances and innovation on one side, as well as various socio-economic factors such as the process of globalization, economic crisis, permanent migrations, demands for skilled and efficient workforce, on the other side have huge influence in shaping and defining the basic set of fundamental skills that the students need to have in order to be able to respond to the demands and be competitive on the market. Multiple scientific studies have been conducted in various countries across the world and their conclusions have one common denominator, namely they are evidencing that the skills in science, technology, engineering, and mathematics are of fundamental importance in the 21st century.

Acknowledging the need for STEM (Science, technology, engineering, and mathematics) skills and recognizing its importance, leads to the conclusion that development of these skillset should be stimulated since early childhood, and it should be an intrinsic part of the education system.

Although children get aware of the nature and are capable to identify some phenomenon or distinguish between species, their knowledge is not exact and deep. Therefore, it may be useful and beneficial to create dedicated pre-school, and later on in primary school, programs that will help in brothering their knowledge in natural science.

Currently, the primary education system in Republic of North Macedonia, integrates the natural science education fundamentals in several subjects related to the development period of the child and following the nine-year primary education concept.

Biology, physics, chemistry, geography, but also ecology and environment are part of these courses. Moreover, multiple reforms in the primary school are aimed at supporting the integration of natural science and social science with the final goal to develop the required skillset during primary school.

However, many analyses and studies from both academia and business world show that there is a huge decline of students' interest about natural science subjects, absence of deep understanding, lack of capacity to apply the gained knowledge and worrying apathy for studying natural sciences.

Therefore, in addition to the reforms of the curriculum, mechanism for increasing children motivation becomes one of the biggest problems. Motivation should be considered an intrinsic part of learning and education. One of the key drivers for increasing the children motivation are the teachers. In this process they may use and rely on various tools. However, among variety of available education tools for increasing motivation for learning natural sciences, digital tools with an emphasis on educational games, are the most preferred ones by Gen Alpha.

In this context, multiple education games have been developed and integrated in the national education platform called Eduino.

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 (Figure 1).

Although multiple scientific studies evidenced that game-based learning has the potential to increase the learning motivation in primary school children, this study aims to provide scientific evidence that it is valid and applicable to natural science education.

To advocate that carefully tailored dedicated education games could be an efficient tool for enhancing the natural science learning, we have followed some basic game-based principles and characteristics. As an outcome of this process, a dedicated education game entitled "Knowledge hunter" (Figure 2) for self-paced learning and evaluation of knowledge was developed. Later on, we have evaluated its impact on the learning process.

Figure 1. Education games developed and hosted on the EDUINO collective platform

Figure 2. Education game "Knowledge hunter" developed for game-based learning of natural science

III. METHODOLOGY AND RESULTS

The research was conducted in a primary school in the capital of North Macedonia - Skopje. 32 pupils from 5th grade, at average age of 10.2 years were selected for this study. 16 of the pupils included in the study were males, and 16 girls. This study was conducted at the end of first semester after the pupils were thought natural science material foreseen for that semester.

The single group pre-test and post-test design was used in this study. Pre-test and post-test were executed before and after the use of educational game. Pupils' achievements were assessed, both before and after the applied game-based learning process. Assessment was done using dedicated tests that were conducted to obtain pupils scores.

The main goal of our study was to reveal the influence of game-based learning on learning natural science. Therefore, we have posed one basic research question:

Does using game-based learning enhance primary education pupils' learning of natural science?

We have tried to answer the question, using the scores of each pupil in pre-test and post-test. The scores were then normalized on the scale from 0-100%. Obtained dataset was processed using IBM SPSS Statistics Version 23 application.

No missing values, in both pre-test and post-test scores, were found and therefore, responses from all 32 pupils were taken into account. The obtained results show that the scores for the pre-test were varying in the range from 34 to 82, while the mean value was 60 with a standard deviation of 9.42. For the post-test the scores were varying in the interval from 67 till 98, with a mean value of 82.69 and standard deviation of 8.86.

The descriptive statistics of the obtained results is reported in the Table 1.

As one may observe, there is significant shift of the mean values between pre-test and post-test scores. Moreover, this is valid also for the minimum and maximum obtained scores. This may lead to a conclusion that the game-based learning has a positive impact and enhanced the learning of the subject natural science.

TABLE I. DESCRIPTIVE STATISTICS

		PreTest	*PostTest*
N	Valid	32	32
	Missing	0	0
Mean		61.5000	82.6875
Std. Error of Mean		1.66438	1.56669
Median		60.0000	84.0000
Mode		60.00	79.00
Std. Deviation		9.41516	8.86253
Variance		88.645	78.544
Range		34.00	31.00
Minimum		48.00	67.00
Maximum		82.00	98.00

Sum	1968.00	2646.00

IV. CONCLUSSION

Designing and developing educational games is more than creating games for playing and entertaining the pupils. It is a process that should lead the student through the material towards an end goal. The carefully designed and developed education games can significantly motivate the pupils and enhance the learning of natural science.

The outcome of this study shows that the game-based learning can have a positive impact on student outcome as indicated by the increase in scores from pretest to post-test on the natural science knowledge assessment. These results correspond to the use of digital games in game-based learning in previous studies. Moreover, the use of the educational game, also enhanced learning motivation and increased students' interest in learning of the subject natural science.

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The Role and Importance of Principles, Subjects, and Measures for Quality Assurance in the Quality Assurance System of Higher Schools of Applied Studies

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Abstract – The paper shows the role and importance of the principles, subjects, and measures for quality assurance in the quality assurance system of a selected higher school (college) of applied studies. Subjects have clearly defined competencies, rights, and obligations in the quality assurance system and are an important element for the realization of the set principles. Quality assurance measures can be external and internal. Strict implementation of measures for quality control/assurance enables the selected higher school (college) of applied studies to improve the quality of all segments of its work and move closer to EU quality standards.

I. INTRODUCTION

The quality assurance system is a system by which colleges (schools) of applied studies and academies of applied studies monitor and evaluate existing conditions so that by applying certain measures they can improve the quality of the teaching process and extracurricular activities, that is, the entire work.

Taking into account that quality assurance is one of the key elements of the reform of applied studies in the Republic of Serbia and their integration into a unique European educational space, the Law on Higher Education [1], as well as the following acts prescribed by the National Council for Higher Education: Rulebook on standards and procedure for accreditation of study programs [2] and Rulebook on standards and procedure for accreditation of higher education institutions [3]; higher education institutions of applied studies must have established and implemented strategic and operational internal acts in the field of quality assurance.

Internal legal acts in the field of quality assurance must define the following basic elements:

- Commitment to continuous and systematic work on improving the quality of study programs and the entire Institution;
- Quality assurance measures;
- Quality assurance subjects and their rights and obligations in that procedure;
- Areas of quality assurance;
- Commitment to building a culture of quality;

This paper shows the role and importance of defined principles, subjects, and measures of quality assurance in the quality assurance system for the successful functioning of the quality assurance system on the example of a college of applied studies.

II. GENERAL PRINCIPLES OF QUALITY ASSURANCE

To achieve the set quality goals, through strategic documents, the Institution imperatively defines the following general principles of quality, which support appropriate quality assurance measures.

The general principles of quality assurance include:

Fulfillment of National regulations and standards in the field of accreditation and external quality control [1-4]. In this way, the unification of the quality of all institutions in the Republic of Serbia is achieved, while reducing costs and increasing the efficiency of studying. The above is realized through the process of self-evaluation [4].

Ensuring, evaluating, and constantly improving quality is the task and responsibility of the Institution's management, which is reflected in the change of management style. In the quality

control/improvement process, the active involvement of students in defining/assessing the quality and content of the teaching process and given study conditions is very important [1,4].

III. PRESENTATION OF SUBJECTS IN QUALITY ASSURANCE ON THE EXAMPLE OF ONE HIGH SCHOOL OF APPLIED STUDIES

Subjects and measures in quality assurance in the selected example of a college of vocational studies derive from the Rulebook on standards for self-evaluation and assessment of quality assurance of higher education institutions and study programs [4] prescribed by the National Council for Higher Education, the Strategy for Quality Assurance of the Institution itself [5], as well as the Statute of the Institution [6].

Subjects of quality assurance of the Institution's work are all employees, all students, and all professional bodies, as well as the Council of the Institution [7].

Institution bodies that deal with quality assurance are [7]:

- Quality Assurance Commission;
- Council;
- Director;
- Teaching and professional council,
- Collegium;
- Teachers;
- Associates;
- Student services;
- Non-teaching staff;
- Students Parliament;
- Students;
- All parties who complete certain tasks in the Institution.

All entities have a duty and obligation to participate in quality assurance [7].

IV. PRESENTATION OF QUALITY ASSURANCE MEASURES ON THE EXAMPLE OF ONE HIGH SCHOOL OF APPLIED STUDIES

Quality assurance measures include activities that improve quality [7]:

- Self-evaluation and assessment of the quality of study programs and Institutions by National standards, in three-year intervals;
- Respect and implementation of standards and procedures for ensuring the quality of study programs, teaching and working conditions, as well as the criteria prescribed in the general acts of the Institution, and that, while creating a positive environment, further development of study programs;
- Continuous work of the Quality Assurance Commission, for monitoring and quality control of the Institution's work;
- Compliance with the criteria for the selection of teachers and fellows by the Law on Higher Education and internal acts,
- Permanent training of teaching staff and ensuring the unity of educational and professional work, the results of which are used in the teaching process and future accreditations;
- Permanent investment in contemporary literature, as well as the development of electronic teaching materials;
- Constant investment in the workspace, audio-visual equipment, and provision of free internet access to all employees and students at the Institution;
- Establishing cooperation with the National Employment Service, employers, and alumni students, to obtain feedback on the quality of study programs, and competencies acquired by graduate students, but also on the application of acquired knowledge in practice;
- Provision of human resources, and infrastructure for the collection and processing of data important for the analysis and assessment of quality and degree of success in the achievement of set goals and tasks;
- Provision of working conditions for student representatives in the process of evaluating the teaching process and non-teaching support;
- Publication of quality evaluation results;
- Provision of other conditions that promote the organizational culture of quality in the field of higher education.

Quality assurance measures are specifically defined for each of the quality assurance subjects [7] and are prescribed by the Institution's Statute [6].

This paper will give an overview of the competencies of the Director as the management body of the Institution, selected professional bodies of the Institution, and students.

A. Director

The Director of the Institution is responsible for the legality of work and the successful performance of the Institution's activities [6].

In addition to the duties established by law, the Director performs the following duties:

- Organizes and manages the overall operations of the Institution;
- Plans and organizes the implementation of the study program;
- It takes care of quality assurance and improvement of educational work;
- It takes care of the implementation of the Institution's development plan;
- Plans professional development of employees;
- It takes care of informing employees, professional bodies, and management bodies promptly about all issues of interest to the work of the Institution and its bodies;
- Prepares, convenes, and manages the sessions of the Teaching and Professional Council;
- Directs and coordinates the work of expert bodies;
- He regularly submits reports on his work to the Council, at least twice during the school year;
- He signs diplomas, certificates, contracts, and other acts related to business and public documents;
- Adopts general acts, if they are not within the competence of the Council;
- It takes care of the dedicated use of the workspace;
- He prepares the report for the implementation of the expanded activity of the Institution, by the law and the work permit,
- It takes care of the implementation of the public bidding procedure and the procedure of collecting written offers and the documentation necessary for its implementation, as well as the public procurement procedure;
- Represents the Institution;
- Undertakes all legal actions in the name and on behalf of the Institution;
- Performs other tasks and is responsible for their execution, by the law and general acts of the Institution;
- It appoints various commissions within its jurisdiction;
- Obtains from the competent authorities the license for the operation of the institution, amendments, and additions to the license for the operation of the Institution, certificates on the accreditation of study programs and the Institution;
- He participates in the procedure and coordinates the procedure of removing the deficiencies mentioned in the findings of the educational inspection and long inspection bodies in the supervision procedure;
- Participates in and monitors the process of creating documentation for accreditation.

B. Quality Assurance Commission

The responsibilities of the Quality Assurance Commission are regulated by the Statute [6] of the Institution [7].

The quality assurance committee has the following responsibilities [6]:

- It works on monitoring and ensuring the quality of study programs, teaching, and working conditions;
- Makes suggestions for improving and developing the quality of study programs, teaching, and working conditions;
- Monitors the implementation of quality assurance strategy, standards, and procedures and proposes appropriate measures to the school management;
- It regularly collects data on the quality of study programs and school work from business representatives, economic and non-economic organizations, and other relevant institutions;
- It carries out the process of self-evaluation and assessment of the quality of study programs, teaching, and working conditions;

- It also performs other tasks established by law, the founding act, and other general acts of the Institution.

C. Commission for Accreditation of the Institution

The responsibilities of the Quality Assurance Commission are regulated by the Statute [6] of the Institution [7].

The Accreditation Commission of the Institution is responsible and authorized to carry out the procedure of preparation and creation of documentation for the accreditation of study programs of all study levels, as well as the accreditation of the Institution [7];

The scope of work of the Commission for Accreditation in the Institution includes in particular the following tasks [7]:

- Collection and processing of relevant data for the development of all standards for accreditation;
- Creation of the curriculum of study programs according to the methodology of the prescribed standards for accreditation;
- Collection, processing, and preparation of the necessary documentation and studies to prove the fulfillment of the conditions prescribed by the standards for accreditation by the competent republican authorities;
- Cooperation with all professional services of the Institution;
- Preparation of studies aimed at eliminating perceived deficiencies in the accreditation process by the Accreditation Commission appointed by NEAQA;
- Creation of cover letters and including accreditations, etc.;
- Forwarding of prepared proposals to competent authorities for adoption.

D. Students Parliament

Students Parliament [6]:

- It brings the plan and program of its work;
- Elects and dismisses the president and deputy president of the Students parliament;
- Elects and dismisses student representatives in school bodies, by the law and the Statute of the Institution;
- Takes positions on issues of interest to the implementation of teaching, on issues related to ensuring the quality of teaching, on reforming the study program, and analyzing the effectiveness of studying;
- Takes positions on the issue of establishing ethical principles in relations between teachers and associates, other employees and students;
- Determines the assessment of the quality of the study program, teaching, and working conditions in the school's self-evaluation process and the institution's quality assurance process;
- Gives an opinion on the results of the pedagogical work of teachers and associates during the selection for the positions of teachers and associates;
- Gives instructions to student representatives, related to the needs for work and actions at the sessions of the Council of the Institution and professional bodies of the Institution;
- Performs other tasks by the Law, Statute, and other general acts of the Institution.

V. CONCLUSION

Principles, subjects, and measures for quality control/assurance (defined by documentation from the field of quality assurance) on the selected example of a college of applied studies have a very important role and exceptional importance for the successful functioning of the quality assurance system.

All subjects have defined responsibilities, that is, rights and obligations in the system of quality assurance of the observed college of applied studies.

Quality assurance measures include external control and internal quality assurance measures.

External control consists of external quality control and the accreditation procedure of the institution and study programs. The aforementioned is carried out by the Committee for Accreditation and Quality Control as an expert organ of NEAQA.

Internal quality assurance measures are defined by a set of quality assurance documents within the Institution. Internal quality assurance measures essentially rely on the following pillars: compliance with the Standards for Accreditation of Higher Education Institutions and Study Programs and Standards for Self-Evaluation and

Quality Assessment; development of organizational culture, quality culture, and awareness of quality development.

The Institution has a developed mechanism for quality monitoring/control of all work segments with defined measures for quality improvement.

The further course of work could include the analysis of the compliance of the general acts of the Institution with the relevant regulations, as an important segment in ensuring the quality of work, etc.

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Implementation the Similar-Task Algorithm in Graph and Relational Database

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Abstract - This paper investigated relational databases as currently the most needed concept for storing data, and they represent an organized collection of data in which data is organized into a set of relationships. With the development of a large number of applications, a huge amount of data has been created, where relational databases have proven to be less adequate for data storage and processing, as well as for flexibility. Overcoming their shortcomings has led to the implementation of new data models. Not only Structured Query Language (NoSQL) databases are not based on, or at least do not firmly adhere to, a relational model. In addition, they are easily distributed, horizontally scalable, and the value structure is usually not strictly predefined. Graph NoSQL database as a data model uses data modeling in the form of graphs consisting of interconnected nodes. This paper presents the possibilities of applying a Similar-Task algorithm to compare performance between graph and relational database.

I. INTRODUCTION

Relational databases are the most common form of data storage today. They have implemented a relational model that basically has the concept of structure, operation and dynamic rulebooks. The structure of this model is very simple because relational databases are aggregated tables. The operations in a set of given tables generate outputs that are also tables that are simple and easy to apply. In addition, a formal-mathematical interpretation of tables is possible, where tables are treated as mathematical relations and rich mathematical devices can be used to develop database data and relational database design methodologies [1].

For relational databases, a standardized SQL language has been developed and fully equivalent to the theoretical relational model.

With the development of a large number of applications, a huge amount of data has been created, where relational databases have proven to be less adequate for data storage and processing, as well as for flexibility. Overcoming their shortcomings has led to the implementation of new data models.

NoSQL databases are not based on, or at least do not adhere to, a relational model. In addition, these databases are easily distributed, horizontally scalable, and the value structure is usually not strictly predefined.

Process mining has emerged as a technique for analyzing processes based on system event records. The main goal of process mining is to analyze event logs and discover business process models, improve them, or check for a priori compliance. Nowadays, all kinds of events in the information system are recorded, because it is of great importance for the security of the information system, as well as for analyzing data and gaining knowledge from logs. The significance of the knowledge gained is of great importance for the further analysis of reality, i.e. a realistic relationship between business processes.

Many algorithms have been proposed to build a process model based on the analysis of the sequence of events observed in the event log. As a result, other aspects were neglected, e.g. Organizational environment and peer interactions. The focus here is on organizational mining. Organizational mining refers to Process Mining and Analytics (PMA) activities directed toward analyzing implicit information about resources in event logs [2]. The techniques used in this paper are techniques for discovering Organizational Models in a log-based information system, where these models can help improve basic processes in an organization.

Similar-Task algorithm is a metric based on joint activities and algorithm under Organizational Mining. The focus of this algorithm is on jobs performed by individuals, not a group of users to solve a common problem. In fact, the main goal is to find similar activities and to more closely connect users (person-p) who have similar activities than those who have different activities. Similar-Task algorithm can use similarity measures such as: Cosine-Similarity, Euclidean, Jaccard, etc. [6].

It uses a Similar-Task algorithm to compare RDBMS and GraphDB at the similarity level of the processes that are being performed involves implementing the Similar-Task algorithm in

Relational Database Management System (RDBMS) and in GraphDB.

This paper is structured as follows: After Introduction, where We describe process mining to achieve goal to analyze event logs and discover business process models in different RDBMS, comes Section II which describes methodology how to implement the Similar-Task algorithm on the Films project, which deals with films, actors, directors, producers and writers. Section Methodology which was developed, as the usage is concerned, is a starting basis for the proposed solution outlined in Section V. In order to compare the two databases, we first created a Relational Database Films Section III and then created an equivalent Graph Database on the Neu4j platform Section IV. Section V, contains the main focus of this research paper with technical details required for implementation Similar-Task algorithm in the RDBMS database (MS SQL) of the Films database, as well as in the Neu4j Films database. Practical example of the Queries specially developed for the Relational database Films in SQL, while for the Graph database Files are written in GraphQL described in Section V, provide to us a visual means to confirm our summary and conclusions outlined in Section VI.

II. METHODOLOGY

The Similar-Task algorithm is a metric based on joint activities. This algorithm belongs to Organizational Mining. The focus of this algorithm is on Activities that are performed individually and does not include group work in the analysis [3]. The basic task of Similar-Task algorithms is to find similarities between Actors by the matching criteria or similarity of the Activities they perform. The algorithm should provide greater connectivity between Actors performing the same or similar activities than those performing different [3]. Only similarity calculations are done using Cosine-Similarity in our case. In addition to Cosine-Similarity, it is also possible to determine similarity using: Euclidean, Jaccard, etc. The Similar-Task algorithm is implemented in various ways with RDBMS and GraphDB.

A. Similar-Task algorithm in RDBMS database

RDBMS system Films has a special spreadsheet that stores logs and events of all users. Users are known and have their accounts. Each user can perform or initiate an activity. Only events related to activity and a case are considered here. Case represents instances of a process and it is processed. An event can be represented by (c, a, p) where c is the case, and is the activity, and p is the person. Events are time dependent, so it is possible to establish cause and effect relationships between activities. The input to the Similar-Task algorithm is a two-dimensional matrix called the Person-Activity Matrix. In this matrix the rows are Person and the columns are Activities. Cosine-Similarity (1) was used as a similarity measure.

Similar-Task Algorithm in RDBMS

Data: Person-Activity Matrix (M)
Result: Matrix with similarity values between Persons

1 Get the number of rows of M into m.
2 Get the number of columns of M into n.
3 $D[m][m]$ = Declare square matrix to store results.
4 **foreach** i = 1 to m-1 **do**
5 P =Vector corresponding to i^{th} row.
6 **foreach** j = i + 1 to m **do**
7 Q=Vector corresponding to j^{th} row.
8 Apply Cosine-Similarity between i^{th} and j^{th} row

$$\text{Cos}(P, Q) = \frac{P * Q}{\| P \| \| Q \|} \quad (1)$$

9 Set $D[i][j]$=similarity value obtained in the Step 8.

B. Similar-Task algorithm in Graph Neo4J database

Getting into the Similar-Task Algorithm in GraphDB is the person information contained in the Person-Activity Graph.

Similar-Task Algorithm in Graph Database

Data: User-Activity Graph
Result: Graph with similarity values between Actors

1 A_i = Get an User 'i' from the User -Activity Graph.
2 A_j = Get another User 'j' from the User -Activity Graph.
3 Find intersecting Activities between A_i and A_j.
4 Collect frequencies of Activities from the edges of intersecting Activities.
5 Apply Cosine-Similarity with the values

obtained in Step 4.

6 Set [: SIMILARITY] between A_i and A_j with the value obtained in Step 5.

First, intersecting Activities between Person are found, then values [: PERFORMS] are used, which represents the number of Activities that the Person performs, and is located between node Person and node Activity.

Based on these values, a Cosine-Similarity calculation between Persons is performed. Finally, the resulting value is written to [: SIMILARITY] between the two Persons in the Person-Activity Graph.

III. RELATIONAL DATABASE FILMS

The theory and practice of Relational Databases have been developing and applying for a very long time, so it is safe to say that they have reached their full maturity. Relational databases represent an organized collection of data in which data is organized into a set of relations [4]. Based on the above statements the relational data model describes the data in a natural way and uses their natural structure. No new structures are added to this model for easier integration. This data model has the feature that it supports the independence of data from their physical representation, as well as the independence of data connections and implementation methods.

The relational data model includes not only relational structures in the form of two-dimensional tables, but also a special way of processing data called relational processing [5].

RDBMS is a complex system that should enable [1]:

- Data storage with minimum redundancy;
- Reliability of data even with possible hardware and software failures;
- Reliable parallel use of shared data by multiple authorized users;
- Logical and physical independence of the program from the data;
- Easy communication with the database through questionable languages;

The Relational Films Database, developed for the purpose of this research, consists of a relatively large number of tables, seven in total. For our research, five Tables were used, while two tables were not used in the searches that were carried out here, and therefore are not shown in Fig. 1. The most important are the Film and Person tables. Queries are formed over them, and are linked to other tables via foreign keys. A person can star in a film in a certain role and this is placed in the Acts table, then he can be a director on a film and this is placed in the Directs table and he can be a producer on a film and this is placed in the Production table.

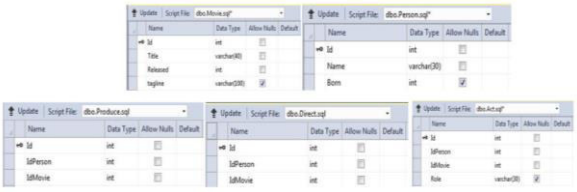

Figure 1: Tables of MS SQL database

Structured Query Language (SQL) is a standardized language for working with Relational Databases, i.e. with structured data.

The data is processed at the logical level so the user does not have to take care of the implementation details. An optimizer is used to access the data, which provides the most efficient way to access the data. SQL is not intended for the development of complete applications, but it does provide connectivity to classic higher programming languages. SQL belongs to non-procedural languages [7].

Searches performed on a relational database Films are very demanding because of the relatively large number of tables that this database has and require complex SQL queries. In addition, merging these tables is mandatory, and we face the problem of having to deal with a large number of tables that require interconnection merging and usage complex SQL queries in process of searching the data in database.

IV. GRAPH DATABASE FILMS

NoSQL databases are not based on, or at least do not adhere to, a relational model. In addition, these databases are easily distributed, horizontally scalable, and the value structure is usually not strictly predefined. Since 2009, many different NoSQL solutions have been developed that have different approaches to organizing the data stored there but all have common features that visibly separate them from relational databases. The most important representatives of this initiative are: Key-value, Graph, Document store and Column data bases.

Database graphs are databases where data is stored in a graph structure. They are often treated as alternatives to the Relational Database Model.

The reason is that both models are based on similar mathematical models. Given that the underlying relational and graph database mathematical models of these two types of databases are much easier to compare than other types of databases [8].

Just as Relational databases have their RDBMS, so does Database Graph have their RDBMS. The most popular RDBMS for Database Graph is Neu4j. Neu4j has evolved over time, so today Neu4j is one big data connectivity platform, while its RDBMS is just one of the modules of this platform. The complete Neu4j platform was developed using the Java programming language.

The Films database graph is derived from the Relational Films database. Each node of the Films database graph represents a specific item in the Films and Person tables of the relational database. The other tables represent the connection between these nodes. This procedure produces the graph of the database shown in Fig. 2.

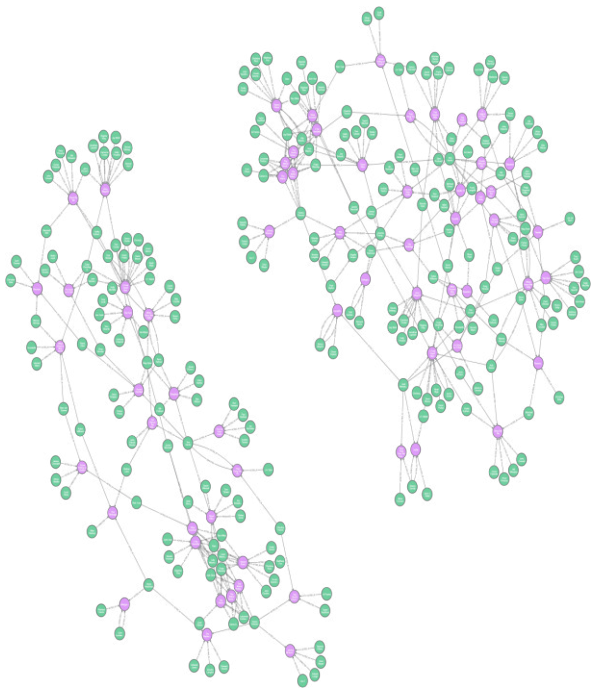

Figure 2: Data in GraphQL database

GraphQL is a query language that uses graph as the basic unit for defining and executing queries. GraphQL provides support for graphs with variable attributes and data sizes, so any node, link, or graph can have an arbitrary number of attributes (1 or more). In addition to the above features, GraphQL is an effective implementation language that can deliver satisfactory performance in more complex application areas.

V. IMPLEMENTATION OF SIMILAR-TASK ALGORITHM IN DATABASE

Since these are two different bases, the implementation of Similar-Task algorithms is realized in different ways [9].

A. Implementation of Similar-Task algorithm in RDBMS database

The implementation of various algorithms (mining, AI, cluster, etc.) and methods in RDBMS, in this case MS SQL database, is performed using SQL procedures. Two procedures are required to implement Similar-Task algorithms. Initially, a log table is required that is obtained from the main log table and consists of three columns: Case ID, Activity ID, and Person. The values for this table are imported from the main log table. An example of such a table is given in Table 1. The first SQL procedure in RDBMS creates a Person-Activity Matrix table (Table 2.) based on Table 1. The event log, which is a matrix. The procedure then fills this matrix with data representing the number of activities for each person. Another SQL procedure in RDBMS creates a Result Matrix table (Table 3.), which is obtained from the Person-Activity Matrix, where columns and rows are filled with people.

TABLE 1. EVENT LOG

Case ID	Activity ID	Person
Case 1	activity A	Marko
Case 2	activity A	Marko
Case 3	activity A	Danica
Case 3	activity B	Darko
Case 1	activity B	Zoran
Case 1	activity C	Marko
Case 2	activity C	Zoran
Case 4	activity A	Danica
Case 2	activity B	Marko
Case 2	activity D	Goran
Case 5	activity A	Danica
Case 4	activity C	Darko
Case 1	activity D	Goran
Case 3	activity C	Danica
Case 3	activity D	Goran
Case 4	activity B	Danica
Case 5	activity B	Jovana
Case 5	activity D	Jovana
Case 4	activity D	Goran

TABLE 2. PERSON-ACTIVITY MATRIX

	activity A	activity B	activity C	activity D
Marko	2	1	1	0
Danica	3	1	1	0
Darko	0	1	1	0
Zoran	0	1	1	0
Goran	0	0	0	4
Jovana	0	1	0	1

TABLE 3. RESULT MATRIX

	Marko	Danica	Darko	Zoran	Goran	Jovana
Marko	-	0.984	0.577	0.577	0.000	0.288
Danica	-	-	0.426	0.426	0.000	0.213
Darko	-	-	-	1.000	0.000	0.500
Zoran	-	-	-	-	0.000	0.500
Goran					-	0.707
Jovana						-

Implementing a Similar-Task algorithm using SQL in RDBMS involves using Create, Read, Update and Delete (CRUD) statements and can be represented by the following steps:

1. Create a Person-Activity Matrix and fill it with data using the First SQL procedure.
2. For each activity, calculate how many times a person has used it.

```
COUNT (IF (ACTIVITY='ACTIVITY1', 1,NULL))
COUNT (IF (ACTIVITY='ACTIVITY2', 1,NULL))
COUNT (IF (ACTIVITY='ACTIVITY3', 1,NULL))
...
```

3. This produces the final Person-Activity Matrix that is presented in Table 2.
4. Create Result Matrix using Other SQL procedure.
5. Based on Person-Activity Matrix, calculate Cosine-Similarity values for every two persons and the results are placed in Result Matrix is shown in Table 3.

B. *Implementation of Similar-Task algorithm in Graph Neo4J database*

The implementation of the Similar-Task algorithm in Graph Neo4J database is implemented in accordance with the characteristics and properties of GraphDB and can be represented by the following steps:

Create nodes and relationships in the Person-Activity form. Only create unique Persons and Activities and the relationships between them. In addition, directly calculate and enter activity information of each person. Connecting each Person to the Activity is done using relationship [: PERFORMS]. Relationship [: PERFORMS] represents the number of Activity repeated by Person. The implementation of this step in the Neo4J database gives the form shown in Fig. 3.

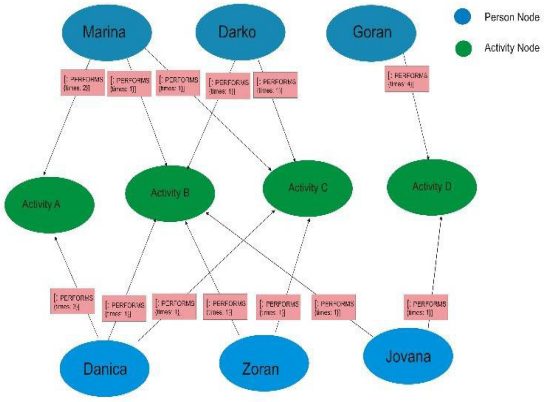

Figure 3: Person-Activity form in Neo4J database

1. Calculation of Cosine-Similarity:
   a. Find all Activities that are in the intersection between each Persons pair.
   b. Calculate Cosine-Similarity using values from [: PERFORMS] for all Persons pairs found in 2. (a.).
   c. The resulting Cosine-Similarity values in 2. (b.) Are stored in in the relationship [: SIMILARITY] between the nodes of the graph (Persons).

The implementation of this step in the Neo4J database gives the form shown in Fig. 4.

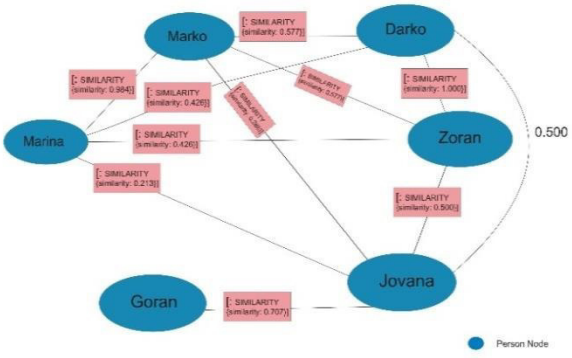

Figure 4: Neo4J database with similarity values

VI. CONCLUSION

This paper outlines relational databases who are the dominant form of data storage today. They are based on a relational model where the structure of the model is very simple and represents a set of tables. In addition, a formal-mathematical interpretation of the tables is possible. SQL is used as a standard relational query language to work with relational databases.

NoSQL databases are not based on, or at least do not adhere to, a relational model. In addition, these databases are easily distributed, scalable

horizontally, and the value structure is usually not strictly predefined. Database graphs are of the NoSQL type where the data is stored in the graph structure. Database graphs are based on a mathematical model, so they are much easier to compare with relational databases than other types of databases.

In presented solution, outlined in Chapter V, we have achieved goal and proposed a solution that seems to be the most optimal from the standpoint of ease of use. MS SQL Relational Database Films were realized, and for the Graph Database Films the Neo4J platform. Similar-Task algorithms have been implemented in both databases that allow for a measurable comparison of the activities performed on both databases. One of the main results of research of this paper is deployment in practice of Similar-Task algorithms as a metric based on joint activities and algorithm under Organizational Mining.

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Overview of Simulation Tools for Fog, Edge and Clouding Computing

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Abstract – In the last decades we are witnessing the rapid technology development and a growing number of complex ICT systems. The complexity of these systems shapes the need for educating students and engineers to plan, design, implement, and maintain these complex systems. This research can be helpful in finding the most applicable simulation tool for using it in the process of education at university courses. This paper has presented research results in analyzing representative tools for the simulation of cloud, fog, and edge systems which can be used in university curricula as a part of lab exercises, student projects, and bachelor and master thesis.

I. INTRODUCTION

The term information and communication technologies refer to technologies that provide access to information through telecommunications. It is like information technology, but primarily focuses on communication and data transfer. This includes the Internet, wireless networks, mobile phones and other communication media [1].

The term information technology describes hardware and software that enables the processing and display of information electronically, while the term communication technology describes telecommunication equipment that can be used to receive, send, search and access information [2].

Cloud computing is a term commonly used to describe data centers accessible to many users via the Internet. Large clouds, which are dominant today, often have functions distributed across multiple locations with central servers. If the connection to the user is relatively close, it may be labeled an edge server. Clouds can be limited to a single organization (enterprise clouds), be available to many organizations (public clouds), or a combination of both (hybrid cloud). The largest public cloud is Amazon AWS [3].

Cloud computing is anything that involves the delivery of hosted services over the Internet. Services are divided into three main categories of cloud computing: infrastructure as a service (IaaS), platform as a service (PaaS), and software as a service (SaaS). The cloud can be private or public. A public cloud sells services to anyone on the Internet. A private cloud is a proprietary network or data center that provides hosted services to a limited number of people, with specific access and permission settings. The goal of cloud computing is to provide easy, scalable access to computing resources and IT services [4]. Cloud infrastructure includes the hardware and software components needed to properly implement the cloud computing model. Cloud computing uses virtualization technologies that allow easy abstraction and provisioning of cloud services and underlying systems into logical entities that users can request and use. In addition, automation is used to provide users with a high degree of self-service provisioning, service connectivity and workload deployment without direct intervention from the cloud [4].

The history and evolution of cloud computing begins in the 1950s and 1950s. Companies used large mainframe computers, but it was expensive to buy a computer for each user. A process called time sharing was developed to make more efficient use of expensive CPU time on the mainframe. Time sharing allowed users to access numerous instances of mainframe computers simultaneously, maximizing processing power and minimizing downtime. This idea represents the first use of shared computing resources, which is the foundation of modern cloud computing [4].

In 1969, Licklider helped create the Advanced Research Projects Agency Network, the so-called forerunner of the internment. His goal was to connect computers around the world in a way that would allow users to access programs and information from any location. The introduction of the first virtual machines (VMs), it allowed users to run more than one computer system within a physical setup. The functionality of the VM led to the concept of virtualization, which had a major impact on the progress of cloud computing. In the 1970s and 1980s, Microsoft, Apple, and IBM developed technologies that improved the use of cloud servers and server hosting. In 1999, Salesforce became the first company to deliver business applications from the web. In 2006, Amazon launched AWS, providing services such as cloud computing and storage. Other major tech

players, including Microsoft and Google, later launched their own cloud offerings to compete with AWS [4].

Today, it is highly likely that organizations will migrate critical workloads to public clouds. One reason for this change is that business leaders who want to ensure that their companies can compete in the new world of digital transformation demand the public cloud. Many businesses have focused on new cloud-native applications. S Lambda, Google Cloud Functions, and Azure Functions are examples of serverless computing services. Public cloud computing is suitable for processing big data, which requires huge computing resources in a relatively short time. Providers have responded with big data services, including Google BigQuery for large-scale storage and Microsoft Azure Data Lake Analytics for processing huge data sets. Another type of new cloud technology and services is related to AI and machine learning. Amazon Machine Learning, Amazon Lek, Amazon Polli, Google Cloud Machine Learning Engine, and Google Cloud Speech API are examples of these services [4].

II. CLOUD, EDGE, FOG AND MIST COMPUTING

A. *Cloud computing*

Cloud computing can be based on a sensor network and is used to manage sensor data. Transmitting and processing huge amounts of data through cloud computing causes several problems such as service response time delays. The field of application of such sensor networks is expanding and the need for processing and transmitting information and for managing IoT devices in real-time is also increasing [5].

Cloud computing has a major impact on IoT performance and development. It is able to improve the capabilities of the device by transferring the workload to external computing platforms distributed along the network, such as cloud servers, cloudlets or other edge platforms [6].

Cloud computing has an imperative to support the demands of millions of IoT devices and provide a variety of new and exciting IoT applications for end users. Machine-to-Machine (M2M) communications, or Machine Type Communications (MTC), enable direct communication between IoT devices. A standard M2M platform (service layer), called oneM2M, has been established and developed to standardize the deployment of IoT services [7].

Cloud computing consists of several key components, each of which consists of multiple servers that perform different tasks. Servers are set up as virtual machines (VMs) using virtualization technology. They are independent of each other even if they run on the same physical machine. Using VMs, load balancing or reverse proxy servers, databases and application servers can be configured.

B. *Edge computing*

Edge computing is more suitable than others for implementation in transport environments. In edge computing, data processing, and analysis take place near the end devices. Edge acts as an intermediary between the cloud and the device that collects or generates data. Servers that have computing and storage capabilities (edge nodes) are deployed close to the user (at the edge of the network). This approach provides in some cases better quality of services through edge computing. A powerful communication and computing engine are needed to support modern edge applications, especially in certain fields such as automotive networks and smart vehicles. Sensors present in vehicles collect data and this data is further processed and stored by edge servers. These services ensure low-latency communication and greater context awareness [8].

Edge computing has its advantages in context awareness applications with low latency, for example, they can provide security applications, e.g., driving safety), as well as applications that do not require it (video streaming, AR). Software-defined networking provides comprehensive network control and follows edge computing and complements the intelligent transportation system to cope with the complexity of the heterogeneous and massive number of vehicles, huge data flow, and frequent topology changes to provide immediate vehicle mobility to increase driving safety [8].

Edge computing is a concept that is the opposite of cloud computing. Cloud computing is a way of direct communication with the data center, while edge computing communicates primarily with the so-called "edge data center" located near the device, leaving the secondary work to the central cloud. In other words, edge computing is a concept of computer topology [5].

C. *Fog computing*

Fog computing manages data and computation between the edge of the network and the cloud and provides new types of applications and services, with low latency, high bandwidth, and geographic

spread. Fog computing serves to deliver IoT data efficiently and reliably to appropriate IoT applications while ensuring time sensitivity. Fog computing provides efficient power management in IoT device communication between sensors and secure data management that is decrypted based on user attributes [5]. A new type of computing that is emerging as a solution is fog, as the amount of data generated by sensors increases and the data processing routine becomes more and more complicated. Fog introduces a data management model by performing communication and data processing near the sensors, thus offloading

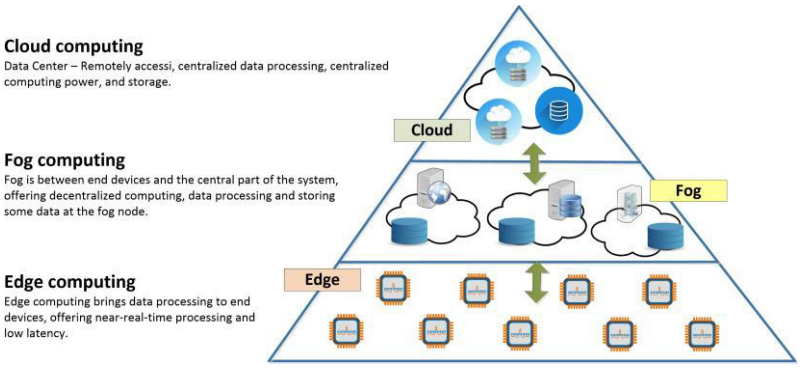

Figure 1. Internet of Things (IoT) architecture [14]

the network core. Since the devices in fog computing use near-field communication and processing, their response speed is faster than cloud computing, and the number of sensors assigned to the device is smaller than in cloud computing. More and more concurrent tasks with faster processing are possible compared to cloud computing. The fog computing functions that have been developed so far consist of data generation, processing, and transmission. In other words, the server in the cloud or the proxy server allocates functions according to the type of data, and the creation of data on the sensor. Then the server creates rules based on the analysis of the sample and after that, it is decided how to store or process the data. The data processed through this process is provided to the data owner or user in a customized service. In such systems, service user data is stored in plain text and transferred to a monitoring server for future access and use. Sharing and using data are inevitable functions. The data generated on the sensor can be sensitive information for an individual user, thus, a delegation function to grant data access rights to a legitimate user and a revocation function to remove data access rights from a user [5].

D. Mist computing

Mist computing implies that the place of responsibility for control is transferred to the gateways while the control of data transfer is decentralized to the end nodes which reduces the communication delay of the network, thereby increasing the throughput. Mist computing helps build large IoT systems. The network must provide information, not just data. The network should provide only the information requested and only when requested. In this architecture, devices must be situationally aware and must adapt to information needs and network configuration. There should not be static binding rules for devices and data collectors, but devices must dynamically discover data providers [9].

Cloud and fog computing are aware of user needs and global situations, while mist computing is aware of the physical environment and local situation, so all these architectures have specific responsibilities and ability to enable the execution of IoT applications. In edge computing, data processing takes place at the edge of the network, and the functionality and configuration of the application are fixed. While in mist computing, there are functionalities and schedules that are dynamic and adaptive, there are high-level applications with specific rules that are specific to a particular application, and new applications can be downloaded from existing devices at runtime [9].

III. OVERVIEW OF CLOUD, FOG AND EDGE COMPUTING SIMULATION TOOLS

As IoT systems have a very complex architecture, tools for simulating their operation can be very useful. The simulation tools can help in understanding and planning such systems and can be useful for usage in higher education for teaching too. In this section, tools for simulating IoT in the cloud, fog, and edge environments and their basic features will be presented.

A. *Cloud simulation tools*

Cloud computing is a leading approach for providing reliable, secure, fault-tolerant, sustainable, and scalable computing services. Hence, timely, repeatable, and controlled methodologies for evaluating the performance of new cloud applications and policies are important before proceeding with their development. Since performing experiments in real systems is quite limited, it is necessary to use simulation tools. CloudSim's goal is to provide a generalized and extensible simulation framework that enables the modeling, simulation, and experimentation of new cloud computing and application services, allowing its users to focus on the specific system design questions they want to explore without worrying about low-level details. cloud-based architecture and services [11].

CloudSimSDN simulates host and network usage and request response times in SDN (Software Defined Network) enabled cloud data centers. CloudSimSDN is a plugin for CloudSim. CloudSim supports the calculation of host and switch-side power consumption. For example, guidelines for deploying a network-aware virtual machine can be evaluated using CloudSimSDN. For example, data center cloud energy savings enable SDN through virtual machine (VM) consolidation. If VMs are consolidated to the smallest number of hosts, unused hosts and switches can be powered down to save more energy [10].

CloudSimPy is based on a pod-oriented event simulation framework. It is based on SimPy and implemented in Python. Scientific computing, deep learning, and the economy of machine learning with the use of the Python language are more complete than other programming languages. CloudSimPy can be combined with deep learning frameworks with Python support (such as TensorFlow, PyTorch). A good combination is useful for studying resource management methods based on machine and deep learning [11].

B. *Fog simulation tools*

EmuFog helps in more efficient testing of fog architecture applications. Instead of deploying large network topologies with a test application, EmuFog helps in generating networks that can be easily emulated using MaxiNet, a distributed version of Mininet. It gives more realistic results than simulations and is cheaper and faster than actually developing applications. As input EmuFog supports generated topologies from BRITE or measured real topologies of Caida tool. In those networks, EmuFog effectively deploys fog architecture nodes based on user constraints such as network latency thresholds or resource limitations. Fog client and node applications can be delivered in a Docker container [11].

EmuFog is built using Kotlin 1.4 on JDK 11. It uses Gradle to include dependencies and build binaries from source code. The repository contains a Gradle wrapper file for Linux, macOS, and Windows [11].

The Fogbed emulator allows the user to use Docker containers as hosts and create virtual instances where resources may be limited or over-allocated. Two emulation modes are available: local or distributed, allowing construction from simple patterns to large, multi-node ones. All integrations were performed by extending the functionalities of Containernet and Makinet [11].

Fogbed is a framework that extends the Mininet emulator to create fog patterns in virtualized environments. Using a desktop approach, Fogbed enables the deployment of virtual fog nodes as Docker containers under various network configurations. The Fogbed API provides functionality to dynamically add, connect, and remove containers caused with network topology. These features enable the emulation of real-world cloud and fog infrastructures where compute instances can be started and stopped at any time. It is also possible to change resource limits for the runtime container, such as CPU time and available memory. A Fogbed emulation environment can be created by placing virtual nodes, virtual switches, virtual links, and virtual instances in a virtual network environment running on a host computer. Flexible setup is achieved using pre-configured Docker container images. Each container image contains part of the distributed application, the required services, and protocols. Different types of container images can be used to instantiate virtual nodes. Using Fogbed requires Ubuntu 16.04 LTS or later, and to create a Python-based network topology [11].

FogNetSim++ extends OMNeT++, a framework for building network simulators, to model all the necessary aspects. It includes popular communication protocols for simulation, such as TCP, UDP, MQTT and CoAP. In addition, FogNetSim++ models several other aspects, such as energy consumption, prices, mobility, and handover mechanisms. OMNeT++ is an extensible, modular, and component-based C++ simulation library and framework, primarily for building network simulators. The INET framework is an open-source model library for the OMNeT++ simulation environment [11].

FogTorchPI is an open-source prototype developed in Java, based on the fog architecture and application model. It takes into account the non-functional parameters in the model (i.e. hardware, software, latency and throughput) to analyze the application data in fog computing. In the case of hardware capabilities, it takes into account the CPU cores, RAM, and storage available in a given node or required by a given software component. Software capabilities are represented by a list of software (operating systems, programming languages, frameworks, etc.). It takes into account latency and bandwidth for downloading and uploading QoS (Quality of Service) attributes. Latency is measured in milliseconds, while bandwidth is given in megabits per second. The outputs of FogTorchPI can be input to iFogSim [19].

iFog is based on fog computing, which presents it as an infrastructure that has similar characteristics to cloud computing but is positioned close to the edge network. Application deployment is north-south, and it is not possible to transfer modules to other devices at the same hierarchy level. Therefore, scenarios such as smartphone-to-smartphone offloading cannot be implemented with the current version of the simulator. In addition, direct communication between two devices at the hierarchy level is also not possible in the current version due to the hierarchical organization. To implement the functionality of the iFogSim architecture, the basic event simulation functionality from CloudSim is used. Entities in CloudSim, such as a data center, communicate with each other through forwarding operations (sending events). The core CloudSim layer is responsible for handling events between fog computing components in iFogSim. The implementation of iFogSim consists of simulated entities and services [12].

C. Edge simulation tools

EdgeCloudSim provides a simulation environment specific to edge computing scenarios where it is possible to run experiments that take into account both computational and network resources. EdgeCloudSim is based on CloudSim but adds significant functionality so that it can be effectively used for edge computing scenarios. EdgeCloudSim is an open-source tool. EdgeCloudSim has a modular architecture that provides support for a number of key features such as WLAN and WAN specific network modeling, device mobility model, realistic and adaptive load generator. The current version of EdgeCloudSim (Figure 2) has five main modules available: Core Simulation, Networking, Load Generator, Mobility, and Edge Orchestrator. To facilitate prototyping, each module contains a default implementation that can be easily extended [21].

The Mobility module manages the location of edge devices and clients. CloudSim focuses on the conventional principles of cloud computing. The Load generator module is responsible for generating tasks for a given configuration. By default, tasks are generated according to a Poisson schedule via an active/inactive task generation pattern. The Networking module separately handles the transmission delay in WLAN and WAN taking into account both the upload and download of data. The default implementation of the networking module is based on a single server model. EdgeCloudSim users can embed their own network behavior models by extending the NetworkModel abstract class. The Edge Orchestrator module makes system decisions. It uses information gathered from other modules to decide how and where to handle incoming client requests. The core simulation module is responsible for loading and running edge computing scenarios from configuration files. Additionally, it offers a logging mechanism to save simulation results to files. Results are saved in Comma Separated Data (CSV) format by default but can be changed to any format. EdgeCloudSim uses a factory pattern that makes it easy to integrate the new models mentioned above. EdgeCloudSim requires a factory class scenario that knows the logic of creating abstract modules. EdgeCloudSim can be used on Linux systems, including macOS, using the Java programming language and development environments such as Eclipse, NetBeans, etc. [11].

EdgeSim is an open-source edge architecture and caching simulator. JDK10 must be installed, if the professional version of the score plot is required to be used directly via the emulator, and the Python environment must be pre-installed and the matplotlib and Numpy libraries must be downloaded [11].

IoTSim captures the behavior of heterogeneous IoT and edge computing and allows users to test their infrastructure and framework in an easy and configurable way. IoTSim-Edge extends the ability of CloudSim to include various features of edge and IoT devices [11].

The architecture of the simulator consists of several layers. IoTSim-Edge is built on top of the CloudSim simulation tool. CloudSim provides the basic mechanisms for handling communication between components (eg Broker, edge data center, IoT resources) using an event management system. The core components of CloudSim are extended to

represent the edge infrastructure according to its characteristics. The IoT resource layer contains different types of IoT devices (e.g., car sensor, motion sensor) and each of them has its own properties and behavior along with performing different operations, different sensitivity, and triggering modes [13].

Sensors in an IoT device seamlessly generate data while actuators are responsible for generating responses. Traditionally, cloud resources are used to process IoT data. In the Edge-IoT approach, sensor data is processed at the edge data center for faster

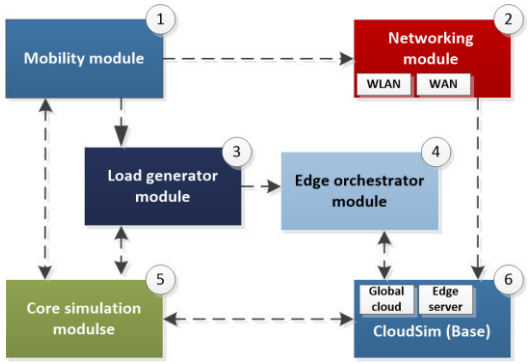

Figure 2. The connection between EdgeCloudSim modules

processing time. Edge data center consists of heterogeneous processing devices, such as smartphones, laptops, Raspberry Pi, etc. The Edge-IoT control layer coordinates the processing by receiving the user request from the user layer and processes the requests using the Edge-IoT resources. The resource broker facilitates the deployment process. A user can provide input to users via a graphical user interface (GUI) by mentioning various device configurations and policies. The Edge-IoT management layer consists of several components such as Edgelet, Policy, Mobility, Battery, Synchronism, QoS, Network Protocols, Communication Protocols, Transport Protocols, and Security Protocols [13]

IV. CONCLUSION

This paper has presented research about representative tools for the simulation of cloud, fog, and edge systems. This research can be helpful in finding the most applicable simulation tool for using it in the process of education at university courses. This is an important question, considering the importance of cloud, fog, and edge system architecture and its complexity.

In this paper, a brief explanation of cloud, fog, and edge architecture approaches, especially in complex IoT systems is given. After the architecture description, the differences in different approaches are explained. The descriptions of selected simulation tools for all three architectures are given at the end.

Again, this research can be an initial but very important step in the process of implementing simulation tools for aforementioned architectures in the university curricula as a part of lab exercises or student projects, bachelor and master thesis tools.

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