



**UNIVERSITY OF NOVI SAD
TECHNICAL FACULTY
"MIHAJLO PUPIN"
ZRENJANIN**



ITROCONFERENCE¹¹
INFORMATION TECHNOLOGY AND EDUCATION DEVELOPMENT



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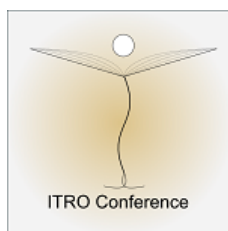
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DEVELOPMENT OF EDUCATION**
ITRO 2020
PROCEEDINGS OF PAPERS



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For publisher:

**Dragica Radosav, Ph. D, Professor,
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Editor in Cheaf - President of OC ITRO 2020:

Dragana Glušac, Ph. D, Assistant Professor

Proceedings editor:

Marjana Pardanjac, Ph. D, Professor

Technical design:

Dusanka Milanov MSc, Assistant

Maja Gaborov MSc, Assistant

Marko Blažić BSc, Assistant

Nemanja Tasić BSc, Assistant

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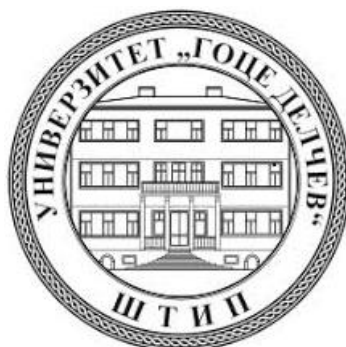


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With this publication, the CD with all papers from the International Conference on Information Technology and Development of Education, ITRO 2020 is also published.

INTRODUCTION

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

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

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

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

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

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

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

Chairman of the Organizing Committee
Ph.D Dragana Glušac

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Teaching and Learning Mathematics during COVID period

L. K. Lazarova*, M. Miteva* and T. Zenku**

* University “Goce Delcev”/Faculty of computer sciences, Stip, Macedonia

** University “Mother Teresa”, Skopje, Macedonia

limonka.lazarova@ugd.edu.mk, marija.miteva@ugd.edu.mk, teuta.zenku@unt.edu.mk

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

I. INTRODUCTION

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

Usually mathematics is perceived as difficult subject for the students in schools and faculties, [2]. Most of the students learn mathematics only when they are obligated to study. The first chance when they can omit mathematics, they do that. This is acceptable for those who see mathematics as only subject or exam which have to be passed. But this problem is very sensitive for the society. Mathematics is a gate for many technological and

scientific fields. Leaving mathematics is a beginning of appointment of barriers for the students. Without mathematics, they have limitations for studying of many important sciences, in that way they have limitations of their future jobs. Therefore, it is very important to make efforts to improve the quality of mathematics teaching. Students must be convinced that mathematics is necessary for their quality as future competitors in the labor market. Mathematics develops logical thinking, introduces us to forms in the world around us, enables us to handle with numbers, shapes and other physical structures, and the most important, mathematics teaches us to think concisely, clearly and logically.

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

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

II. TRADITIONAL METHODS OF LEARNING MATHEMATICS

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

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

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

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

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

III. CONTEMPORARY METHODS OF LEARNING MATHEMATICS

The basic idea of the modern mathematical and educational community is that in the present conditions of living, mathematics is used everywhere and that all people can successfully learn mathematics and apply it in certain situations. The modern mathematics education has set up main goals in form of standards. Standards related to the

knowledge that the student must adopt the call content standards (or mathematical concepts), and competencies that an individual must develop a process called standards (or mathematical processes), see [3]. These standards allow comparison of mathematical results on international level and create broader methodical mathematical community united in order to achieve better educational outcomes in mathematics. Unlike the traditional way of learning mathematics, in modern way of teaching mathematics the practicing of mathematical facts and procedures is not the most important, but it emphasizes the gradual building of knowledge networks of mathematical concepts and their relationships, and flexible application of different procedures, procedures for resolving problems, see [5].

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

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

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

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

IV. EDUCATION PROCESS DURING COVID PERIOD

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

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

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

According to [6], it was published at the end of March 2020 a framework to guide an education response to the COVID-19 Pandemic, as a tool to support education leaders, based on a survey

conducted between the 18th and 27th of March 2020. The survey assessed educational needs, priorities, implementation challenges and emerging responses, and was the first of a series of surveys to monitor the evolution of responses to emerging needs in the education sector. Subsequent modules will include radio and educational television resources, and a module to guide the implementation of effective education responses. Those resources will help educators collaborating across institutions and countries in the important and urgent task of supporting students' opportunity to learn during this challenging crisis shared among humankind.

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

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

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

V. TEACHING MATHEMATICS DURING COVID PERIOD

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

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

According to the U.S. National Council of Teachers of Mathematics (NCTM) and the National Council of Mathematics Supervisors (NCSM), and taking into account that students learn at different speeds, they conclude that the curriculum must be flexible so students can reach the content at varying rates. They focus on three critical areas for planning,

namely, structural considerations, teaching practices, and advocacy. They gave the instructions for all three critical aspects of the planning process, see [9], [10].

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

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

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

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

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

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

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

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

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

- IllustrativeMath.org
<https://www.illustrativemathematics.org>, this website supports Kindergarten through twelfth grade. It is organized by the Common Core State Standard math clusters and includes the 8 Standards for Mathematical Practice. The website includes high-quality tasks and analysis of answers. Teachers can assign a choice of tasks via Google Classroom using the student view.
- KhanAcademy.org
<https://www.khanacademy.org/> This website includes list of high-quality, standards-aligned lessons for kindergarten through twelfth grade. The lessons include videos, practice, and a formative assessment for math, science, reading, and more. Students are given immediate feedback and teachers are able to observe daily progress. Teachers may assign the lessons via Google Classroom or by using a class code.
- <https://illuminations.nctm.org/>. This website offers quality standards-based resources for teaching and learning mathematics, including interactive tools for students and instructional support for teachers. The lesson plans for teachers are also included in this website. There are many games and applets for the students.
- StrADDeGy, <https://app.straddegy.com/big-ideas>, this website is for the small children in the first years of the primary education. StrADDeGy is designed to move children away from a reliance on inefficient counting strategies and rote memorization to a mastery of addition and subtraction facts constructed from an understanding of the parts of numbers and their relationships.
- [Cookie](http://www.cookie.com/kids/games/viewallgames.html), <http://www.cookie.com/kids/games/viewallgames.html> – this website offers mathematical games for children from three to seven years. It also included working tables, videos and coloring pages.
- PurpleMath, <https://www.purplemath.com/> - this website is intended for the students in

primary schools who face up with problems and difficulties with mathematics.

- Free Math, <https://freemathapp.org/> - this application allows to the students to have access to the problem which is solved in a few steps.
- AAA Math, <http://www.aaamath.com/> - this website offers many interactive mathematical lessons in arithmetic.
- All In One High School, <https://allinonehighschool.com/> - this is a free source for the students. All the material is distributed by themes. It includes videos, quizzes and activities for every day.
- Math Modeling, <https://m3challenge.siam.org/resources> - this website includes many mathematical real-life problems, which can be solved by using of mathematical modeling. There are mathematical handbooks, instructive videos and guidelines for mathematical modeling.

VI. CONCLUSION

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

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