

# Analysis of Using Information and Communication Technologies in Mathematics Courses in the Republic of Macedonia

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**Abstract**– The current advances in global economy require worldwide unceasing changes in the education. In the past fifteen years, the education in the Republic of Macedonia was also subject to reforms in order to initiate development of the skills for digital literacy, inventive thinking, effective communication and high productivity. This paper presents the results obtained from research about using information and communication technologies (ICTs) in the classroom of the teachers’ point of view. This research aims to explore how the mathematics teachers in the Prilep region respond to these fast changes, what are the advantages and disadvantages of the education reforms, as well as to detect the major problems they faced during the reform implementations and what can be done in order to overcome these obstacles. For that purpose, we proposed a new educational portal.

**Keywords**– *e-learning, information and communication technologies, learning management systems, ICT in mathematics education.*

## I. INTRODUCTION

Nowadays, tremendous technological changes and globalization lead to development of a new global economy followed by the unceasing lifelong learning. Thereby, the education cannot be indifferent for those changes which lead to a transition from industrialization-based society to information-based society. Every participant in the global society beside the basic reading and writing skills has to develop skills for lifelong learning: skills for digital literacy, inventive thinking, effective communication and high productivity skills [1].

Therefore, under the influence of the globalization and the rapid technological development, the global educational process in the past years is subject to continuous changes. In general, these educational reforms have a tendency to employ the technology in the teaching and learning processes. Teachers had started to prepare their teaching materials in electronic form, while pupils and students had started to do their homework and projects in the same form. These changes led to the student’s achievements and examination to be monitored by

using ICT, printed books are replacing with electronic books, traditional boards are replacing with smart boards etc.

ICTs in a very short period of time became important part of the contemporary society, because in many countries their usage is considered as basic knowledge and skills, like reading and writing. For properly use of the term ICT, it has to be noted that the term isn’t only used for computers and computer activities, but it has more general meaning: Internet services, information and communication equipment and services, computer networks, mass media and broadcasting, libraries and documentation centers [2] [3].

Numerous studies about using ICT in the education are conducted and almost all of them have shown the gain of their application. The use of ICT in the education has potential to speed up the learning and teaching processes, to give an opportunity for wider and deeper knowledge, to motivate pupils and students for active learning process, to help them for easier memorizing and understanding lectures and to encourage their ambitions for self-study and self-research [2][1].

Based on the research carried out in 2002 in the Republic of Macedonia, regarding the state of the education, it was concluded that the education in Macedonia wasn’t following the development of the new global economy engendered by the rapid technology development and globalization. Therefore, Macedonian Ministry of Education and Science authorities had decided that the education needs to be reformed in order to promote the development of the skills needed in the 21st century. Starting from 2005, in the next ten years the education in Macedonia, according to several programs that were approved, was subjected to respective changes that are detailed in the next section.

The goal of this paper is to explore how teachers react to those changes after implementation of the educational reforms. The targets of this research were teachers that teach Mathematics in the primary schools. The research intends to identify the advantages of the use of ICT in the Mathematics education, to identify the problems that Mathematics teachers

encountered during implementation of ICT in education, and to offer appropriate solutions for some of the noticed problems.

The rest of the paper is organized as follows. In second Section, the conditions of the education in Macedonia is detailed, during the implementation of the educational reforms since 2005, while Section 3 details the methodology of the research. Section 4 gives the results gained from the research followed with brief discussion. Next section provides a proposal to overcome some of the identified problems that faced during the implementation of ICT in the classes, while the final section provides concluding remarks.

## II. THE STATE OF THE EDUCATION IN MACEDONIA

In order to fulfil the reform in the primary and secondary education, in 2005 several programs, such as “*National Program for Educational Development (2005-2015)*”, “*Draft Program for Development of ICT in Education (2005-2015)*”, “*National Strategy for Development of Informational society (2005 - 2015)*”, “*National Strategy for e-content (2010-2015)*” and “*National short-range ICT Strategy (2016-2017)*” were introduced [4][3] [5] [6] [7]. The reform for digitalization and computerization of the education started in 2005, but its impact started to be perceived in the schools two years later with the realization of the project “*Computer for every child*”. With this project in every classroom of the 366 primary schools and 93 secondary schools 17.818 personal computers, 98.710 LCD monitors, keyboards and mice, 53.00 portable computers for the students in the first, second and third grade, and 22.000 portable computers for the teachers were installed. With the installed computer equipment two thirds of the students in Macedonia had a possibility to access to computer and educational applications during their time spend at school. The installed computer equipment works under the Edubuntu platform, which includes additional 46 educational applications intended for particular application of ICT in the following subjects: Computer Science, Mathematics, Physics, Chemistry, Music and Latin language.

For successful implementation of the educational reforms, several trainings and workshops about using installed hardware and software, aimed to teachers, were organized by the Ministry of Education and Science and the Ministry of Information Society and Administration. The trainings and workshops started in 2009 and were intended to introduce the teachers with the installed computer equipment, operating system Edubuntu, software packages OpenOffice and another 46 additional educational software applications.

In 2010, an educational portal containing 513 learning objects was created, whose learning objects were composed of simulations, multimedia contents and notes. This portal was intended to assist in the learning process for the following subjects: Mathematics, Biology, Chemistry and Physics.

As a final phase of the reform for development of ICT in education, a web-portal as a Learning Management System was created. This web-portal was intended to make available the online learning, connections among all students/pupils and all teachers involved in the educational process, as well as to control and monitor the student’s achievements, sharing of learning materials, etc. But, although the implementation of

this reform in the education is finished, this Learning Management System was not yet fulfilled completely.

The Bureau for education development has changed the educational programs by introducing new subjects in order to support ICT literacy and ICT skills, such as: “Working with Computers” (facultative subject in first, second and third grade), “Computer Science” (mandatory subject in sixth and seventh grade) and “Projects from Computer Science” (facultative subject in seventh, eighth or ninth grade). Also the Bureau for education development has made annexes of the existing syllabuses regarding the methodical directions (recommendation and praxes) for all subjects, in order to make the use of ICT obligatory process in the formal education in Macedonia. According to those directions at least 30% of the classes that are held for one subject yearly, have to be implemented using ICT tools. It means that for the subject Mathematics in primary school, which is represented with four hours weekly or annual fund of 144 hours, teachers have to implement ICT at least in 44 hours or once in every school week. The teachers have completely freedom in the selection for the ICT tools that have to use in their classes.

In the meanwhile, the subject Mathematics in 2013 was subjected to another reform called “Cambridge Educational System”. Then the Ministry of Education and Science signed an agreement with the Center for International Education of Cambridge to implement its programs and to use its books. The Center for International Education of Cambridge is the largest provider of international educational programs and qualifications for students from 5 to 19 years that are accepted in 9000 schools in 160 countries. This reform in the primary school was achieved in three time stages or in three successive school years. The “Cambridge Educational System” was implemented in three successive grades. The new reform had an intention to develop the critical thinking among students.

According to the described state all teachers in Macedonia in a very short period of time had faced many changes in education. In order to investigate how they handle with the numerous changes, particularly with the implementation of the ICT in their classes, in 2015, a study that is described in the next section was carried out.

## III. METHODOLOGY

The observed target group was the Mathematics teachers from the primary schools in the Prilep region. Thirty Mathematics teachers were questioned, which is 80% from all Mathematics teachers that realized classes in the Prilep region.

As an instrument for data collecting a questionnaire, which contained 36 questions in open and closed form, was used. The questions were organized in four categories: (1) basic data for the target group, (2) implementation of ICT in education, (3) usage of ICT tools and (4) problems in implementation of ICT in education.

The first category had three questions needed to make teachers’ profiles. The second category contained eleven questions in order to gain the data for implementation of the ICT in education, like the level of implementation of the ICT in their classes, advantages of implementation of ICT, the time

needed to prepare the lessons, the usage of existing ICT tools in their classes etc.

The third category was consisted of eleven questions in order to gain data about ICT tools used in the Mathematics classes. The fourth category of the questionnaire was also composed of eleven questions, asked in order to identify the problems, which teachers encountered during the implementation of ICT in their Mathematics classes.

#### IV. RESULTS AND DISCUSSION

According to the data collected from the first category of the questionnaire, 10% of the target group belong to the first age group (from 20 to 30 years), 43% of the target group belong to the second age group (from 30 to 40 years), 27% of the target group belong to the third age group (from 40 to 50 years), while 20% of the teachers were aged between 50 and 60 years.

20% of the target group were male teachers, while 80% of the target group are female teachers. This gender imbalance isn't surprising because in Macedonia most teachers are female. 37% of the target group realized classes in the rural areas, whereas 63% in the urban area of Prilep.

The second category of the questionnaire aimed to collect general data about the implementation of ICT in the Mathematics classes. The results for some similar questions are presented in one bullet, as follows:

- 17% from the Mathematics teachers implement ICT almost every day, 53% from the Mathematics teachers implement ICT once or twice per week, while 30% of Mathematics teachers implement ICT once or twice monthly. Hence, generally, 70% from the participants of the target group follow the instructions from the Bureau for education development, and at least once per week implement ICT tool in their classes. Furthermore, analysis related to the teachers' age groups has shown that most participants who do not follow the instructions from the Bureau for education development belongs to the first age group (from 20 to 30 years) and to the fourth aging group (between 50 and 60 years). As a main reason for this results it can be considered the lack of working experience among younger teachers, as well as the refusal of work with computer among older teachers.
- From the implementation of ICT in their classes, they noticed several advantages like better student's motivation, interest and activity during classes, almost all students do their tasks quickly, improve exploratory and creativity skills, gain easy access to data needed for the classes etc.
- The time needed for preparing the activities and materials for Mathematics classes with implementation of ICT is three times bigger than the time for preparing the activities and materials for Mathematics classes in the standard manner. The average time for preparation activities and materials for Mathematics classes by implementing ICT in the class with just one ICT tool is

110 minutes, while in the case of combining of more ICT tools in one class is 142 minutes.

- 70% of the participants declared that the class duration (40 minutes) isn't sufficient to realize the whole prepared activities when the teacher implements ICT in the Mathematics class. The main reasons about this are the technical troubleshoots occurred on the installed computer equipment during the class.
- 40% of the participants answered that they deal individually with the technical problems of the installed computer equipment, 13% of them get help from the Computer Science colleagues, 23% of them get help from the computer equipment maintainers, 10% of the them get help from the students, 7% of them get help from the students' teams for computer equipment maintain, while 7% of them answer that nobody deals with the technical problems of computer equipment. From their responses, it can be seen that teachers have to deal with the technical problems of the computer equipment individually or to get help from students and the Computer Science colleagues, because the computer equipment maintainers at the same time work in 4 or 5 different schools and usually they should be present in one school in one particular day in the week. In the last two years this time of their presence was reduced to once or twice per month.
- 63% of the teachers implement ICT only within the Mathematics classes. 37% of the teachers implement ICT during the Mathematics classes and as well as for preparing homework and projects. The big percentage difference is because there are few electronic, public and free educational contents that entirely match to the Mathematics curriculum and student's tasks.
- 13% of the teachers rarely use ICT tools, 47% of them sometimes use ICT tools, 27% use ICT tools often, while 13% of the teachers always use ICT tools that are prepared by somebody else. This fact is not surprising if the time needed to prepare a lesson with implementation of ICT tools has been taken into account.
- According to the responses given by the participants, more than 80% of the electronic contents prepared by somebody else can be entirely or with few changes used to their classes. The problem is the way they obtain those ICT tools, because most of the teachers get them from other colleagues. Also, more than 70% of the teachers answered that electronic contents, which can be used as ICT tools, are free and publicly available on Internet, are not in Macedonian language.
- The final question from the second group is an open question where the Mathematics teacher has to write some examples of lessons where ICT is implemented and from that responses can be seen that the teachers more often implement ICT in Geometry classes, than in the Algebra classes.

The results from the third category of the questionnaire aimed to collect the data from the Mathematics teachers about the ICT usage in the classes and in their everyday lives. In the questionnaire, there were listed 10 types of different programs and the participants had to answer how often they use the particular type of program in the classroom and in their everyday usage. The results are shown in Fig. 1.

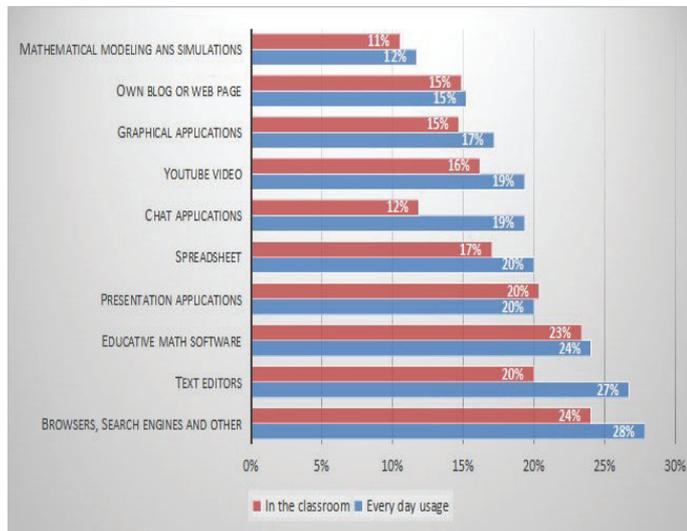


Fig. 1. Usage of different applications in and outside the classroom during the implementation of ICT.

From the results presented in Fig. 1, it can be noticed that the teachers in their everyday usage mostly use the browsers, search engines and other Internet activities. Thus, the everyday usage of the computer is unthinkable without Internet connection, because teachers almost every day use the ICT tools that allow them opportunity to search data, use the social networks etc. The text editors are the second mostly used applications by the teachers in Macedonia in the past ten years have enormous additional administrative work. In the third place are the educative Mathematics applications used by the Mathematics teachers outside the classroom, in order to prepare themselves for the classes.

Browsers, search engines and other Internet activities are also common used ICT tool in the classroom. The second mostly used ICT tool in the classroom are the educative Mathematics applications, while the third mostly used ICT tool are the applications for presentation.

The fourth and last category of the questionnaire aimed to collect general data in order to identify the problems occurred during implementation of ICT in the Mathematics classes. Fig.2 presents the results from the last category of the questionnaire followed by a brief discussion.

One of the main problems, identified by the teachers, is the hardware fault handling. The computer equipment was installed in 2007, and now after more than one-decade intensive usage, the computer equipment is malfunctioning. Most schools do not have a technical person for computer equipment maintain as an employee with full time job, and that

why the teachers are left individually to handle above described problems.

As the second important problem, the teachers identified the shortage of time for creative work and efficient application of ICT in the classes, because of overloading with enormous administrative work in the past ten years.

The third important problem identified by the teachers is that the students do not have access to the installed technology from their homes. This problem covers the problems with the economic status of the students and with the lack of a common educational management system that can provide online learning, at least. Although the “National program for development of education” has predicted design and implementation of Learning Management System, which has to provide online learning, connection between the students and teachers, connection between all teachers in the country, following the students’ achievements and sharing of learning materials, this system was not yet created. Thus, although the “National program for development of informational society” aimed to provide access to computer equipment by Internet connection for everyone, there are still many students (mostly students from low-income families) that don not have a suitable access to ICTs.

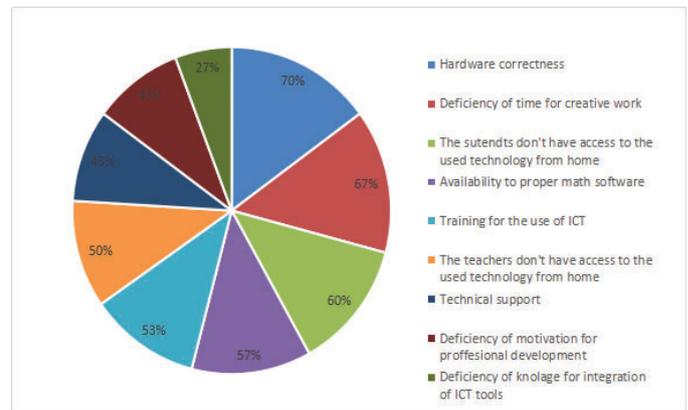


Fig. 2. Arisen problems during the implementation of ICT in education.

## V. EDUCATIONAL PORTAL

As a proposal to overcome the most problems occurred during the implementation of ICT in classes, an educational portal was created. This educational portal aims to provide the necessary electronic teaching and learning materials, to propose an innovative manner for realization of teaching and learning process with different ICT tools, also to provide a place for exchanging teaching and learning materials and to enable a collaboration between students and teachers. In other words, the aim of this educational portal is to grow up and to serve as Learning Management System for primary schools in Macedonia.

The first version of the educational portal presents a frame of electronic contents for teaching and learning Mathematics, Biology, Physics, Chemistry and other subjects in primary school as shown in Fig. 3. All the electronic contents presented in this educational portal implement different ICT

tools in order to initiate development of the skills needed in the 21st century.



Fig. 3. The home page of the educational portal.

## VI. CONCLUSION

From the presented results, it can be concluded that Mathematics teachers from the Prilep region municipalities, generally follow the suggestions from the Bureau for education development and at least once per week implement ICT in their classes. In those classes they mostly implement the applications that allow them to browse or search information through the Internet, educative Mathematics software and applications for presentation. During implementation of ICT in the Mathematics classes, teachers had identified the hardware problems, the shortage of time for creative work and the problem related with the lack of access to the used technology from the students' home as three major problems. Hence it can be concluded that malfunctioning computer equipment, technical computer equipment maintainers with full time job in

the schools, periodical training for usage of new ICT tool, pointing out more electronic contents about the use of ICT tools, as well as design of Learning Management System can improve the implementation of ICT in the classrooms. Some of the mentioned problems can be solved by using the educational portal described in the previous section.

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