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*Review article*

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## APPLICATION OF COMPUTERS IN INITIAL TEACHING OF MATHEMATICS

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### *S u m m a r y*

Modern teaching of mathematics follows the development of technology, and tends to introduce new teaching materials into teaching of mathematics in order to bring it closer to pupils. The use of computers is no doubt an innovation in learning and is creatively used in the context of learning in different ways so as to motivate pupils to improve understanding, finding out and adopting of mathematical concepts, phenomena and laws.

This paper presents the pedagogical - psychological characteristics of teaching in those organisations where computers have been introduced. Directions regarding the use of computers and multimedia presentations, educational software and distance learning for the modelling of teaching are given in this paper.

Special emphasis is put on the possibility of implementing new information technologies in educational process, with the aim of increasing the quality of teaching of mathematics.

**Key words:** *education, mathematics teaching, computer, educational software*

*"New technologies alter the structure of our interests:*

*the things we think about.*

*They alter the character of our symbols:*

*the things we think with.*

*And they alter the nature of community:*

*the arena in which thoughts develop."*

Neil Postman, *Technopoly*  
(Nadrljanski, Soleša, Nadrljanski, 2008)

## Introduction

Science and technology in the contemporary stage of social development is setting new requirements for the successful implementation of tasks in the production, social relations and everyday life. In order to meet the challenges of these requirements changes in all spheres of human life and activity, including education are necessary.

Modern society is characterized by rapid development in all spheres of human life. New technologies cannot be regarded as a separate entity in relation to the educational system. The most powerful initiator of a society is education, which therefore requires the application of innovation in order to secure higher quality work, competent teachers and pupils.

The natural tendency of society and civilization is to develop, to progress in all its fields. During the period we have been talking about education, development has moved from traditional to modern schools.

From one point of view, the class-subject-period system is economical and efficient because it allows the massification of education, but the lack of such a system is that it is appropriate for an average pupil. "In this kind of teaching conditions for realizing a child's whole potential are not fulfilled (multiple abilities of students, different forms of thinking, different approaches to problem solving); neither is it so in contemporary teaching that is understood through the construction of knowledge (which includes the child's ability to go in depth of the process following the path of researchers), rather than acquisition of knowledge" (Budić, Gajic, Lungulov, 2009, 88). As part of thinking about this phenomenon, namely this issue of creating mediocrity, differentiation first appeared and then individualization of teaching followed as a didactic innovation.

When planning the teaching process it is necessary to plan such situations in which students will independently acquire knowledge. The task of teachers is to determine the most reliable and efficient methods, types of activities, facilities, teaching resources and sources of knowledge. Learning from various sources of knowledge is particularly important for active learning, which is one of the essential characteristics of modern education.

It can be said that nowadays life in modern societies is inconceivable without the mass media (television, radio, press, books, films, CD and DVD, video tapes etc.). Application of computers in teaching gives enormous possibilities for learning according to individual needs, interests and learning pace of an individual. Learning by means of electronic media is attractive to students because of active and interactive communication, visualization of information, dynamics. Electronic media are suitable for students because they provide students with information quickly, meet their curiosity; ensure the possibility of fast ideas exchange, acquisition of knowledge through fun, etc. (Nadrljanski, Soleša, Nadrljanski, 2008).

The importance of education for the progress of a society is indisputable just as is the fact that innovation in education contributes to the positive changes in society, but it is also evident that social innovative thinking affects education.

## **Application of computers in initial teaching of mathematics**

It is only natural that contemporary teaching keeps track of the progress of technology and endeavours to implement new teaching resources into educational process so as to bring the teaching contents closer to students, to motivate them for work, to promote their understanding, discovery and acquisition of various concepts, phenomena and laws. It was the same in the previous years with overhead projectors, fluoroscopes, episcope, tape recorders etc. just as we are witnesses to more and more frequent teaching by means of computers, peripherals and program support. Nowadays schools in Serbia are equipped with computers, laptops, various peripherals such as printers, projectors and scanners. Everything is supported with different kinds of programs which all have educational components.

"Contemporary concept of the school implies overcoming of traditional model of education by directing it towards advancement of the quality of process of learning. Transformation of school means affirmation of a student as a subject of self-development, an active participant in life and work of school which enables the student to develop his or her inclinations, interests and abilities." (Budić, 2006, 117).

Information technology education as well as the teaching of information technology in primary and secondary schools includes all those functions. The functions of information technology education must therefore be determined by basic functions of teaching, as well as certain other specificities such as didactic and educational software.

### *Psychological aspects of the application of computers in teaching mathematics*

For a successful use of computers in teaching in general, and in initial teaching of mathematics, it is necessary to consider the basic psychological and pedagogical factors which justify or dispute this model of teaching. Taking into account that in initial learning of mathematics children are at a level of concrete operations it is necessary to base teaching on concrete experience without formal definitions which have no stronghold in a child's real experience.

Nowadays psychological and pedagogical researches are aimed at improving the quality of teaching as well as efficiency of learning as the basis of teaching in schools, and also the development of learning with children. "In psychological circles thinking is defined as solving problems. It is necessary to create such conditions in which students would learn through understanding and feel that thinking operations participate in the learning process (Budić, 2006, 117).

Computers, with its peripheral equipment, can meet different needs of students expressed through their general and specific abilities, most frequently expressed by the intelligence quotient, and which other technical equipment cannot provide.

Emotional characteristics are also very important to follow. In an exact example of applying computers in teaching they are usually expressed in different reactions to new acoustic, cognitive and other effects.

New technologies enable integration of visual, auditory and written material so as to transfer information to students as efficiently as possible. Students learn with more understanding when a learning matter is presented through carefully chosen corresponding words, images and animations, than when that same matter is presented only in words. Motivational characteristics of use of computers in teaching are fully expressed here.

Depending on the level of knowledge of students, that is, their prior knowledge and abilities, there is a certain volume and form of help within the content, form of work, idea and other modes of stimuli, guidance and mimicking their affinities and interests, given to students by computers. A computer in teaching enables differentiation of teaching matter and measurement of students' individual potential forces by adequately assisting them, taking into consideration their individual differences.

Special attention should be paid to students and their inner characteristics which will incite them to actively and creatively participate in the teaching process. Students with different inner motivation are more likely to strive for creative learning, require more frequent control, and quicker feedback. They seek for help and cooperation in learning which comprises incitement and improvement of abilities, motivation and characteristics of personality in new forms of learning.

One of the main goals of modern education is individualization, independent work of students, assisted by teachers. We are aware of what various negative effects in the development of a child's personality an experience of failure may cause, especially when failures are frequent and when they are experienced in the course of gaining primary education. Frequent failures have destructive consequences upon a child's personality. This is the reason why more and more psychological researches are organized in order to create conditions and possibilities of removing these failures to enable each individual to evolve freely and in accordance with their abilities. The help of computers is necessary to this end because it supports a completely individualized work of a user.

### *Pedagogical aspects of application of computers in teaching mathematics*

Teaching should be directed towards students' real potentials and their abilities to acquire mathematical knowledge. It is necessary to put students in the position of an active subject and direct all methods and techniques of work towards training of students to work independently in learning process and practicing mathematical issues in the course of learning and out of it. In order to achieve successful learning in mathematics teaching, it is extremely important to use modern teaching technology which is a relevant factor of individualization and differentiation of teaching work because through its use mathematical tasks can meet the individual differences of students and their abilities.

Active learning implies independent individualized students' computer-work or certain specially prepared material which is a source of knowledge. "Without independent students' work there can be no successful development. Dewey emphasizes that the initial source of knowledge is work in which students actively participate

because in such a way the most efficient and most certain knowledge, skills and habits are gained." (Jukić, 2005). By using computers in teaching, learning contents is presented in an interesting way and therefore incites meaningful and independent learning and develops creative thinking in students.

In organization of initial teaching of mathematics based on the use of computers, the contents that is presented is both more appealing to students and more understandable and logically arranged developing their motivation for learning. Acquiring mathematical knowledge by use of computers allows different structuring of mathematics with respect to capabilities and peculiarities of particular students, where the mathematical contents is structured according to simplicity, logic and abstraction to meet the work of both the "better" and the "weaker" students, extrovert and introvert, i.e. students of different capabilities and features.

The role of a teacher is to incite and sustain a student's participation in work and therefore the teacher needs to know how to begin the lesson, how to transfer from one activity to another and how to end the lesson successfully (praises, conclusions, abstracts) at any moment. In order to maintain students' participation, pedagogically effective and student-occupying activities are required. It is an interactive process in which students influence their teachers as well.

A correct pedagogical approach is necessary because each improvisation would be an impediment to the development of students' learning the material. Forms and methods should be the subject of careful consideration. Those forms and methods cannot be uniformly applied in each mathematical content but differentiated and as various as possible with precise instructions for the students' work.

Ability of a teacher is one of the most important factors in the realization of the teaching contents. In order to achieve changes in the educational process of teaching mathematics, it is inevitable to change the teacher's role. A teacher plans and programs the work, prepares materials, suggests literature, organizes teaching, motivates and leads.

Computers allow more freedom in the teaching of students and it is therefore the cornerstone of a modern organization of teaching mathematics. A general pedagogical demand for a more humane and flexible mathematical education is taking shape in the application of computers in teaching mathematics.

### **Models of application of computers in teaching mathematics**

The use of computers in teaching includes different aspects of use of information and communications technology in education starting from a simple use of computers in traditional teaching (PPT presentations, computer simulation of processes, multimedia presentations, use of web contents, et.), then teaching which uses direct contact during occasional presentations of online activities to completely online organized teaching where all activities of teachers and students take place at a distance and without physical contact.

### *Multimedia in teaching mathematics*

Multimedia educational facilities are the basis for the introduction and implementation of modern methods of work in the initial teaching of mathematics. The issue of a child in the process of learning and the issue of the activities of a teacher are placed in the foreground by these new challenges in education. The activities of children in the process of school learning are the key category which must be defined. The definition of with what it means that a child is active in the process of learning must also be given. This type of work does not represent any release or discharge, or load; on the contrary, all participants in the learning process alter their own positions and activities. By using these educational contents communication and interaction among all participants of the learning process are increased.

Teachers use these contents as a helpful resource aid in teaching. Of course, this does not mean that they do not participate in the work, but that their role has changed. Knowledge and skills are often necessary to create educational software, but the real effect is seen in the realization of a lesson that is overseen, directed and corrected by the teacher himself.

There are programs designed for students of primary school courses that can be used from the first school day. These programs are used for learning letters, numbers, colours, size comparisons, as well as drawing, colouring, solving puzzles, developing memory and the like. Students can independently work on these programs, which requires students' full concentration, patience, but also plenty of time.

It is difficult to make such software that will suit every student, as teachers and students do not have the same attitude towards the use of computers. Teachers view the work with computers from the point of their benefits for students and their work, while for the students it is important that the computer offers pleasure and enjoyment. Therefore, teachers are required to use such programs which will provide students with appropriate knowledge; it means they will encourage students' development, curiosity, creativity, and at the same time students will enjoy themselves while working.

### *Educational software in teaching mathematics*

The term educational software includes ready-made computer programs which are used in the teaching process but it also includes programs which enable a student to learn independently. Educational software is called PC software that provides the conditions for the realization of various aspects of teaching (Nadrljanski, Soleša, 2004).

Educational software is commonly used in the teaching process in the preparation of personnel in the field of education, for developing students' personalities and intensification of the learning process. It is very suitable for self-learning, learning through independent research, insight, detecting, thus producing intensity, independence, creativity and intelligence.

In order to facilitate quality use of educational software in teaching, it is necessary to meet all the required conditions. First it is necessary to analyze the

experiences of countries that have used educational software in teaching and see if there is some research in this area. Taking into consideration that this is a relatively new area, there is still little research. This confirms the fact that we have to rely on our own resources and make good use of educational software programs.

Another important step we need to make is to develop sufficient software to be adapted to the current teaching curriculum and programmes and evaluate them. To do this, it is necessary to hire a group of experienced teachers - subject experts and teams of computer scientists, pedagogists, psychologists, methodologists and developers of multimedia software.

By using educational software teachers' roles are significantly changed since the very organization of different classes changes (didactics-methodology components include methods, forms, principles and organizing of the teaching process with all phases of the teaching process: the processing of new materials, repetition, exercises, and testing of taught and acquired materials).

By application of computers and high-quality educational software in initial teaching mathematics, a student is engaged to the maximum and acquires the position of an active subject in the teaching process. For "active learning in teaching can be achieved only if the students use different sources of knowledge independently, solve problems, learn through the model of discovery, self-reflect, synthesize and systematize courses that they learn, change circumstances, find new and unusual ideas" (Budić, 2006, 181).

Well-designed educational software allows, in addition to general and several special functions: giving demonstrations, simulating certain procedures and processes, conducting joint operations of active teaching, practicing and applying already acquired knowledge and developed skills, enabling modern organisation of the processes of teaching, learning and self-learning (Nadrljanski, 1994).

Intensive development of computer technology has created enormous opportunities for development and use of educational software for the needs of teachers in preparing themselves for teaching mathematics, as well as the needs of students in the process of studying mathematics.

Using computers and educational software has many advantages over conventional methods. Some of them are able to continue multimedia (sound, animation, images, text, linking of related instructional content, tests), software simulations of mathematical concepts (sets, types, area, volume), etc.

The advantages of using computers and educational software in teaching mathematics, compared to the traditional work and the preparation of teachers, are that mathematical facilities prepared for computer work contain parts designed for testing knowledge of each chapter. In this way users' attention is drawn to the gaps in the curriculum mastered.

Students who learn with the help of educational computer software can make progress according to their individual abilities. Each student communicates with the computer in the way that learning material, tasks or questions are displayed on the screen and the student gives the results (answers) through the keyboard or by movements of the mouse.

If we talk about the necessity of modernizing and improving the level of mathematical culture, i.e. ways of organizing classes, then the right way in this direction is the use of new methods that we are offered by information technology.

### *Distance Learning*

Internet presents the largest and the most powerful network in the world. By linking a growing number of colleges, universities, schools, companies and citizens to the Internet, vast opportunities open up for the teachers at distance to bridge time and space in order to reach students.

Distance learning is a term used to describe the learning process in which a source of knowledge and a recipient of knowledge are at a physical distance, and mediated by ICT (Information and Communications Technology). "There is no doubt that these technologies require a more modern and, according to functional logic, a more appropriate pedagogical-psychological and methodological-didactic theoretical basis as a necessary assumption of their immediate implementation in the planning, organization and implementation of distance education. All the more so if one takes into account the fact that the primary issue throughout the world is the struggle to increase the quality, efficiency and effectiveness of education. In this sense, distance education, supported by modern information technology, multimedia, offers almost limitless opportunities to users who, of course, must bear in mind its limitations" (Mijanović, 2005, p. 101).

This technology would enable the monitoring of teaching from home, that is on a home personal computer when the student is unable to come to school for various reasons (illness, storm). It is important that online education serves as a supplement to traditional learning. All that we believe can be done better in a traditional classroom should remain. We must not allow online teaching to become its own purpose; it should be a type of teaching that will help us to improve our classical education.

### **Using the model of application of computers in teaching**

Development of information technology has created prerequisites for changing the roles of teachers and students. The teaching process has become unthinkable without a PC. The focus of a teacher's work moves from the realization to the preparation of teaching. Students become more active and independent in their activities, while teachers organize their work, motivate and encourage students. Contemporary teaching needs teachers who are motivated, responsible, communicative, and who are willing and open to continuous improvement and professional advancement.

Students vary in speed, but also according to learning styles. Some learn best when lessons are explained to them through a drawn pattern, while others learn best when one presents them a material verbally. Such a diversity of students requires a differentiated, individualized teaching approach. The concept of computer teaching was designed to allow precisely such an individualization of teaching, but it is now, even more in developed countries than our own, still being adapted to different rhythms of

learning among students. Teachers who use computers in education have more opportunities to pay more attention to students who have difficulty in mastering the curriculum, than when they work in a traditional way.

When using computers in teaching teachers need constant monitoring and ongoing support and encouragement, as well as feedback on what and how they work. Continuing professional development, self-evaluation and acquisition of titles, have become an inseparable chain of inter-related processes, and the goal should be the continuous improving of the quality of the school.

The curriculum can be made more obvious and understandable to a large extent by the application of computers in teaching. Clarity of teaching is achieved thanks to the ability of the computer to successfully activate a number of senses by its acoustic and visual effects, and thus increase students' cognitive abilities.

In order to learn working on the computer, a teacher needs to put in a lot of hard work, effort and time. On the other hand, such work opens the possibilities to use the computer in teaching in different ways both directly and indirectly. Using computers can help in designing, planning and implementing practical teaching units, in analyzing what was done, in updating school records and in communicating with students and colleagues.

There is an increasing number of teachers who use computers for writing the annual work plan, operational and global, monthly, weekly and daily work schedules, while taking care which facilities are planned and implemented, when and at what time they will be implemented, how much time it is provided for the use of computers, in what order, and the like. Such plans are changed, corrected and revised each year, which greatly facilitates and accelerates their development and the possibility of adjustments in the course of the school year.

Teachers use computers more and more often to prepare a teaching unit in which they use the Internet to access various data. The large worldwide network enables them to keep abreast of all changes occurring in education and beyond. For the preparation of the teaching contents different, computer applications are used whereby creativity of teachers is emphasized. When planning the implementation of educational content on a computer, a teacher has to take into account the time dimension of teaching of the planned content. During the planning of teaching by use of a computer a teacher must take into account the aims and tasks of the lesson, the choice of content, how the content will be presented, and the way of obtaining feedback. The aim of detailed planning in realization of teaching through the use of computers is to see what teaching material can be implemented by using a computer.

A teacher can use computers in a very practical realization of units, not just in preparation. The computer can be used in regular classes for the implementation of a large number of lessons and extracurricular activities and in the additional classes, extra classes or leisure activities.

In the process of its use by teachers the computer should be seen as a technical tool that helps them to be more precise, clear and obvious in their presentation of a specific course content, tasks or questions. It is not used to replace teachers but to help them improve the quality of their work in the teaching process. Therefore it should be

accepted as a useful teaching tool which can replace more different teaching aids and to assume different functions by putting their hardware and software at a user's disposal, no matter whether it is used by a teacher or a student, and all for the purpose of guaranteeing better conditions for higher quality work, learning and development of each individual.

By applying computers in their work teachers primarily want to improve the quality of their work, to create favourable conditions for individual development and progress of each student, to facilitate the learning process and adapt the learning process to modern trends and achieve greater engagement and motivation of the individual.

In the implementation of educational content a teacher can use the computer:

- in the classroom for teaching lessons,
- in the classroom for practicing the acquired knowledge,
- in the classroom for revising and systematizing knowledge,
- in the classroom for testing knowledge,
- in preparing homework.

It is best if a school's technical requirements are such to provide each student with one computer. If a teacher has an insight into the possibilities of using computers in teaching, he or she will organize students to work together, either in pairs or in groups, on the school premises or at home to practice the tasks that the teacher will exchange with students regularly via e-mail. At first this may relate to gifted students, and later may involve other students.

To organize classes by using computers, a teacher can structure:

- individual work using computers,
- work in pairs using a computer,
- work in groups using a computer,
- frontal method using a computer.

Depending on the teachers' assessment the computer can be used at this stage in certain parts of classes or during a whole class. A good and successful teacher will successfully assess the validity of using computers in some parts of the class or the implementation of certain segments of the teaching unit and assess its usage. In the initial stage the gradual introduction of computers into the teaching process is recommended. It takes a little more time to train students for independent learning. The computer here can be used in certain parts of a class (introductory, main or final part) or it can be used more times during the class with the alternation of the teacher's and multimedia activities.

At the stage of testing students' knowledge and skills in solving problems it is also desirable to use a computer. It is important to review all the qualitative effects of a new model of learning that is organized through a level of practical application of acquired knowledge and a level of competence for self-study. In order to avoid subjective factors in testing the effects of using computers in teaching, a team of experts is involved in the review process while it is obligatory that one member is the teacher who was directly involved in the process of teaching according to the new model of

learning. The public is informed of the results of the review in order to introduce not only students, parents and schools, but also the wider community to objective learning outcomes of teaching by using computers.

After the lesson is taught it is recommended to perform a computer analysis, as well as to arrange school records and various data processing (creating schedules, records of evaluation, collaboration with parents, etc.).

Finally, the computer allows the teacher to communicate with colleagues and students via electronic mail or other programs.

To sum up, the computer enables the teacher faster linkage of program units and their integration into the annual work plan. By using computers in planning of teaching, a user 'programs' his or her annual, monthly, weekly and daily activities in a more modern and efficient way.

### **Concluding remarks**

Today, when the volume of scientific information is constantly growing and their breakthrough is more and more abrupt, there is a need for certain contemporary conceptions of teaching. By using innovative models of teaching weaknesses and shortcomings of teaching can overcome in a creative way and headway from what has been achieved so far is enabled.

Innovations in education come at a time when the overall education is in a state of crisis, when a substantial number of teachers and students are resigned, when students are largely treated as an object of teaching, and teachers as transmitters of read-made knowledge.

Today there is therefore a search for new, more original and braver decisions in the organization of teaching and teaching itself, there is an endeavour for innovation that will best suit the spirit of the times, the needs of modern society and the interests and needs of young people. Today, there is a search for those innovations which provide rationalization, intensification and modernization of teaching materials, forms and methods of educational work with minimal financial and other investments. All teachers who organize a teaching process and perform it are aware of the fact that something needs to be changed, schools must be constituted in a different way, relationships within them changed, and also materials, forms and methods need changing. However, many teachers are afraid of innovations mainly because they are not aware of what they would bring, because they do not know their essence, the means of their introduction and the outcomes that they can be expected to achieve when it comes to improving the quality of teaching. This is helped by the widespread belief that every novelty seeks tremendous efforts of both teachers and students, significant financial investments in education and a completely different orientation of educational institutions.

It is necessary to bring modern education closer to the information age, and it is essential to introduce changes to the teaching materials and methods. One of the important tasks of education is further education, not only of IT experts, but also of IT literate professionals prepared to learn continuously throughout their lives.

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## PRIMENA RAČUNARA U POČETNOJ NASTAVI MATEMATIKE

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### *Rezime*

Savremena nastava matematike prati razvoj tehnologije, te nastoji da u obrazovni proces uvede nova nastavna sredstva kako bi se učenicima približila matematika. Upotreba kompjutera u nastavi bez sumnje predstavlja novinu u učenju i kreativno se upotrebljava u kontekstu učenja na različite načine, za motivaciju učenika, da bi se poboljšalo razumevanje, otkrivanje i usvajanje matematičkih pojmova, pojava i zakonitosti.

U ovom radu dat je prikaz pedagoško – psiholoških karakteristika nastave u čijoj organizaciji se primenjuje računar. Date su smernice za modelovanje nastave

primenom računara i to upotreba multimedijalnih prezentacija, obrazovnih softvera i učenje na daljinu.

Poseban akcenat je stavljen na mogućnosti implementacije nove informacione tehnologije u obrazovni proces, a sve u cilju povećanja kvaliteta nastave matematike.

**Ključne reči:** *obrazovanje, nastava matematike, računar, obrazovni softver.*