

SOME IDEAS FOR TRAINING OF COMPUTER MODELING IN ELEMENTARY SCHOOL

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Abstract

With the development of ICT increasingly important is the question for the development of logical and algorithmic thinking of students. It was found that computer science contributes most greatly to achieving this goal. International experience - in the UK, Israel, Belgium, France, the Netherlands, etc., suggests that efforts should be directed at elementary school students. The article will make a review of international experience with training in computer modeling and will share the experience of experimental training conducted in recent years in the Plovdiv region. Will make an analysis of learning content and will offer a version of the curriculum for training in Computer modeling in elementary school.

Key words: computer modelling, block-based programming

1. INTRODUCTION

The fast developing digital technologies require more and more dynamic and adequate changes in the education. The activation of the processes of digitalization, automation and robotics in all of the areas of the public life, determine the need for increasing the effectiveness of the education in the computer science and technologies area. The new technologies entered rapidly into the classroom. As a tool for increasing the effectiveness of the learning process on the one hand, and on the other hand as a base for developing a quality level of the students` intelligence. It is proven that the formation of skills, related to the processing and using information, is directly or indirectly connected to the computer science. These tasks are inseparably connected with the developing of an algorithmic thinking, also operational base for all of the methods and techniques for processing and using information. In this respect, one of the main purposes of the computer science education is the developing of the logic and algorithmic thinking

The contemporary surveys [1] are showing, that the developing of algorithmic thinking in the elementary school largely determine the further formation of different aspects of intelligence in the young people [6], [4]. The logical and algorithmic thinking is complexly formed during the training in all subjects, but in view of the new realities this process has to accelerate itself considerably. In this respect it is necessary the new information technologies to be used in the process of training from the elementary school.

The surveys of the global and European experience, while organizing the training on computer science in all of the levels of the school education, as well as the gain Bulgarian experience [5], [7], give us reasons to feel optimistic. As we recognize the peculiarities of our educational system and the tendencies in the developing of ICT, a group of experts and teachers from Plovdiv County started experimental training on computer modeling with students from elementary school, as we created our own educational program in FET/Freely elective training/. The purpose of the present article is to share with you the gained experience and to present our future plans for applying the block-based programming and computer modeling in the training of the students in the elementary school.

2. COMPUTER SCIENCE TRAINING AND DEVELOPING THE LOGIC AND ALGORITHMIC THINKING OF THE STUDENTS

From a point of view of the pedagogical psychology, the complete evolution of the human includes the physical, cognitive, personal, social and moral development. According to the majority of the psychologies the nature and the upbringing are combining by influencing on the development. Considering the age and the psychological features of the students in the elementary school, we can set our efforts towards the constructing only of separate elements of logical and algorithmic knowledge. The students in the elementary school learn with difficulties the rules presented in concise form, like algorithms. That is why it is necessary to be used different appropriate methods and approaches, by which can be helped to the little students to arrange step by step their actions in easy and natural, for their age, to form and to build the algorithm for achieving the desired goal.

According to Zhan Piazhe the cognitive development of the humans passes through four stages, where during the second stage “Pre-operational” (from the age of 2 to the age of 7) is developing the ability for using symbols, so the objects in the world can be presented. The thinking becomes egocentric, centered and irreversible. The reversibility is the ability of changing the way of thinking, so that it can come back to the starting point. During the third stage “particular operations” (from the age of 7 to the age of 11) the logic thinking ability increases. The cognitive abilities of the students in the elementary school are going through essential changes. The children have already acquired the conception of reversibility and unlike the younger ones do not react to the perceived characteristics, but to the extracted by conclusions reality. In this stage, the thinking of the children is not restricted to reasoning about the interrelations between the different parts, but they can now cope with relations part-whole.

From the stated above follows that, till the age of seven a child already has elements of logical thinking, but the lack of sufficiently developed logic language does not let them to express freely their thoughts and observations and to make more complex logical conclusions. Therefore, we can say that the development of the logical and algorithmic thinking is recommended to begin in the elementary school.

The concept “logical-algorithmic thinking” is used widely in the contemporary methodical literature for teaching computer science. The major part of the authors of the programs for these subjects, determine the development of this type of thinking as one of the main purposes of the training [8]. The specific characteristics of the logical and algorithmic thinking are: the heterogeneity, which is made by designing “step by step” as a specification of the actions for carrying out and structuring the processes and resume, which is a possibility for abstracting from the particular primary data and a transition towards designing the common purpose.

The computational thinking let us to solve problems, to build systems for designing, as well as to understand the power and the boundaries of the human thinking pawned in the “intelligence” of the machine. It is a skill that gives an opportunity to all students to develop their competences, to think algorithmically, to understand and use the computer technologies and this prepares them more successful for today’s world and the challenge of the future. Therefore, the learning of the computer science in the elementary school in different form – in mandatory or in the elective training, will exert beneficial influence on the development of the logical and algorithmic thinking of the students and will help for their future development and realization.

The European and global practice shows that for the reaching of that goal is used wide range of initiatives for coding and motivation of the students to develop their skills in the school environment or outside it. More and more countries in Europe and around the world concentrate their attention towards developing learning programs of computer programming and modeling. In 2014 a Group of European Schoolnet [12], [13] has received the topic, trough survey, in all of the ministries of education in the European countries. A report has been prepared which presents the main point of this survey. In respond to this challenge, the ministries of education decided to review the training programs and to integrate them in the computer science, as a part of the activities on the training programs in their mandatory or elective part. The algorithmic thinking is viewed as an opportunity for solving problems by using graphical, block program environments (for ex. Scratch, Alice etc.). In

some of the learning programs is staked on the opportunity for comparing algorithms on the base of their effectiveness and efficiency, as well as for determining the common models. From the students is expected to acquire skills for preparing block-schemes, through which they could foresee the results from the execution of their programs. The students gradually are meeting with some of the programming languages, after which is proceeded towards coding, compiling, testing and elimination of the mistakes in their programs.

In Cyprus the algorithmic thinking and programming are part of the specialized course for computer science and are compulsory in junior high school stage of education and during the first year in the secondary school (at the age of 13-16). It is suggested as an elective discipline during the last two years of the secondary education, with more that 75% of the training time. Furthermore, the opportunity for conducting afternoon courses is given to the students who want to develop their knowledge and skills in this area.

The integration of ICT in Denmark is determined on national level, but its applying depends on the regional and school programs. The programming is a part of the learning program and it is included as a part of the teaching on the subject ICT in the secondary education.

The program in Estonia is oriented towards preschool, elementary and vocational education. Teachers' educational resources and qualification trainings are provided, financial supporting is provided to kindergartens and schools, for buying different programmable devices. In the elementary education is entered national interdisciplinary subject called "Technologies and innovations", which requires all of the teachers to apply technologies in the teaching. The teachers should integrate, as follows, the technologies in different areas (ex. by using Scratch in math, music programs in the music classes etc.) The learning program does not determine what exactly technology or software should be used. The teachers can choose by themselves, accordingly to their goals, knowledge and experience. There are different national learning programs that are not compulsory in the education on technologies (programming, robotics, 3D, graphics, computer science, informatics etc.), which the schools can choose and add to their school program.

In Greece the computer programming is integrated into the learning program, beginning in the 3-rd year of the elementary education till secondary education as a part of a subject called "Developing apps in program environment". The real integration depends on the level and the range of every grade. In the elementary education the students are programming by using LOGO and turtle graphics.

In Ireland the coding is integrated in the junior high schools as a separate course "Coddling". In this course are developing the skills for computing thinking and problem solving. The students project and create software projects, in which they use their own ideas and imagination. The course is intended to build all the skills in this direction.

In Lithuania the programming is a part of the ICT course in the secondary education. The purpose is building of competences in six directions: algorithms, data base, programming languages, creating a program for solving simple tasks, algorithms and stages for creating program, and the culture of programming.

In Portugal the programming is a part of the subject ICT, which is compulsory in the junior high school and high school level of the secondary education. The activities include projecting multimedia projects (text, images, sound and video), games, animations, interactive stories and simulations. With these activities, it is intended to develop the algorithmic thinking on the bases of describing and solving problems and logical organization of ideas, which are the learning goals of ICT.

In 2014 in the national learning program of UK is led in a new subject Computing, which takes the place of ICT. This is perceived as succession and change, challenge and opportunity. The learning program on this subject includes topics about what the computers and the computer systems are, how do they work and how are they projected and programmed. The learning program is built on the bases of computer science (CS), information technologies (IT) and digital literacy (DL). The training includes four main stages. During the first stage, from the students is expected to create simple programs and to eliminate mistakes from the same; to gain skills for safe using of the technologies; to

understand what the algorithms are and that the programs are executed by following the instructions precise and unambiguous. In the second stage the students learn what the computer nets are and how to use effectively the technologies for searching. The third stage starts in the secondary school. The students study Buleva logics, which reflects the computing thinking; the different hardware and software components, which build the computer systems. The last stage is more open, with an accent on achieving higher levels of education and future professional career of the learners.

France is trying to define measures of national level, where the programming and coding should be integrated in the junior high school level and eventually in the last year of the elementary school.

The computer programming and coding is included in the major part of the surveyed countries in junior high school stage of the elementary education. Most of these countries are integrating it in high school stage of the secondary education in the area of the professional education. Only three countries – Estonia, Greece, United Kingdom (England) - bring in the coding and computer modeling in the elementary school. In Estonia and Greece, the learning of this subject passes through all the levels of the school education, including professional education in the secondary school.

In some European countries like Bulgaria, Cyprus, Czech Republic, Greece, Poland, Portugal, UK, the studying computer science and programming is compulsory. Right now here (in Bulgaria) the informatics (programming) is studied as a compulsory subject in 9th grade – two hours a week. The course includes the studying of the main concepts in the computer science and some math principles. Programming, algorithmic problem solving and presenting information through abstractions (ex. models and simulations) are a part of the two learning disciplines, which complement and extend each other – the informatics and information technologies (ICT). The new Rule in the preschool and school education [14] and based on it learning schedule, orientate the attention to studying ICT in the elementary schools. As a compulsory learning discipline “The computer modeling” is going to be studied in third and fourth grades.

3. OUR EXPERIENCE

In Plovdiv Region with the active participation of RIO-Plovdiv we created Regional methodical council of informatics and IT. We made an analysis of the peculiarities in the development of the logical and algorithmic thinking in students, as well as of the experience during the programming and computer science education in Europe. As a result of this analysis we decided to direct our attention to the students in elementary school. The goal which we set is to stimulate the development of the logical and algorithmic thinking of the students by organizing the study in FET of programming and computer modeling. In parallel with this we set a goal to motivate the students and to increase their activity by studying block-based languages and programming environments [10]. This style of programming is different as a technology and as a way of perception and thinking. That is why we conduct a training for teachers [2], teaching in the different levels of secondary education in county of Plovdiv. We researched the experience of our colleagues from USA, UK, Australia, Russia and others, during the training on block programming of students from the kindergarten to the universities, and we created our own working program.

A few trainings have been conducted by which the students met the most popular 2D and 3D environments for block programming, as: Scratch, Blockly, Stencyl, Move and Turtle, MIT App Inventor, Tickle, Alice, Kodu and others. [16] In the pace of the training the attention has been directed more thoroughly towards SCRATCH 2.0 and App Inventor 2[9], [17].

After the training the teachers applied block programming in their work with the students from elementary, preschool and high school degree and at the end of the last school year they shared their experience. According to them, the programming by Scratch is absolutely available for the students from 4 and 5 grade. They share that the students orient very fast in the block-commands and after a few instructions, they starting to use them successfully. Furthermore, they see the result right away from their program and if something is not like they expected, they orient fast and correct the commands. They understand what programming means – this is the most important thing. When the

students create Scratch-projects, they acquire skills for: creative thinking, communication, system analysis, applicability of the knowledge, projecting, continuity and continuance of the training.

The obtained results show, without hesitation, that we can see the increasing of the interest for programming in the elementary school and preschool. The advantages of this model of work are: motivating and stimulating the cognitive activity of the students; development of the logical and algorithmic thinking; opportunity for applying differentiated approach; establishing skills in the students for working on their own; to apply and develop their skills for self-check, self-control and self-assessment.

The results gave us hope and we developed the whole program for training on computer science for FET, which will give an opportunity for gradually building knowledge, by starting from the elementary education. We decided to experiment with the application of this program in seven different schools in the county: ES/Elementary school/ "P. Volov"- Plovdiv; ES "Ekzarh Antim I"- Plovdiv; ES "R. Popovich" – Karlovo; ES "Vasil Levski"- Rogosh Village; SSGE/Secondary school for general education/ "Hristo Smirnenski"- Brezovo; SSGE – "Prod. d-r Asen Zlatarov"- Parvomay and SSGE "Sv. Sofroniy Vrachanski" – Plovdiv. We introduced the training as FET in elementary course from II to IV grade, for 1 hour every week from the beginning of the following school year. The intermediate results from the experimental training show that the interest, the motivation and the activity of the students, in all of the groups, has increased. A final reporting of the results and opinion, and consent survey of the students, teachers and parents, is ahead.

4. TRAINING PROGRAM FOR FREELY ELECTIVE TRAINING (FET) ON COMPUTER SCIENCE IN THE ELEMENTARY SCHOOL

The "Computer science" training has an introductory characteristics and it is directed towards acquiring general knowledge, skills and attitudes. It is accomplished on the bases of contemporary computer systems and it is suitable for the age of the students' program provision, which creates conditions for positive emotional adjustment and full development of the child's personality. A priority is not to teach the students how to use programming language, but to teach them habits for solving tasks in the computer science, similarly to the way we are learning how to solve mathematical problems. The training will help for the development of the critic thinking – and more concrete a development of computational thinking necessary for the understanding a problem, the ability how to divide the problem into smaller pieces, which we can solve easier etc. Base conceptions will be learned, which are needed in mathematics and other subjects of the training program – what is algorithm, what is data, different methods for analysis.

The goals of the training are: to acquire the skills for working with computer system; the positive attitude and desire for work with computer to be stimulated; to be used the main recourses of the computer for execution of accessible training tasks; to be known and complied the main health and ethical rules during work in a computer office; propaedeutics of base concepts on programming and obtaining of primary practical experience; development of algorithmic and visual thinking; formation of motivation for studying IT by organizing activities with practical purpose.

The focus of the training program undoubtedly is moving towards the programming and other aspects of the computer science.

The role of the programming in the areas of computer science is similar to that of practical work in the other science – it provides motivation, and the context in which the ideas are developing in practice. This program for education gives wide possibilities for the students to develop understanding, knowledge and skills in these areas.

The expected results are: mastering the concepts "algorithm", "program", "object", through the prism of the practical experience in the course of creating program codes; practical habits for realization of main algorithms; skill for creating algorithms by using repetition (cycles), subsidiary algorithms; skill for creating programs for solving not difficult algorithmic tasks in the programming environment Scratch; readiness and ability of the learners for self-development and personal self-determine,

motivation for cognitive activities in order to acquire habits in the using of IT; skill for planning by themselves the path for reaching a purpose, to compare the actions with the planned results, to realize control and correction on their activity in the process of reaching the result.

- Types of information. Man and computer;
- Algorithms;
- Block programming by Scratch

In the core “Types of information. Man and computer” the goals are: familiarizing with the rules for save work with computer; what is information, types of information and how does the human receives information with the help of the sense-organs; to know what type if information the computer can processes and what type of information can a human create on it; to understand that the computer is a system made of hardware and software; the students to understand about the professions which stands behind their favorite apps and games; to understand that the created from the programmers is a part of the every-day life.

The student will be able to work with the particular digital devices, they will know basic rules for safe work with the devise, and will recognize the type of the data with which they work, and know how to save and erase files.

In the core “Algorithms” the goals are: the students to understand the concept “algorithm”, to present algorithms with words, drawings, schemes etc.; to create algorithms; to understand what do “bug” and “debugging” mean; to write programs, which create simple forms and describe their position regarding other forms (up, down etc.). In this core the students work with different resources: squire net, happy cards, robots, <http://code.org> [15] etc.

In the core “Block programming – Scratch” the goals are: the student to express ideas by modeling in visual block programming environment; to create animated project by using linear, branched and cyclic algorithms; to distinguish digital and real identity and to know basic rules for work in digital environment.

The set key competences are: competences in the area of the Bulgarian language, skills for communication in different languages, mathematical competence and basic competences in the area of natural science and technologies, digital competence, skills for learning, social and civil competence, initiative and enterprise, cultural competence and skills for expressing trough creativity, skills for supporting the sustainable development and health way of life and sport.

At the end of the school year in the topic: “Projecting and presenting group project” is shown the inclusion of all key competences.

In Bulgaria, with the entry of the new law for education in 2016 in section A of the training plan (compulsory classes) is provided the studying of:

subject “Computer modeling” in III and IV grade in the elementary education, one hour every week.

subject “Informatics” (programming) in VIII grade, in first high school stage, only in the schools with “Mathematic”, “Software and hardware science”, “Economic development” and “Nature science” profiles, two hours a week.

subject “Information technologies” one hour a week, year-round in all of the grades from V to IX and one hour weekly in the first term in X grade.

For the subject “Computer modeling” in III and IV grade in the elementary stage of education was published a curriculum in the site of MES (Ministry of Education and Science), which is similar to the one prepared and approbated by us.

5. CONCLUSION

The experience gained during the last years confirms our expectations for increasing the interest of the students towards the programming. The students from the elementary course participate with desire into the organized extracurricular forms. The balanced allocation of the school time for creating algorithms, programming robotic devices, the easy work style in SCRATCH- based environments, stimulated the students and gave them an opportunity to concentrate mainly on the logical structure and scenario of the project. This largely develops their logical and algorithmic thinking.

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