DEVELOPING THE SKILLS OF PRIMARY TEACHERS IN PROGRAMMING, ICT AND E-LEARNING

Veneta Tabakova-Komsalova, Todorka Glushkova
Plovdiv University "Paisii Hilendarski"
4000, Plovdiv, str. "Tzar Asen", 24
veni_tab@abv.bg, glushkova@uni-plovdiv.bg

Abstract: *The activation of the processes of digitization, automation and robotics in all spheres of public life determine the necessity to increase the quality and effectiveness of the training in computer science. Taking into account these trends, the Ministry of Education and Science in Bulgaria adopted a new Pre-school and School Education Law according to which from the new 2018/2019 school year computer programming and modelling will be studied as a compulsory school subject from the third grade of elementary school. The article will share the approach chosen in Bulgaria and the authors' experience to develop the knowledge and skills of primary teachers in the field of programming, computer modelling, ICT and e-learning.*

Keywords: computer programming, e-learning

INTRODUCTION

Modern trends in the development of digital technologies require ever more dynamic and adequate changes in modern education. The activation of the processes of digitization, automation and robotics in all spheres of public life determine the necessity to increase the quality and effectiveness of the training in computer science. New technologies entered the classroom at a rapid pace - on the one hand, as a means of increasing the efficiency of the learning process and, on the other, as a basis for developing a qualitatively new level of student intelligence. It has been shown that the formation of important skills related to the processing and use of information is directly or indirectly related to computer science. Achieving qualitative results in building competencies for processing and using information is related to adequate training in and out of school.

Although computer sciences are studied in elementary school for years as an optional school subject, this training is done by computer specialists and not by primary school teachers. Therefore, the problem of the preparation and training of

primary school teachers, who have to teach the new subject matter, is very important. The article will share the approach chosen in Bulgaria and the authors' experience to develop the knowledge and skills of primary teachers in the field of programming, computer modelling, ICT and e-learning.

The rest of the paper is organized as follows. A short review of learning computer programming is considered in Section 1. This is followed by an overall description of the various trainings and teacher initiatives in Section 2. Section 3 demonstrates the the authors' experience in organizing and conducting training with primary school teachers.

1. REVIEW OF COMPUTER PROGRAMMING STUDIED AT SCHOOL

ICT is one of the areas with the greatest potential for future development of young people and their professional careers. Basic digital skills are needed not only in the IT sector but also in almost 90% of the professions in the modern world. Educators, parents, economists and politicians in Europe and around the world have long been convinced of the need to raise the level of digital competences among pupils from a very early age. Undoubtedly, skills related to computer programming, abstract and algorithmic thinking help to solve more of the problems in the modern information society (Tzanev, 2010).

One of the main challenges to education in Bulgaria is the continuing need for raising the qualification of educators (Kirova & al., 2012). Some of the issues related to promoting teaching and learning computer programming are:

- How to integrate computer programming in the curriculum into classroom and out-of-class work, given the case studies of the new Preschool and School Education Act?
- How to use computer programming for cross-discipline connections?
- How to connect computer programming with other ICT skills?
- How to train future and current teachers in ICT and eLearning?

The development of digital competencies is a top priority in almost all education systems. The importance of computer programming in European countries in relation to other ICT skills priorities is also reflected in the development of: consumer ICT skills; skills to develop key competences or as a learning tool. This is the reason why European countries should monitor the development of the following competencies and priorities:

1. Developing digital competence (including media literacy);
2. Developing the application of ICT as a learning tool;
3. Developing skills for using ICT;

4. Use of ICT to develop key competences;

5. Develop computer skills for computer programming, including coding.

Table 1 shows the importance of computer programming in terms of different priorities across European countries.

Table 1

Importance of computer programming for different priorities

Main priori-ties	Development of digital competence (including media literacy)	Developing the application of ICT as a learning tool	Developing skills for using ICT	Using ICT to develop key competencies	Developing computer skills for computer program-ming
Countries	BE (Fl), BG, CY, DK, IE, LT, NL, NO, EE, ES, Fl, FR, LU, PL, TR, UK	BE (Fl), CZ, CY, DK, EE, EL, ES, FR, IE, IT, LU,NL, NO, PL, PT, TR	BG, CZ, CY, DK, EE, EL, ES, Fl, FR, IT, LT, LU, NO, PL, TR, UK	CZ, CY, EE, ES, IE, FR, IT, LT, LU, NO, PL, PT, TR	BG,CY, EE, EL, FR, IT, LT, Fl, , IE, IT, TR, UK (England)

Source: *Own work based on Computer programming and coding Priorities, school curricula and initiatives across Europe, http://www.eun.org/bg/resources/detail?publicationID=661*

The data show that most countries have adopted several priorities for the development of ICT competencies. The development of pupils' digital competence is a priority in almost all countries. The use of ICT as a learning tool is one of the main priorities for most countries. Developing skills to use ICT to develop key competences also plays an important role. Computer programming and coding skills are mentioned as a top priority for only ten countries. Although this is relatively small, it illustrates the approach to integrating computer programming into the curriculum in addition to other ICT skills. Countries such as Belgium (the Province of Flanders), the Czech Republic, Ireland, Malta and Poland define computational thinking as a basic skill acquired through integrating computer programming into the curriculum.

In the conducted studies it was found that one of the reasons for slowing down the introduction of computer programming in schools is that in very few countries it is studied as a compulsory and separate subject. Quite a few students choose to study programming through facultative forms of learning. One of the reasons for this is the complete lack of classes for learning this subject in the early years of student education. In addition, some students have a misconception about what the subject "Computer Programming" is, as they have the impression that computer work in this subject is the same as in the field of ICT. Another finding is related to

discovering the fundamental difference between what teachers can teach and what they are supposed to know.

The following Table 2 examines the levels of education in which computer programming is studied as a compulsory or optional subject in different EU countries, and at what levels of education this training is being implemented. Countries marked in blue are still planning to integrate computer programming. In states marked in yellow, computer programming is an optional subject for the indicated levels. In countries marked in red, computer programming is a compulsory part of the curriculum.

Table 2

Levels of education in which computer programming is studied

Country / Level of education	AUSTRIA	Belgium (NL)	BULGARIA	CZECH REPUBLIC	DENMARK	ESTONIA	FINLAND	FRANCE	HUNGARY	IRELAND	ISRAEL	LITHUANIA	MALTA	POLAND	PORTUGAL	SLOVAKIA	SPAIN	UK (England)
Primary level																		
Lower secondary (general) level																		
Lower secondary (vocational) level																		
Upper secondary school (general) level																		
Upper secondary school (vocational) level																		

Source: *Own work based on Computer programming and coding Priorities, school curricula and initiatives across Europe, http://www.eun.org/bg/resources/detail?publicationID=661*

Computer programming is integrated in most European countries at lower and upper secondary level. Estonia, Israel and Slovakia integrate computer programming at all levels of education, and in Slovakia it is a compulsory element of the curriculum in all stages of school education, i.e. all students learn it in the course of their entire education. Poland also has integrated it at all school levels since 2016.

In seven countries (Bulgaria, the Czech Republic, Denmark, Portugal, Slovakia, Spain, UK (England), computer programming is mandatory for specific levels of

education and is part of the general computer training course. In ten countries - Estonia, France, Israel, Spain, Slovakia, the United Kingdom (UK), Belgium, Finland, Poland and Portugal integrate computer programming from primary level of education, while in the United Kingdom (UK), Bulgaria and Slovakia it is a compulsory subject in the primary education.

All this brings up the current task of teacher training and motivation of students for studying computer programming since primary school. The first step towards this is the organization of formal and informal initiatives and trainings for teachers.

2. TRAINING COURSES AND INITIATIVES FOR TEACHERS

If computer programming is integrated into the curriculum in order to ensure that students acquire the necessary skills, this training must be complemented by training and initiatives related to methodological support for teachers in this field. Teaching a programming language can be a challenging task, especially for teachers who do not teach ICT or computer science, as well as for teachers who have not had prior training in this area. Training can best be described as a mix of centralized support coupled with additional stakeholder-oriented initiatives. In some countries, teacher training is officially provided as part of training at the workplace or as part of adapting newly recruited teachers to their upcoming duties. In most cases, however, training predominantly is provided by professional stakeholders.

2.1. The experience of the EU countries

In thirteen EU countries (Austria, Bulgaria, France, Estonia, Hungary, Ireland, Israel, Malta, Poland, Portugal, Slovakia, Spain, England), which integrate computer programming into the curriculum, a preliminary training course is applied to support teachers in teaching computer programming at different levels. Training courses Ministry of Education. In the Czech Republic, France, Finland, Hungary, Lithuania and Poland, the Ministry of Education does not provide direct training opportunities. Instead, a variety of other institutions offer such training. In many countries such as Belgium, Bulgaria, the Czech Republic, Estonia, Finland, Ireland, Israel and Lithuania, training courses are held by universities, but also by companies and non-profit organizations. In France, Finland and Poland this training is organized at a local or regional level. In the UK, Estonia and Ireland, centralized support is offered through funding of learning resources and training projects to assist teachers in implementing curricula. Portugal supports initiatives and competitions at central level. Slovakia, Hungary, Malta, Spain provide ICT training in the workplace, which includes training of teachers from all over the country in computer programming. Spain plans training in computer programming for teachers both at national level and in the autonomous regions where it is integrated. In Malta, all teachers have been trained for two weeks at their

workplace. In Slovakia, the Ministry of Education assists in providing training centres in the workplace in schools and universities.

Teacher training is considered to be particularly important in countries and regions where new curricula or new disciplines are to be introduced. In these cases, it is necessary to train a large number of teachers for a relatively short period of time. Therefore, teacher training is mainly organized by universities integrating computer programming into their curricula. There are also many other initiatives and training courses for computer programming teachers through the networks of amateur programmers, non-governmental organizations, private companies, teachers' organizations, and professional associations.

Examples of popular initiatives to increase the activity and motivation of both teachers and students include computer programming clubs and the organization of summer schools and courses. Competitions are a means of attracting talented students who are interested in computer programming and prizes for outstanding achievements - for example, in Bulgaria, the Czech Republic, Estonia, Finland, France, Hungary and Poland. Many countries support computer programming teachers by providing educational resources at various national or regional portals (for example, Ireland, Belgium, Flanders, Estonia, the Netherlands). Other countries encourage teachers through specific computer programming sites and public platforms (such as Bulgaria, France, Norway, and Poland). Several countries also support pan-European initiatives such as Code Week (for example the Czech Republic, Poland, Bulgaria, Portugal and Spain).

2.2. Initiatives and training for teachers in Bulgaria

Popular initiatives in Bulgaria are clubs for computer programming and robotics, the organization of summer schools, often conducted by authoritative training organizations or scientific institutions. Over the last few years, over 100 school robotics clubs have been created with support from SAP for students in all age groups. There were free online training courses for the teachers who organized the activities in these clubs. All these initiatives motivate primary school teachers and teachers in different learning disciplines to look for a variety of computer programming training opportunities.

Historically, in Bulgaria, until 2016-2017, computer programming was studied as a compulsory subject in the 9th grade within 2 hours a week. The new Pre-school and School Education Act stipulates that from the 2017/2018 school year this school subject is to be taught to students in the 8th grade (2 hours a week or 72 hours per year) who are trained in profiled education with intensive study of a foreign language with profiles "Mathematics", "Software and Hardware Sciences", "Economic Development" or "Natural Sciences". From the new 2018/2019 school year the subject "Computer Modelling" is introduced in 3rd and 4th grade as compulsory school hours.

The introduction of new curricula and curricular changes require a continuous increase in the level of knowledge and skills of all teachers, but this process is critical, especially for primary teachers who have not yet studied ICT, computer modelling and programming. This and the fact that a large percentage of these teachers do not feel comfortable working with digital devices, determines the need to look for a variety of ways, methods and approaches to stimulate and motivate primary teachers to learn.

3. OUR EXPERIENCE IN TRAINING TEACHERS

Surveys of the world and European experience in organizing computer programming training at all levels of school education, as well as the accumulated over the years Bulgarian experience (Glushkova, 2016) give us grounds to seek opportunities to stimulate the teacher's interest in this scientific field. A few years ago in Plovdiv region, together with the regional education administration, we set up a methodological ICT council, which included leading teachers, university lecturers and experts. We have identified several stages in which teachers will consistently learn about different aspects of computer modelling and programming:

- First Stage - Learning to Use Interactive Methods, Cloud Technologies and E-Learning Environments (2014/2015)
- Second Stage - Training of Primary and Lower Secondary Teachers in Block-Based Programming (2015/2017)
- Third stage - training of primary teachers to teach the new subject "Computer Modelling" in third grade.

During the first period, we held several training seminars that examined the capabilities of ICT and cloud technologies for organizing interactive learning. In particular, the opportunities for applying e-Learning in the classroom and in the independent learning of students were discussed. A review and classification were made of the existing learning environments (Glushkova, 2014) and the different levels of interactivity that are being reached with them (Rachnev, Rahneva & Valchanov, 2007). More attention has been paid to Moodle-based learning platforms. The main types of learning resources and services in this platform were outlined. The participants were given the task of developing one lesson from a general course. After their final completion and testing the electronic educational resources were published in the MOODLE platform of one of the leading schools, the Hristo Smirnenski Secondary School in Brezovo, for use by all participants (Glushkova & Neykova, 2013). Also, in greater detail was studied the creation of different types of tests in the MOODLE platform. Each participant had the opportunity to test the various test development options. Each training seminar ended with a feedback survey, the purpose of which is to trace whether there is an increased interest in using computer technology and whether teachers are more confident in its application in the classroom. To our satisfaction, all participants

have responded that the structure and organization of the seminar is good, the goals are clear, the lessons learned would serve them in their work. 89% of the participants welcomed the style of presentation and encouragement, and the same percentage have responded that the training was varied and informative and its goals were met.

The assessment of the effectiveness of the training was done using the following methods:

- A test developed and conducted in an e-learning environment.
- Practical task – Development of an electronic lesson that includes a variety of resources (teaching material, homework assignments, tests, online consultations, forums, learning games, etc.)

A quantitative and qualitative assessment was carried out by the experts and seminar presenters. The average test score of the participants is 87%. It was found that in the 2015/2016 school year, over 90% of the participants had repeatedly applied the obtained knowledge in their work with students. This gave us confidence to continue our work in this direction by planning and organizing the training in the next stage.

In the second period, we set ourselves the goal to introduce teachers to the potential of block-based programming environments. We decided to organize and conduct a three-year experiment with training of students from different cities, schools and age groups in computer programming in interest clubs. We analysed the peculiarities in the development of logical and algorithmic thinking in early stage students as well as the experience gained by computer programming and computer science education in Europe. The goal we have set is to stimulate the development of students' logical and algorithmic thinking and to increase student activity by studying block-based languages and computer programming environments. To achieve this goal:

- we organized teacher training on block-based programming;
- we set up a school curriculum for training students (Tabakova-Komsalova & Glushkova, 2016);
- we have periodically conducted support training on an online platform;
- we created sets of sample learning tasks in each of the curriculum topics;
- we traced, analysed and summarized the learning results of the students. (Tabakova-Komsalova & Glushkova, 2017).

It is difficult to learn a new language for computer programming and at the same time to learn a new way of thinking and solving problems. This hampers teachers and they fear mistakes. All participants were briefly acquainted with the most popular 2D and 3D environments for block computer programming such as: Scratch, Blockly, Snap!, Stencyl, MIT App Inventor, Alice, Kodu, etc.

(Tabakova-Komsalova & Glushkova, 2016). Since teachers were already familiar with work in the Moodle e-learning environment, training was conducted in mixed form of attendance courses and online training. Throughout the experiment, periodic online discussions, seminars, meetings and discussions took place.

As a result of the training, teachers became more confident and found that programming can be fun and entertaining. Motivated by this, they wished to apply the acquired knowledge and skills in their work with students. For the three-year period considered, programming clubs were formed that included pupils from all primary school classes. In order to get statistically correct results, we took a sample of students from different types of locations, different types of schools and different grades of primary school from Plovdiv District. These students were monitored and tested. The analysis of the results fully confirmed the expectations. The average result of the students is 4.92 or 79.8%. The interest in programming is very high, and the use of interesting interactive approaches and the opportunity to program robotic devices further enhanced student activity and the efficiency of the learning process.

The accumulated knowledge and experience of teachers during the second training period increased their confidence and motivated them to seek additional opportunities for self-improvement and realization. Some of the teachers created robotics clubs, others sought to be distinguished with their pupils at various competitions and contests. Thus, it was easier to accept the fact that, according to the new changes in education, they should teach computer programming as a compulsory subject.

The first and second stage training was not mandatory for all teachers. In the third stage, however, all primary teachers had to be trained. The Ministry of Education and Science of Bulgaria together with various training organizations and universities carry out free qualification advancement courses for primary teachers who will teach the new subject "Computer Modelling" in the 3rd grade of the 2018/2019 school year. The experience gained during the previous two stages has enabled us to organize and conduct successful training with a practical focus. The training program contains the following topics:

1. Block programming
2. Digital identity and digital identity management
3. Constructing sequential actions
4. Constructing cyclical actions
5. Visual programming environment
6. Working with text and sound
7. World of animation

Kits of learning tasks were developed, classified according to the curriculum topics (Garov, 2017). The training is practically oriented, and at the end of the course, each teacher receives a theme for developing a project in the field of Animation and/or Computer Games. Throughout the learning process, teachers can use online resources provided in the Moodle-based e-learning platform specifically created. The best practical projects were shared in the platform. Thus, after several training courses, teachers themselves created a rich collection of sample projects that they could use in their future work.

CONCLUSION

Worldwide, computer programming is becoming more and more relevant in school education. Bulgaria is one of the first countries to introduce programming in 1986 (Rahnev, 1987). Currently in our country, tendencies in computer science education, typical of the developed European countries, are maintained. The introduction of computer modelling and programming as a compulsory subject in the primary level of education from the school year 2018/2019 is forthcoming.

Training primary school teachers is an important and current task, given the introduction of new technologies from the very beginning of school education. Lifelong learning and the use of electronic and distance learning environments enable better and more effective teacher training and faster and more sustainable learning outcomes for students of the digital generation.

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