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Research Article

Microworlds or Robot Programming as Possibilities for Teaching the Basics of programming

Veronika Gabaľová *

Department of Mathematics and Computer Science, Trnava University, Faculty of Education, Slovakia.

(veronika.gabalova@truni.sk)

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Abstract **–**Currently, the extremely rapid development in the field of information and communication technologies is virtually unstoppable, and the penetration of information and communication technologies into all areas of everyday life is also unstoppable. Information and communication technologies are becoming increasingly invasive, and this fact also points in the direction of where attention should be focused in the educational process so that the youngest generation also acquires the skills and habits that are necessary for their effective mastery. One way of orienting education is to aim at the development of algorithmic thinking skills in children and young people. It is important that children learn the basics of algorithmisation and programming specifically through visualised programming environments. This paper discusses the possibilities of teaching the basics of algorithmization and programming through appropriate tools and problem visualization. Children's programming languages as well as robot programming are considered as appropriate tools. Especially robot programming is nowadays an interesting way of teaching programming, regardless of whether it is a robot that pupils can grab in their hands or whether they are programming an online robot, for example VEXcode Vr . Teaching programming through the creation of computer games is another option. Special emphasis is placed on the attractiveness of the microworld object when teaching pupils the principles of programming. There are several ways to make it attractive. It is important, however, that we get closer to the real world. There are a number of ideas for teaching programming in children's programming languages that, depending on the language being taught or the level of knowledge of the pupils, can be incorporated into the classroom. A suitable motivation can be programming games.

Keywords – Microworlds, Robot Programing, Microcontrollers, Teaching Programing, Algorithmic Thinking

I. INTRODUCTION

Today, the extremely rapid development in the field of information and communication technologies is virtually unstoppable, and so is the penetration of information and communication technologies into absolutely all areas of everyday life. This fact also points in the direction of where attention should be focused in the educational process so that the youngest generation also acquires the skills and habits necessary to master them effectively. One of the options offered in education is to focus on the development of algorithmic thinking skills in children and young people. However, even this is a virtually

endless process, as these skills need to be continually honed and given room to progress. After all the curriculum of the subject of computer science for primary school pupils aims to make available the basic concepts and techniques used in working with data or creating algorithms and computational processes. A fundamental module of this curriculum is the opportunity to impart education in algorithmic problem solving and to improve algorithmic thinking through the creation of programs and work in children's programming languages.

During her pedagogical practice, the author has often encountered the question whether it is necessary and important to teach algorithmization and programming to children already in primary schools. Based on my own experience, it can be concluded that such a question is usually asked only by those who have little or no knowledge of the subject.

II. CHILDREN'S PROGRAMMING LANGUAGES

Although computer science is a relatively new discipline, its origins date back to the 1980s. Also the history of the development of programming languages dates back to the second half of the twentieth century, which is also a relatively recent history. During that period, however, hundreds of programming languages have been developed, some of which have disappeared, some of which are constantly evolving, with their versions constantly being improved, simplified and, above all, adapted to the present day. At the same time, new programming languages have been created throughout history, depending on the specific requirements of technology and the increasing knowledge and experience of programmers. A special group consists of educational programming languages, which are designed to teach programming and algorithmic thinking. In this context, children's programming languages, mini-languages or microworlds are often spoken of. (eg. [3]).
The base of writing algorithms in an environment of appropriate and age-appropriate programming languages is a topic that the pupil should be exposed to from the first contact with school. Algorithmisation and programming provide the basis for both logical and abstract thinking, which is an important moment in primary education.

The advantage of children's programming languages, as the name suggests, is that they are also suitable for the youngest age category, for children. These programming languages have a limited syntax and usually a simple semantics. The writing of algorithms in children's programming languages is visualised. Their main characteristic is simplicity and comprehensibility. Primary school children can learn them easily and in a relatively short time and subsequently use them to solve various tasks. They will thus learn the secrets of well-known algorithmic principles and programming principles.

The other quite important advantage of children's programming languages is that they are built on metaphors, thus allowing the creation of rich sets of different problems related to students' everyday life experiences.

Visualizing the operations performed by the central character in that-any child programming language helps to reveal the semantics of the language and its linguistic constructs. Just visualization can help pupils to understand the semantics of the constructs presented and implemented by the central character, it can also be helpful in clarifying the principles of the implementation of programming structures and also prevent the occurrence and propagation of errors. Visualization of objects also supports exploration-oriented teaching, which is one of the activating teaching methods.

When we are teaching students the principles of programming, special emphasis is placed on the attractiveness of the microworld object. There are several ways to make it attractive. However, it is important that we get closer to the real world.

A good programming environment, which we use in teaching algorithmization and programming, should allow pupils to see not only the microworld on which the central character moves on the computer screen,

but also the pupil's program at the same time. Ideally, in the interactive programming mode, the pupil can implement the correction in the command, and again have the central character execute the written algorithm. It is also very important that the execution of the program is illustrated (see Fig. 1)

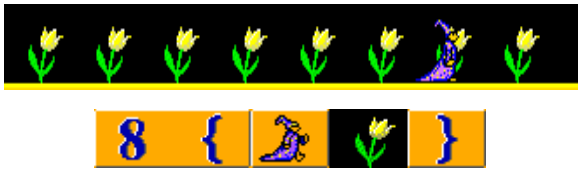

Fig. 1 Example of code in Baltik 3.0 and its visualisation

It is very important that the teaching of programming is sufficiently motivating for the pupil. Exiting several perspectives on what motivation is from various examples we select the view of Kassin that motivation is an internal state that gives a person the energy to achieve a set goal. Motivation can be considered as a stimulus that the learner needs to identify with. Positive as well as negative motivation in school can interfere very strongly with a pupil's academic achievement, performance and the development of the pupil's personality. Positive motivation is one of the conditions for effective learning, it influences concentration, memory processes, but also learning stamina. Children who enjoy learning and feel happy about it have a positive perception of their school life. However, if they experience control and guidance or even direction from outside as part of the learning process, they will not be motivated. On the other hand, there are also many situations which, on the contrary, cause a decrease in pupils' performance. Usually these cause students' frustration accompanied by boredom, fear, anxiety, but also over-motivation. In any activity, correct and early feedback is necessary, focusing on the progress or outcome of the activity. However, it is never appropriate to judge the qualities of the student doing the activity. (eg. [5], [6], [7])

Knowledge is formed in pupils after certain stages, which can be illustrated by the author of the article as illustrated as follows:

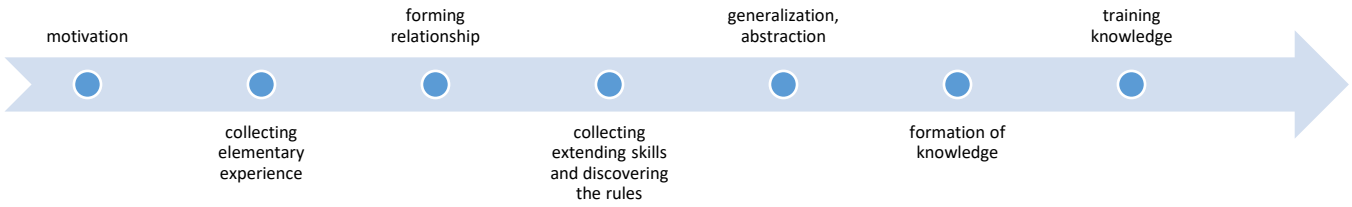

Fig. 2 Phases of knowledge formation based on the didactics of mathematics according to Professor Hejný

The illustrated stages of knowledge formation are based on the didactics of mathematics, the foundations of which are anchored in the theory of Professor Hejný (eg. [1], [2]). The authors argue that new (mathematical) knowledge can be acquired by the pupil through sufficient experiences and their rearrangement.

The pupil enjoys such tasks whose degree of difficulty of solution corresponds to his highest abilities. In addition to an acceptable degree of difficulty, the context of the problem to be solved must also be interesting to the pupil.

The problem assignments used to teach programming need to be oriented not only to the design of new algorithms, but the students need to demonstrate that they also understand the algorithms written, i.e. they understand the task assignment.

A constructivist approach is important for teaching algorithmisation and programming. When applying the constructivist approach, it is perhaps most important that ideas and concepts can be tested and

visualised almost immediately, as imagination is extremely important for pupils. In the case of children's programming languages, visualization is respected. In the interactive mode, the learner immediately knows what the object does as an executor of the algorithm written in the source code, and in the programming modes, after the code has been written and executed, the object visualizes the overall implementation of the code written in the algorithm.

III. ROBOTICS PROGRAMMING

In parallel to teaching the basics of programming through microworlds, there is another rather powerful and of course visualised tool for teaching the principles of programming, namely robot programming. Whether it is robots that children can grab in their hands and build from a Lego kit, for example, or programming microcontrollers such as the Arduino, which they can also build into a "jigsaw puzzle" of something that they have built or its components printed on a 3D printer. There is also the possibility of programming online or virtual robots, for example the VEXcode VR programming environment allows the user to control and program their "own" virtual robot at https://vr.vex.com/.. The approach to programming is based on composing so-called blocks into a sequence by dragging the mouse, which makes it a suitable choice also for pupils of lower grades, thanks to its simple operation. (eg. [4], [5])

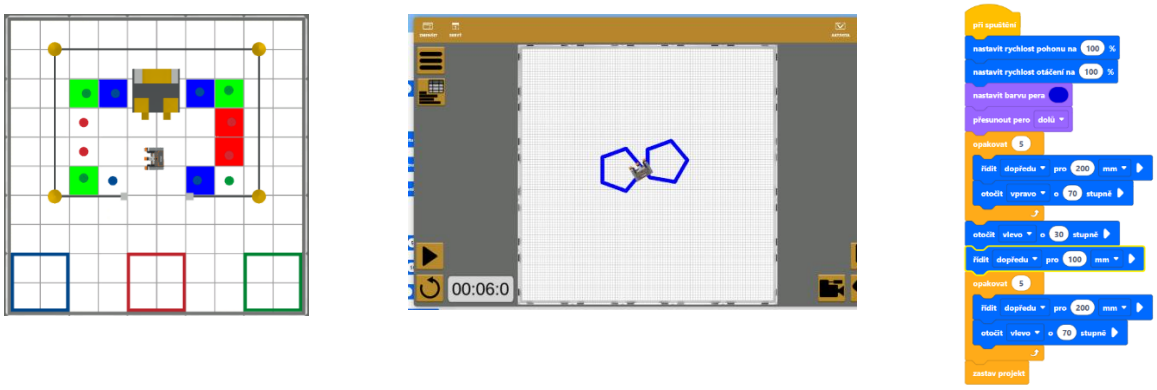

Fig. 3 Examples of visualisation robot in VEXcode VR and example of code VEXcode VR

IV. DISCUSSION

Teaching programming in microworlds and programming robots or microcontrollers are two important areas in modern computer science education. Microworlds, or children's programming environments, are interactive environments designed to teach programming, allowing students to experiment with code and algorithms in a simplified context. Robot and microcontroller programming combines programming with real hardware to support practical applications of computer science and engineering. The most commonly used platforms are LEGO Mindstorms, Arduino, Raspberry Pi, micro:bit or VEX Robotics. Benefits of this approach include hands-on experience where pupils see how their programs affect physical devices; developing critical thinking and problem solving skills; testing, debugging and optimising code in real-world conditions. The interdisciplinary link, combining computer science, electronics and mechanical engineering, is very important. Both approaches, programming in microworlds and programming robots or microcontrollers, are effective for developing students' algorithmic thinking and creativity. Their combination allows a smooth transition from visual and block programming to text-based programming languages and more complex robotics and IoT projects.

V. CONCLUSION

For teaching basic programming, it is important to know the advantages and disadvantages of different programming languages and to choose the most suitable one for teaching basic programming. The choice of an appropriate children's programming language is very important, especially if the pupils are gaining their first experience of programming. The perspective of the children's programming languages used is equally important for the computer science teacher. It is also necessary to place great emphasis on the pupil getting a lot of experience gradually and especially in small steps. It is therefore necessary to allow sufficient time and to choose an appropriate sequence of tasks from simple assignments to more complex ones. Progressively increasing the difficulty of assignments and problems and positive motivation should be taken for granted. One way of positively motivating pupils is to take advantage of their natural competitiveness. Especially for pupils who are particularly gifted and have a huge interest in programming as such. The fact that they can compare their skills and knowledge in different competitions is also a great benefit. There are a number of topics for teaching programming in children's programming languages, programming robots, which can be included in the classroom depending on the language taught or the level of knowledge of the students. A suitable motivation can be programming games. Gamification, or the teaching of programming through game programming, is another very attractive area for teaching programming in primary and secondary schools.

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