Приложното блоково-базирано програмиране като иновативен метод за преподаване в основните и средните училища

Георги Христов, Пламен Захариев, Нина Бенчева

The applied block-based programming as an innovative teaching method in the primary and secondary schools

Georgi Hristov, Plamen Zahariev, Nina Bencheva

Abstract:
The block-based programming is a proven and successful method for introduction of the basic programming concepts in the elementary and secondary education. This method is characterized by many advantages, but also has one significant drawback – most of the used programming environments and online platforms are not allowing the establishment of a connection between the created programs and the actual physical world. To overcome this problem, the block-based programming can be used in combination with innovative hardware platforms, robots or drones.

This publication presents several solutions for applied block-based programming, which involve the use of different types of hardware platforms and are suitable for teaching processes with students from the third to the seventh grade. The publication also presents the results from the implementation of two pilot training courses on applied block-based programming, which were conducted with teachers from primary and secondary schools in the Municipality of Ruse.

Keywords: block-based programming, practical programming, programming of robots, micro:bit, micro:maqueen, DJI Tello

For contacts: Prof. Dr. Georgi Hristov, PhD, University of Ruse, ghristov@uni-ruse.bg

INTRODUCTION

The Block-Based Programming (BBP) is a proven and successful method for introduction of the basic programming concepts and principles in the elementary and secondary education. Currently, there are numerous programming environments and online platforms, which can be used for block-based programming (Fig. 1) [1].

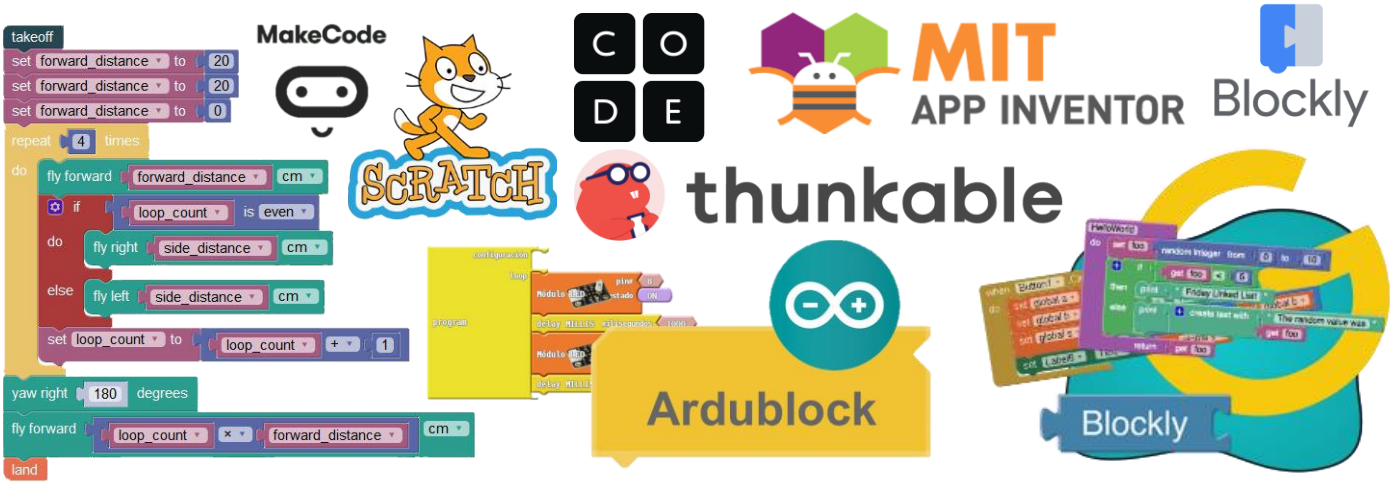

Fig. 1. Different block-based learning environments and online platforms

The concept of the BBP is based on the constructive learning approach, which was initially introduced by Prof. Seymour Papert – a pioneer in the field of artificial intelligence and the learning technologies [2]. He is also known for his studies on the impact of the new technologies on the children and their learning perception and is also widely recognized for having recognized, before everyone else, the role of the computers in the education. Seymour Papert is also co-author, together with Wally Feurzeig and Cynthia Solomon, of the Logo programming language [3] and is one of the co-founders of the MIT Media Lab [4]. His book, Mindstorms, is considered to be the inspiration for the LEGO Mindstorms series of robotic platforms for children, which were also developed based on his ideas [5].

Scratch [6], which is one of the most popular BBP solutions, was originally introduced as a computer application in 2007 by the Lifelong Kindergarten Group at the MIT Media Lab [4], the same research institutions, which was co-founded by Prof. Papert. Scratch, which was also inspired by the Logo programming language, was developed as an open-source platform that is based on blocks and allows for different possibilities for the development of different programs [7]. Since its initial public release, Scratch has gained massive recognition and has been widely adopted by primary and secondary schools and many other educational institutions. Scratch was originally used as a tool to teach programming technologies to children (Fig. 2). As of May 2024, the platform has more than 132 million registered users, which makes it the largest programming platform for children [8].

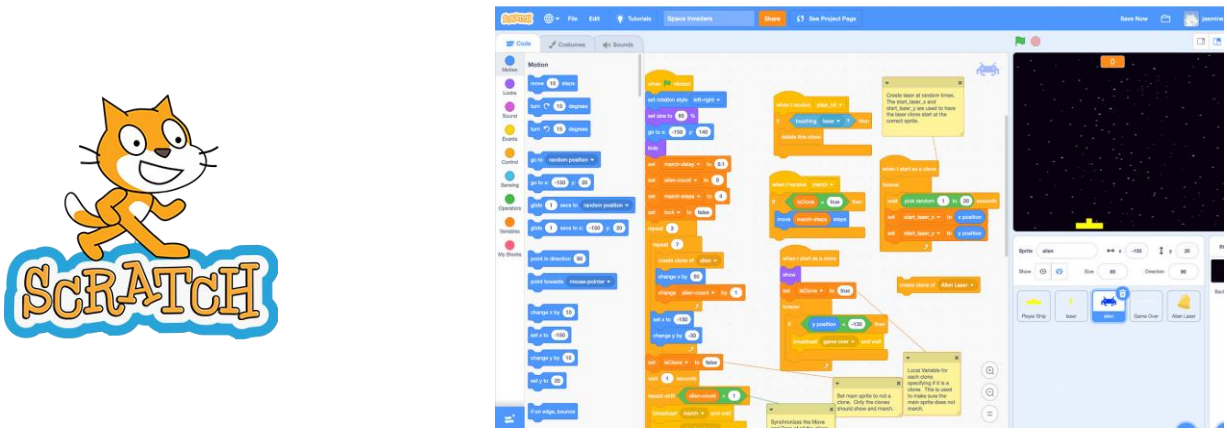

Fig. 2. The logo of the Scratch BBP platform (left) and the main interface of the platform (right)

The block-based programing platforms and solutions are known to have numerous advantages over the traditional script-based programming environments. Above all, the BBP solutions are requiring only limited basic initial knowledge, as the process of "assembling" the programs by dragging the elements makes the programming much more convenient and less complicated for the students. Further to this, the BBP comprises an easy method of learning and teaching, which challenges the learners to experiment, makes the learning interesting and entertaining and helps in the development of logical thinking. The debugging of the programs is also a relatively easy process, which is further reducing the code troubleshooting burden for the educators. Last, but not least, the BBP teaching methods provide means for a smooth transition of the students to the scripting programming languages [9].

APPLIED BLOCK-BASED PROGRAMMING OF ROBOTIC PLATFORMS

Regardless of the many advantages of the BBP, this teaching and learning approach is characterized by one serious drawback - most of the available programming environments and online platforms are not able to provide means for the linking of the developed programs to the real physical environment. This means that the children often do not realize how their programs can be used in the real world, i.e. outside the computers [9].

To overcome this problem, many educators and teachers have started to develop or use educational robots, which were adapted or solely developed to be compatible and used with the available BBP solutions (Fig. 3).

Fig. 3. Various robotic platforms for educational purposes, which are compatible with the block-based programming platforms

Despite of the wide availability of the mentioned educational robotic platforms, their widespread and use in the educational institutions in Bulgaria was found to be limited. This was mainly due to the lack of funding for the purchase of these platforms, the lack of teaching materials and most importantly the lack of training for the educators. To solve all of these problems, we have developed a methodology for the integration of the applied BBP teaching method in the educational institution in Bulgaria (Fig. 4).

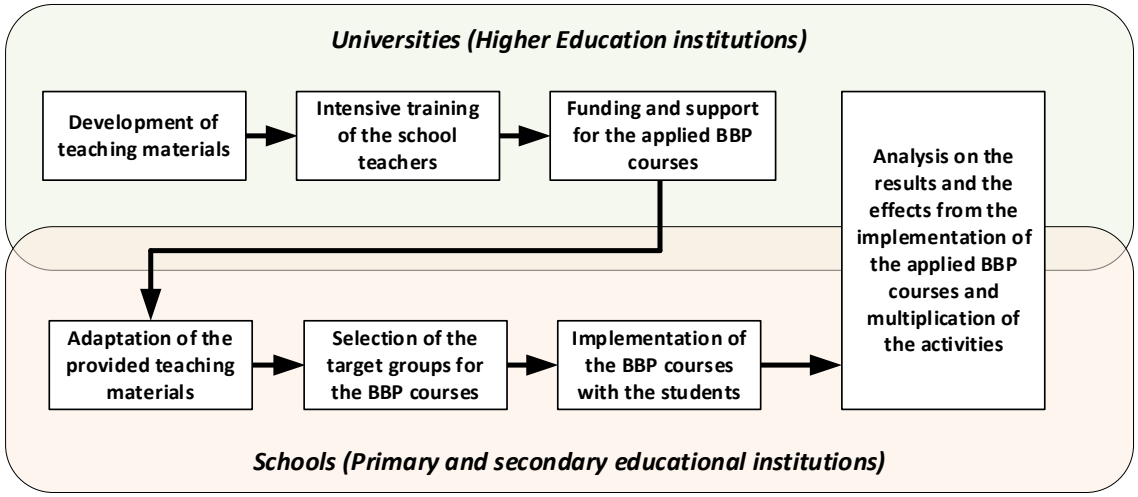

Fig. 4. The developed methodology for integration of the applied BPP methods in the educational institutions in Bulgaria

To test the effectiveness of the proposed methodology, we have developed two training courses for teachers in the primary and secondary schools in the Municipality of Ruse.

The first of these training courses was entitled "Block-based programming of drones" and consisted of 10 main classes and 2 bonus topics. The course was developed for use with the DJI Tello Edu mini drones [10] and the DroneBlocks BBP platform for mobile devices [11]. All of the developed course materials were presented to the teachers in the form of PowerPoint presentations and were further made available to the educators using a proprietary online learning platform [12]. Following the development of the first course, a second course entitled "Robotics with micro:bit" was also developed. This course was developed for the use with the micro:bit microcontroller [13] and the micro:maqueen robot platform [14], while the used BBP programming platform was MakeCode [15]. The course consisted of 20 main and 3 bonus topics, which were also presented to the participants in the course in the same was as the first course. Both pilot courses were conducted with 20+ school teachers in the period between November and December 2023 (Fig. 5).

Fig. 5. Moments from the two specialized courses on applied BBP with drones and robots

To evaluate the effects from the conducted courses, a special competition for school students from the 3rd and 4th grade in the schools from the Municipality of Ruse was organized. These students were correspondingly trained by the teachers that were involved in the applied BBP courses. A total of 65 students have participated in the competition (Fig. 6) and have demonstrated significant applied BBP skills.

Fig. 6. Moments from the student competition with robots that were programmed using applied BBP

CONCLUSIONS

The applied block-based programming is an attractive and engaging way for introduction of new knowledge and for development of practical skills that can solve the presented problems with the traditional BBP. The universities can play an extremely important role for the successful large-scale deployment of applied BPP courses – by providing qualified educators to prepare the school teachers and by developing interesting and entertaining teaching materials, textbooks and presentations.

ACKNOWLEDGEMENT

This paper was prepared with the support of Project 2024-FEEA-03, financed under the Scientific and Research Fund of the University of Ruse "Angel Kanchev".

REFERENCES

1. Z. Xu, A. Ritzhaupt, F. Tian, K. Umapathy, Block-based versus text-based programming environments on novice student learning outcomes: a meta-analysis study, Computer Science Education, vol. 29, 2019, pp. 1-28, ISSN 0899-3408, DOI 10.1080/08993408.2019.1565233
2. S. Papert, I. Harel, Constructionism, Ablex Publishing, pp. 193–206, 1991
3. H. Abelson, N. Goodman, L. Rudolph, Logo Manual, Artificial Intelligence Lab, Massachusetts Institute of Technology, 1974
4. Official webpage of the MIT Media Lab, available at: https://www.media.mit.edu
5. S. Papert, Mindstorms: Children, Computers, and Powerful Ideas. New York: Basic Books, 1982, ISBN 978-0-465-04629-4
6. Official webpage of Scratch, available at: https://scratch.mit.edu
7. J. Maloney, et al., Scratch: A Sneak Preview, Proceedings of the 2nd International Conference on Creating, Connecting and Collaborating through Computing, Kyoto, Japan, 2004, pp. 104-109, DOI 10.1109/C5.2004.1314376
8. Official webpage of the Scratch statistics, available at: https://scratch.mit.edu/statistics/
9. D. Weintrop and U. Wilensky, To block or not to lock, that is the question: Students' perceptions of blocks-based programming, Proceedings of the 14th International Conference on Interaction Design and Children, pp. 199–208, 2015, DOI 10.1145/2771839.2771860
10. Official webpage of the DJI Tello Edu AI-powered educational drone, available at: https://www.ryzerobotics.com/tello
11. Official webpage of the DroneBlocks BBP platform, available at: https://droneblocks.io
12. Official webpage of Academy BG, available at: https://www.academy-bg.eu
13. Official webpage of the micro:bit microcontroller, available at: https://microbit.org
14. Webpage of the micro:maqueen robot extension kit at the DFRobot website, available at: https://www.dfrobot.com/product-1783.html
15. Official webpage of the MakeCode BBP platform by Microsoft, available at: https://makecode.microbit.org