Using mBot robots for the motivation of studying computer science

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Abstract - Students in primary and secondary schools in Slovak republic are not very interested in study computer science, especially programming. At our department, we are trying to motivate primary and secondary school students to learn programming through multiple activities, such as computer science extracurricular activity and doing workshops in primary and secondary schools. This contribution deals with using Makeblock mBot robots for teaching programming in primary and secondary schools.

Keywords – mBot; teaching informatics; programming;

I. INTRODUCTION

Due to the massive expansion of computers and mobile devices into almost all areas of everyday life, it is required to have more and more people skilled in computer thinking. Students use mobile devices and computers almost constantly, but they do not have a particular interest in studying programming. Therefore, it is useful to motivate them teaching programming since the primary school. Nowadays we can find enough great tools and teaching aids for programming, such as Scratch, Lego Mindstorms, Kodu, BBC micro:bit, Ozobot robots, etc. For teaching computer thinking it does not matter which tool or didactic aids we use. Almost all of them are appropriate for teaching programming. The problem could be low interest of students to learn programming.

Recently, an increasing number of educators have considered educational robotics as a promising field for applying the embodied cognition view [1]. Researchers and teachers are popularizing Computer Science and its practical usage in Slovakia as well [2-5].

Robotics for STEM (Science, Technology, Engineering and Mathematics) is an interdisciplinary emphasizing collaborative learning, and robots have been perceived as a potentially powerful vehicle, providing opportunities for construction, experimentation and collaboration between learners [6].

Ts. St. Georgiev from Ruse University did research about using MIT App Inventor programming environment at different levels of education. [7]. S.-W. Kim and Y. Lee have conducted a study [8] on the possibility of including App Inventor in the national curriculum for primary school students in South Korea. The results show, that the use of this program does not improve the ability of small group students to creatively solve problems and also that more time is needed for learning.

The solution could be using STEM robots and online tool App Inventor for increasing students' interest about teaching programming. The worldwide most popular STEM robots are Lego Mindstorms robots, but the main disadvantage of these robots is their price. The solution could be to use Makeblock robots which are significantly cheaper compare to Lego Mindstorms.

II. COMPUTER SCIENCE EXTRACURRICULAR ACTIVITY

We are using various types of STEM robots in our computer science extracurricular activity at Department of Computer Science FNS Matej Bel University in Banská Bystrica, Slovakia. This activity is focus on gaining additional teaching experience for our students from department and to teach programming to primary school students. Its free and its organized twice a week (different students on each group) since the academic year 2017/2018. This academic year, we have 27 students from primary schools and 20 students from our department (as teachers). Fig. 1 shows programming mBot in computer science extracurricular activity at our department.

Figure 1. Computer science extracurricular activity - programming mBot

III. WORKSHOPS

To increase interest of learning programming we offer free workshops for primary and secondary schools in Banská Bystrica county. Each school could choose workshop topic (programming microcontrollers Arduino, programming mobile applications, programming robots, etc.).
Due to pandemic of covid-19 this year, we did only two workshops of programming robots topic. One of them was in the Gymnázium Jana Chalupku in Brezno and the other was in the Gymnázium Milana Rúfusa in Žiar nad Hronom. Both of these schools were eight-year secondary grammar school. In the Gymnázium Milana Rúfusa in Žiar nad Hronom we had two-day workshops.

In the teaching process we started with simple robots Phiro Pro and the main time we focus on using mBot robots. Fig. 2 shows workshop with mBot in Brezno.

![Figure 2. Gymnázium Jana Chalupku – workshop](image)

Fig. 3 shows workshop with mBot in Žiar nad Hronom.

![Figure 3. Gymnázium Milana Rúfusa - workshop](image)

IV. MAKEBLOCK ROBOTS

Makeblock Co., Ltd, founded in 2013 is targeting the STEAM education and entertainment markets for schools and everyone who want to learn programming. Makeblock provides comprehensive hardware, software, content solutions, and top-notch robotics competitions, with the aim of achieving deep integration of technology and education.

The company offer various types of robots which could be programmed in the mBlock app (for computers') or for mobile devices Makeblock app (iOS and Android').

We used for teaching mBot Ranger and mBot robots. Basic version of this robots is mBot, which is entry-level educational robot kit. mBot Ranger is educational robot, which is improved version of mBot, that comes with 3 preset forms, the tank-like Off-road Land Raider, the three-wheel racing car Dashing Raptor, and the Self-balancing Nervous Bird. Both of them contain Bluetooth module, line follower sensor, ultrasonic sensor, gyroscope, lights and mainboard contain microcontroller Arduino. mBot is cheaper version (99€) as mBot Ranger (150€). Fig. 4 contains robots: mBot Ranger and mBot.

![Figure 4. mBot robots](image)

V. MBOT TASKS

We prepared the various types of tasks for mBot and mBot Ranger. The robots are almost the same with very small difference in functionality. Because of that, we can use them for the same tasks. All students already have some previous experience with Scratch block environment, these experiences were useful for them.

All tasks and teaching materials are available at our webpage⁴.

In this paper we describe three types of tasks, students from extracurricular activities and workshops worked on as an example.

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1 https://www.mblock.cc/en-us/
3 https://play.google.com/store/apps/details?id=cc.makeblock.makeblock
Activity name: Programming mBot robots
Target group: 5.-9. year primary school
Expected time: 2 hours
Goal:
Cognitive goal - The student learns to program using visual programming.
Affective goal - The student is able to respond correctly to regulations and rules.

Methods and forms:
- investigative and research methods,
- methods of individual work of students,
- narration, description, explanation,
- question and answer method,
- methods of practicing and improving skills.

Preparation, teaching aids:
Materials:
Computer with internet access, robots mBot
software:
Off-line: Mblock (Windows), Makeblock (Android, iOS)

The course of the activity:
Task 1 - checking lights, turn signals, horn before driving
The first thing we should do, when we sit down in the car is to check the lights, turn signals, brakes, horn. It's similar with our mBot. This task is focus on the basic functionality of the car:
1. Turns on white lights (LED)
2. The brake lights come on for 1 sec - red
3. Turns on the left turn signal for 1 sec - orange
4. Turns on the right turn signal for 1 sec - orange
5. Starts the horn for 2 seconds

Students read the assignment and the teacher verifies, that students understand the assignment. Students work on tasks individually or in pairs. The teacher watches the students and if necessary, he explains the ambiguities.

Into the block “When the green flag clicked”, we will gradually insert a commands for displaying lights.

Extension options:
- set longer lights (e.g. 3 seconds)
- Add a command, that delayed the lights for 2 seconds (white light, 2 seconds wait, red light, 2 seconds wait, left turn signal, 2 seconds wait, right turn signal, 2 seconds wait, trumpet)
- Finally, add flashing turn signals. Program them, so that they will flashing (eg both at the same time).

Task 2
After pressing the button (green flag), the red light on the mBot lights up for 1 second, then the orange light for 1 second and finally the green light for 1 second. After the green light, the lights turn on - the white light (which will always be on) and the mBot will start first at a speed of 40% (0.5 seconds), then 60%, 80% and finally 100%. When the speed reaches 100%, mBot lights up the bridle (red light) and mBot stops.
Task 3 – cycles

Edit previous example # 3 to create a variable, that you initialize to 40. This variable will store the vehicle speed mBot. Modify the "move forward" calls, so that you only use this command once in the code (use a loop, don’t forget to increase the value of the global variable by 20)

VI. METHODOLOGY AND RESEARCH

Our research was held in the academic year 2019/20 and it still lasts. In our research, we used didactic aids - robots for learning programming in two eight-year secondary grammar school in Brezno and Žiar nad Hronom (Slovak republic). The main aim of our research was to find out, whether we can increase students’ interest to study programming by using didactic aids - robots. We used the questionnaire for measuring data of our research. We asked 41 students several questions in the questionnaire. The questionnaire filled 28 boys and 13 girls. The respondents were 7 and 8 class students (13-14 years old). Students were selected according to their interest (except extracurricular activity at our university).

First question after the gender selection was focused to whether they use didactic aids - robots before. All of them said, that they used Lego Mindstorms.

Question How much did you enjoy programming mBot robots? was aimed to measure interest of using mBots. On a scale from 1-5, they chose options - 1 meant did not enjoy at all and 5 had a lot of fun. Fig. 5 shows, that almost all of students chose the option “had a lot of fun”.

Figure 5. How much did you enjoy programming mBot robots?

Question Were the activities difficult for you? was aimed to complexity of tasks. Fig. 6 shows that, 41,5% students said no, 51,2% said “rather no” and only few of responders said “yes” or “rather yes”(6%).

Figure 6. Were the activities difficult for you?

We asked same questions also our students in Computer science extracurricular activity at our university. The questionnaire filled 20 students, all of them were boys.

On the same question as in the secondary grammar school How much did you enjoy programming mBot robots? Fig.7 shows, that all of the students answered positively.

Figure 7. How much did you enjoy programming mBot robots?

35% of students of Computer science extracurricular activity answered question Were the hours difficult for you? “no” and 65% “rather no”.

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MIPRO 2020/CE
VII. Conclusion

In this paper we focused on using mBot robot for teaching programming in two secondary grammar schools and in the Computer science extracurricular activity. The main aim was to motivate pupils and teach them some programming basics. We received from almost all participants positive feedback. We described 3 tasks as an example of methodological sheets, students worked on.

Acknowledgment

This contribution has been processed as part of the grant project Interactive Applications for Teaching Mathematics at Primary Schools, project no. 003TTU-4/2018 and Implementation of Blended Learning into Preparation of Future Mathematics Teachers and Future Computer Science Teachers, project no. 001UMB-4/2020.

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