Using Drones in Teaching Computer Science

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***Abstract* - More and more teachers from primary and secondary schools are using some type robots, microcontrollers, or some new tools for teaching programming. Thanks to the lower prices of these robotic building blocks and aids, students are better prepared for their future profession. We used four types of drones in the teaching process in primary school and in the extracurricular activity at the Matej Bel University for teaching programming. The contribution deals with describing our experience of using drones in the educational process. In this paper, we introduced a methodic focus on using drones in the educational process.**

Keywords – Airblock; micro:bit; LiteBee Wing; Ryze Tello; programming;

I. INTRODUCTION

Currently, there are many professions in the world that are constantly changing with the development of mankind. New professions are emerging, and some, on the contrary, are disappearing. There are professions that make their work more efficient thanks to new information and communication technologies. For this reason, it is essential that students in primary schools become familiar with new technologies.

Research in our country and around the world shows that the use of ICT technologies increases clarity and efficiency in the teaching process. Thanks to this education, it is possible to use various robotic kits, microcontrollers, and create interesting inter-subject projects, which mostly need to be programmed, which is also why it is important that students learn programming already in the first grade of primary schools. Pupils already use micro:bit educational boards in (not only) computer science classes, they model 3D objects that are then printed on a 3D printer, they use various popular games for teaching not only computer science (e.g. Minecraft: Education Edition), they create mobile applications (e.g. in App Inventor) etc.

Drones are enjoying increasing popularity thanks to their low prices (it's no problem to get a drone with a camera for just a few tens of euros) and modified legislation that allows for their wide, but at the same time, safe use. This is also why it is essential that students in elementary schools already study this technology, so that they know what they can and cannot do with drones, so that they can try to control the drone under the guidance of teachers and not by themselves. Added value is if they know how to programme their own controller for drones or programme the drone autonomously.

Various companies that develop educational hardware and software have also realized the growing availability of drones. This popularity was not missed even by the manufacturers of the most popular robotic construction companies, MakeBlock, Elecfreaks, MakeBlock, DJI, etc.

II. PREVIOUS RESEARCH

Several studies have been devoted to the use of drones in the teaching of computer science at various levels of schools. Velasco and Valente [1] provided a mapping review of the online courses available for drone education. Sanches et al. [2] reviewed some of the most accessible and economical commercial drones for use in various educational environments. Lobo, et al. [3] report in their research an active learning-based instructional approach that prepares students for careers in the drone industry (drone programming using Python, designing and fabricating drones using Computer-Aided Design (CAD)). Their research was implemented in an undergraduate class that engineering and computer science students attended. Quantitative assessments indicated that most students excelled at the technical subjects covered in the class. Phang et al. [4] in their research focused on the use of drones for drone technology for primary school students to learn STEM. Their research described that the use of drones in education was effective for young children. Kinaneva et al. [5] used in their research block-based programming to teach programming with drones. The students who participated in the courses have acquired new knowledge by launching drones to implement different tasks and missions on demand, and at the same time they had fun participating in the classes, which made the educational process more efficient. Yepes et al. [6] analyzed the feasibility of using a set of technologies based on drones, designed based on the theory of significant learning through active methodologies. The study was carried out with 30 high school students and it was found that the workshops with the platform based on drones helped in the understanding, construction, and interpretation of the content covered. Fokides et al. [7] in their study presented the results of a pilot project in which the use of drones to teach primary school students was examined. The target group was 40 fifth-grade primary school students, divided into two groups. The first group was taught with the use of drones, while the second was taught conventionally. The results indicated that the students in the drone group outperformed the students in the conventional teaching group on the Maths evaluation sheet and on all delayed post-tests. In the other two cases (Physics and Geography evaluation sheets), the results were the same. Students' attitudes toward drones were highly positive. Sivanes and Koutromanos [8] investigated the perceptions of 60 in-service teachers' regarding the use of drones through mobile applications. The results showed positive perceptions about using drones through mobile applications. Regarding the facilitation conditions, teachers

indicated the need for teacher training on the pedagogical use of drones, assistance with visual programming, and infrastructure support. Engineering schools have also recognized the need to prepare professionals entering the job market with experience in drone operation, leading to the development of a curriculum focused on this niche [9-15].

III. DRONES SUITABLE FOR THE EDUCATION

The increasing popularity of drones among young people was not missed even by manufacturers of the most popular robotic construction companies, who decided to make drones that can be used in the teaching process.

A. *Airblock drone*

One of the first manufacturers to offer drones for education is MakeBlock, the company behind the popular mBot robots. They created a modular drone called the Airblock, which can also be converted into a hovercraft in water and air. Airblock has won several awards. The Airblock consists of a main module and six additional hexagon-shaped modules that can be attached to the main module in various ways using magnets. Figure 1 shows a picture of all the possibilities of how the drone can be built.

Figure 1. Airblock - modular drone

Airblock has several advantages - it does not contain a camera and thus there is no need to deal with GDPR approvals, it is highly impact resistant (made of high-quality foam) and can be used indoors (Airblock is light, in case of strong wind, we do not recommend using it outdoors, how much the drone can be blown away). We program it using blocks in the mobile application for iOS and Android.

B. *LiteBee Wing*

LiteBee Wing is a drone inspired by the children's favorite bricks building activity - compatible with Lego bricks. Drone could be programmed using a Scratch or Python programming language. For programming is possible to use software for computer or mobile application (iOS and Android).[1]

Figure 2 shows the LiteBee Wing.

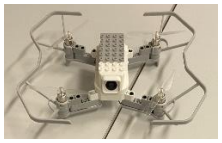

Figure 2. LiteBee Wing drone

C. *Ryze Tech - Tello*

Ryze Tello is one of the cheapest drones sold here. It is not primarily intended for teaching programming, but with the Tello Edu mobile app it can be programmed using blocks. For programming, it is possible to use the commands take off, land, set the speed, take a photo, record a video, use conditions, cycles, variables, basic mathematical operations, work with sensors. Figure 3 shows the Ryze Tello.

Figure 3. Ryze Tello drone with Telle Edu app

D. *Elecfreaks micro:bit dron:bit kit*

This drone uses one of the most popular educational aids for programming, micro:bit. Because of this, it is not possible to use a mobile device to program the drone, but we have to use the website https://makecode.microbit.org/ where we have to add the drone:bit extension to our project. After adding the extension, new blocks will appear with which the drone can be programmed. The advantage of this drone is the possibility to program your own game controller, with which we will program the drone using radio communication - we will set the controller and the drone to the same radio frequency and then we will send commands, what the drone should do (e.g. after pressing the joystick on the controller up, we will send the drone a number 1, which will signal that the drone should climb). Figure 4 shows drone:bit.

Figure 4. Drone:bit

E. *Comparison of drones suitable for teaching programming*

In our opinion, the most suitable drone for teaching in the classroom is the Airblock, because when it hits a wall, we will not damage either the drone or the wall, the drone will fall apart and then we can build it again. LiteBee Wing disappointed us the most, because it lasted the least, we spent the most time on calibration, and after about a month it broke down and we had to send it for a claim. The Ryze Tello and drone:bit drones, which lasted the longest, surprised us with their endurance and the possibility of programming.

[1] https://www.litebee.com/product/liteBeeWing/download/

Table 1 shows a comparison of the drones available in our department.

TABLE I. COMPARISON OF DRONES

	Airblock	**LiteBee Wing**	**Ryze Tello**	**Drone:bit**
Dimensions	230 x 222 x 53	210 x 180 x 50	98 x 92,5 x 41	410 x 410 x 51
Weight	141 g	128g	80 g	509 g
Battery Life	6-8 minutes	10 min	13 min	8 min
Control Distance	10 meters	100m	100 m	100 m
Indoor environment	yes	yes	yes	yes
Outdoor environment	no	no	yes	yes
Charging time	60 min	60 min	90 min	60 min
Camera	no	HD	HD	no
Android, iOS app	yes	yes	yes	no
Programming in PC	yes	yes	yes	yes
Programming languages	block based language	block based language	block based language	block based language, JavaScript, MicroPython
Extensions	no	yes	no	yes
Price	179 €	190 €	109 €	177 €

IV. COMPUTER SCIENCE EXTRACURRICULAR ACTIVITY

Since the academic year 2017/2018, our Department of Computer Science (Matej Bel University in Banska Bystrica) has been organizing free extracurricular activities for students in primary schools. The first year we started with the frequency of one 90 minute lesson once a week. After the first year, based on the great interest of the children, we decided to organized this activity for two groups. The main aim of this activity was to teach children programming to various types of robotics. The secondary objective was to gain more exercises for our teaching trainees of computer science. Each of our students in the department taught 2-3 children in primary school.

During the Covid-19 pandemic (from March 2020) we were teaching online through Microsoft Teams. The content of our activity was changed to software for teaching programming (Minecraft: Education Edition, App Inventor, Scratch, beginning of Python, HTML). During Covid-19, students from our department were preparing teaching materials for the lessons.

In the academic year 2022/2023 we decided to organize this activity only once per week but in two parallel classrooms. The reason was that 9 students are visiting our activity for four years and the rest 15 primary school children started this year for the first time. These two groups are having mainly different content for their lessons. The only similar activity was drone teaching. This year, each group was taught by a student from the department. Figure 5 shows our students from the department in the teaching process.

Figure 5. Teaching drones (our students from department are lectures)

Figure 6 shows the testing of three drones in our hallway.

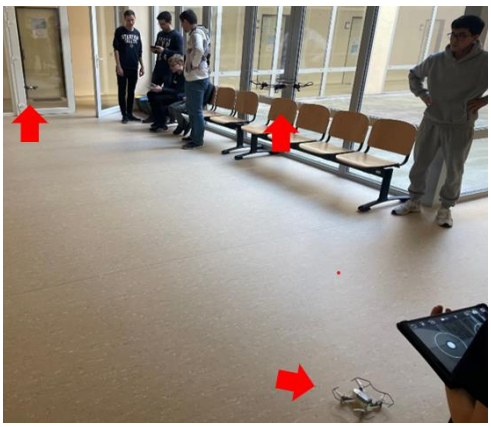

Figure 6. Drone testing.

V. DRONE METHODIC

We prepare various types of tasks to teach programming with drones. In this article, we describe one type of task that was used in extracurricular activities. Table II shows our methodology of using drones.

TABLE II. METHODOLOGY OF USING DRONES

Activity name:	Drones Programming
Target group:	7.-9. year primary school
Expected time:	90 minutes
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 practising and improving skills.
Preparatio, Teaching Aids:	Materials: Computer, iOS or Android mobile device, drone:bit, Airblock drone, LiteBee Wing drone, Ryze Tello drone

Today, we will learn how to use drones and how to programming drones. At the beginning fill out the work list.

Work list

A drone can be an unmanned _____. Regardless of the type of drone, it is characterized by control on _____. The drone can be used, e.g. in (fill in the possible use):
- to the army- _____
healthcare- _____
- police- _____
- agriculture- _____
- companies- _____
- real estate companies - _____

The drone _____ to be used in the vicinity of airports, as there could be a _____ with a plane or helicopter. Drones also _____ to be used to monitor neighbors because it infringes on their _____.
Airblock is a programming drone that can be used (rebuilt) for the following:
- _____ (the air)
- _____ (Water)
- _____ (the earth)

We can program the drone in the Makeblock application. For programming, we use a language that is similar to another block language._____. We will use English blocks to control the drone:
- power on/off- _____
- forward- _____
- turn left/right- _____
- rising/downward - _____
- hover/landing- _____
- shake _____

When we want to set some action that the drone will perform, we set the behavior of this action in the _____ component (also the English name).
If we want the drone to wait, e.g. For 1 second, we assign the command _____ (wait). To set the colors that the drone will display in its control section, we will combine RGB colors: R_____, G_____, B _____.
Before connecting the drone to the mobile device, we need to build the drone. The Airblock drone consists of a control unit and 6 propellers. We connect the propellers to the drone. _____ is used for the connection. To connect the drone, we need to turn on _____ technology in the mobile device. To connect, we have to press the _____ (connect) button.

Task 1:
The drone (it does not matter the specific type) must:
- Wait 5 seconds and take off
- Move 30 centimeters forwards
- Land

Figure 7 shows the solution to 1.

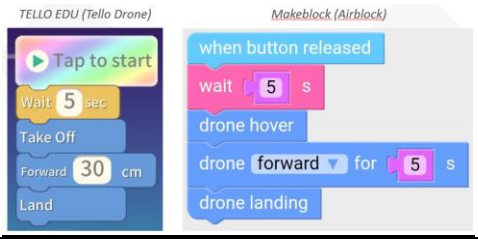

Figure 7. Solution of task 1

Task 2 - square:
The drone must take off and draw square in the air and then land.

Figure 8 shows the solution to task 2.

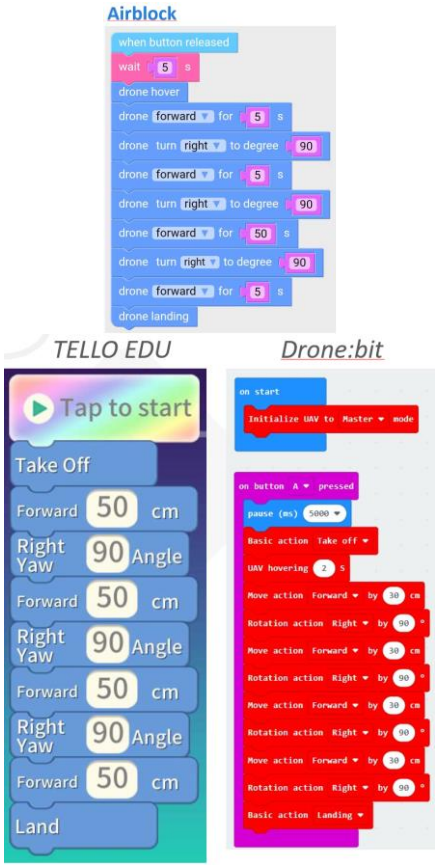

Figure 8. Solution of task 2

Task 3:
The drone must take off and draw:
- drawing 2D geometrical shapes (triangle., rectangle, circle, etc.)
- drawing 3D geometrical shapes (cube, rectangular prism)
- traffic light: drone turns on, shows the red colour for 1 second, wait 1 second, change the colour to orange for 1 second, wait 1 second, change the colour to green for 1 second and hover until 1 metre,
- Record video, take off to a height of 150cm, slowly turn 360 degrees, wait 5 seconds, land, stop video.

VI. METHODOLOGY AND RESEARCH

Our research was similar to other researchers from section 2, we would like to find out if using drones could be interesting, and motivational for students also in the Slovak republic. Our research was conducted in the academic year 2022/23 and still lasts. We were based on our experience in teaching the Airblock drone in the academic year 2017/2018 (the children really liked working with the drone). In our research, we used four types of various drones for learning programming in our extracurricular activity at our university. The main aim of our research was to find out whether we can increase students' interest in studying programming by using drones compared to other robots that we used in our extracurricular activity. A secondary aim was to find out which drone is the best for teaching. We used the questionnaire to measure the data of our research. We asked 24 primary school children several questions in the questionnaire. 22 boys and 2 girls completed the questionnaire. Respondents were students in the fifth and eighth grade (11-14 years old).

The questionnaire consisted of 11 questions. First, two questions focused on gender and the school year they attended.

The next question was aimed at if the children had piloted a drone before. Figure 7 shows the results. Almost all of them said no (20 respondents no, 4 respondents yes).

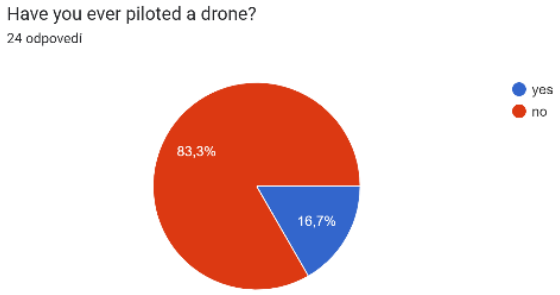

Figure 7. Have you ever piloted a drone?

The third question asked them if they had programmed drones before. All respondents choose not to.

The next question asked if these activities make sense to them. All respondents select yes.

Based on the answers from question Were the classes difficult for you? We can state that the activities were not difficult for the respondents. Figure 8 shows the answers.

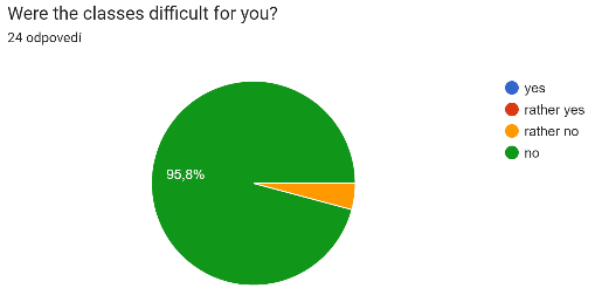

Figure 8. Were the classes difficult for you?

In the question Would you like to continue programming activities with drones? we asked if the students liked the drone activity. Everyone replied that they liked her.

We were curious how they liked working with specific types of drones. Figure 9 shows the answers. The pupils liked the Ryze Tello drone the most and the LiteBee Wing the least.

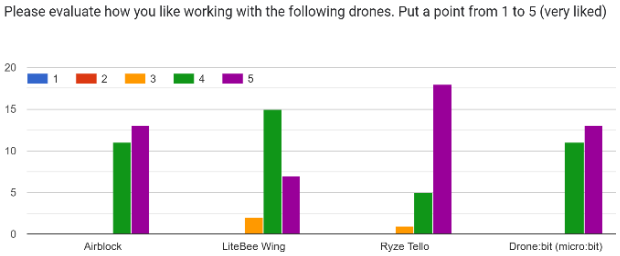

Figure 9. How do children like to work with specific types of drones?

In the next question, we wanted to know which drone the students would take home if they could. Figure 10 shows the answers - children selected drone:bit.

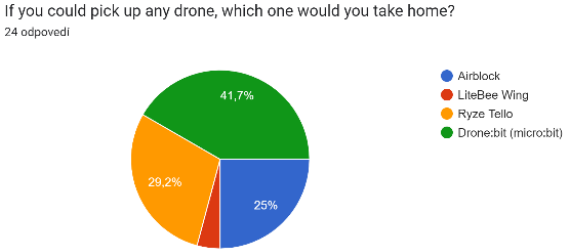

Figure 10. If you could buy any drone, which one would you take home?

In the penultimate answer, we wanted to know which drone programming environment the students liked the most. The answers (Figure 11) revealed MakeBlock, which is used to program the Airblock drone.

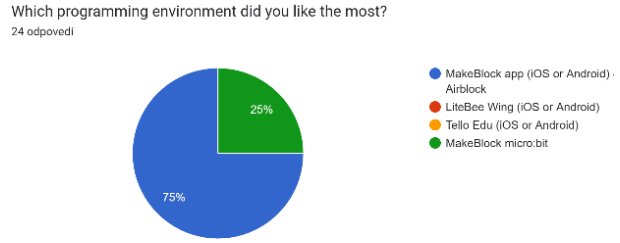

Figure 11. Which programming environment did you like the most?

In the last question, we asked the students which activity they did in the circle they liked the most. The responses (Figure 12) showed that they liked drone programming the most so far.

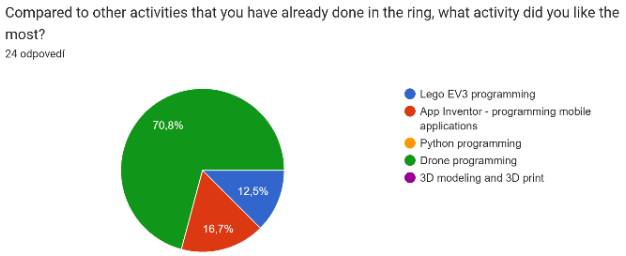

Figure 12. Compared to other activities that you have already done in the ring, what activity did you like the most?

VII. CONCLUSION

In the article, we focus on using drones to teach programming in computer science extracurricular activity. The main purpose was to motivate the children and teach them some programming basics. We described one task as an example of methodological sheets on which the students worked. The questionnaire showed that most of the students had not piloted drones before, none of them had programmed them before. The students liked working with the Ryze Tello drone the most - we assume that it is because of its size (it is the smallest, fastest). Of the drones used, it has the best camera - we assume these are the main reasons why they like it the most. They would most like to take the drone:bit home, perhaps because it lasts the longest and is the largest of them. Among the programming environments, students liked the MakeBlock environment the most - we liked this environment the most, it is intuitive to use. Of the activities in the circle so far, the students liked the activity with the drone the most. Our research confirms similar results from other researchers, using drones can increase interest about studying programming or computer science

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