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The Introduction of Micro:bit in Elementary School, from Unplugged Activity to Programs

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Abstract. In this article we would like to present a good practice and its results, in which the main role is given to understanding the micro:bit device and its programming. Starting from an unplugged activity that helps understand the device's functioning and basic concepts, the workshop leads fourth-grade students to create simple, yet impressive programs written in the device's block-based language. The research was focused on investigating the success of the unplugged activity developed specifically for micro:bit, as well as on assessing the motivation of the students and the level of knowledge that could be transferred to the students through this method. It was also important that, in addition to the results, the practice material, with a detailed description, should be available to other teachers who would like to introduce micro:bit to their students in this way.

Keywords: unplugged, robotics, micro:bit, programming, STEM, elementary school.

1. Introduction

In Hungary, before 2020, informatics was only present as an optional subject in school education for students in grades 3–4. However, in most schools, informatics does not appear among the optional subjects, which is probably due to the fact that career abandonment is highest among informatics and engineering teachers, and the ageing teaching population is more difficult to keep up with the development of informatics (Gaál, 2020). The situation will definitely be improved by the new National Core Curriculum, where digital culture is already present as a compulsory subject in grades 3–4 (Education Authority, 2020a).

The students of fourth grade participating in the experiment first encountered informatics in classroom conditions during the unplugged session, as they were still under the old curriculum at the time of writing the article. The topic focused on programming the micro:bit and getting to know it, but we felt it was important to introduce the topic in an unplugged way. The Computer Science (CS) unplugged methods are extremely effective in that students see another, interesting side of informatics, namely what happens inside the computer (Rivka *et al.*, 2012). It is important that their first experience be appropriate for their age and that they encounter different logical and programming problems through activities where they do not have to write program code to solve them (CSERG, 2021). Therefore, in the first half of the session, we simulated the running of a micro:bit program in an unplugged activity, through which the children were introduced to the device and gained an understanding of how it works, as well as some basic programming concepts.

The second half of the session focused on creating short (robotics-related) programs. We tried to present programs that were sufficiently attention-grabbing and enjoyable for the students. Before the method is implemented, we also set up several hypotheses, which were followed by a questionnaire for both the unplugged activity and the programming part, which we will elaborate on in the second half of the article.

[Hypothesis 1]: By the unplugged activity, students will be able to distinguish the different elements of the micro:bit, and be familiar with some basic concepts that only older age groups know.

[Hypothesis 2]: Even just one of these robotics lessons can spark children's interest and motivation to work with robotics, in their informatics and science lessons and even in their free time.

For other future research, it was important that students were also open to using micro:bit in other subjects.

2. Presentation of the Lesson Material

We used the new V2 version of the micro:bit for the sessions (Fig. 1). The device has undergone a lot of innovation and many new features that are interesting for children have been integrated. In addition to the increased memory and more modern processor, the device also received a capacitive touch sensor, speaker, and built-in microphone. We also tried out the latter function with the fourth-grade students. It is important that during

Fig. 1. The front and back of the micro:bit V2
(Source: `https://microbit.org/new-microbit/`).

the development of the device, one of the key topics of the 21st century, environmental awareness, was also taken into account and the device became more energy efficient and already has a sleep state function (MEF, 2021; Abonyi-Tóth, 2021).

The implementation of the session took place in two parts, which took four lessons, but this can be greatly influenced by the group dynamics and the individual needs of the students.

The first half of the session was devoted to testing and verifying the unplugged method developed during my studies. This was preceded by a detailed presentation of the device so that students have an idea of what we are going to work with. The essence of the unplugged activity is to familiarize students with the internal functioning of the micro:bit, to show them playfully what operations the processor has to perform and how the device communicates with the user. This also clarifies the concept of input and output peripherals. The first step in implementation was to select from among the students those who played the roles of different parts of the micro:bit (Fig. 2). The students were given the role of certain parts of the micro:bit, for example, the "Managers of the screen pixels" were given the task of plotting the output on the board as if it were the LED matrix of the micorbit, and the students in the role of "buttons" were given the task of indicating when they were pressed. Those who did not want to take on these roles were given the programmer role. They were the ones who created the program commands using statements cut out of paper and passed them to the CPU. The preparatory requirement for the session was to print out the blocks according to the task. And through the unplugged activity, students simulated the entire programming process, from coding to switching on the LEDs, by personifying the processes of the device themselves.

After the preparation, students in role of "programmers" independently try to create the program code from the blocks. In our case, an animation about a waving robot (Abonyi-Tóth, 2018) was the first program to be implemented. The code causes the image of a robot to wave with its left or right arm by pressing the appropriate button.

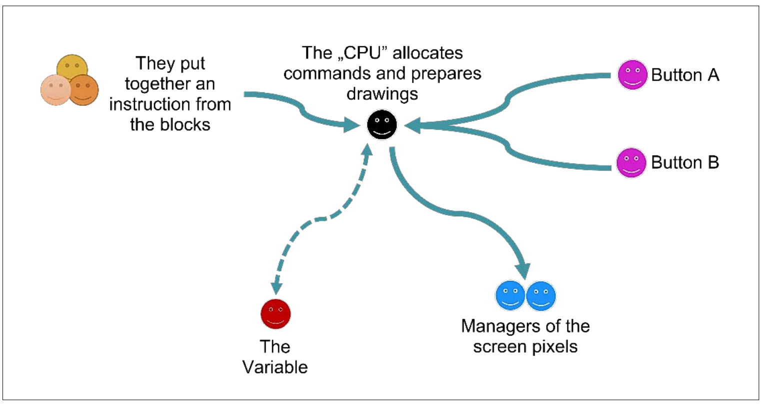

Fig. 2. How to implement the method
(Note: the use of variables was not discussed during this exercise).

The instructions are received by the student in the "processor" role and based on these it notifies the students in role of another necessary micro:bit parts and assigns the tasks, e.g.: *the button sends a notification if it is pressed*. The display can be implemented at the board. Here we can assign more students for the role of "managers of the screen pixels" to speed up the process, as each movement has to be drawn out. With this role, we can ensure that everyone is part of the activities even in larger groups. We can further increase the number of roles, if necessary, for example, we can also distribute messenger roles. After we played a few steps, discuss with students what happened during the process. For a better understanding, it is recommended to project the schematic diagram that students can see the direction of the arrows and understand why the directions are important (Fig. 2).

The questionnaire examining the success of the unplugged activity was completed after this part of the session. (see Chapter 3) The second part of the session involved implementing the previously created program in a digital environment as well, using the makecode interface. The length of solving the task was greatly increased by the fact that they were fourth-grade students, for whom this was the first informatics lesson. And for us to get the micro:bits working, it is essential to know file and folder operations. During the session, perhaps this was the most difficult part of the material for the students. Once the animation was already waving with one hand, it was up to the students to get the other hand working as well (Fig. 3), and to create individual animations with both buttons pressed. Implementing this did not cause any problems after the unplugged activity and the implementation of the first version of the code.

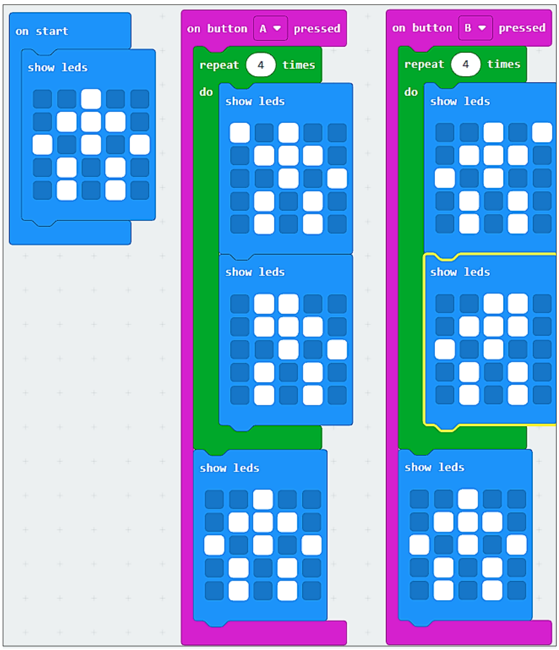

Fig. 3. Example code of the waving robot (Abonyi-Tóth 2018).

The second task we prepared with the students was a graph that changes with sound. Here, the students could choose their favorite music, which, when played on a smartphone, provided a perfect effect for the spectacular presentation of the program code. Here the emphasis was more on the spectacle than on the difficulty of programming, this was sort of a relief for them, as they learned a lot of new things in a very tight pace. At the end of the session, the stem:bit accessory package developed for micro:bit was also presented and students could also take a look at an obstacle-avoiding crawler robot.

This part of the session also ended with a questionnaire. (see Chapter 4) This questionnaire focused on the motivation of using micro:bits and the feelings of the students related to the lessons.

3. Testing the Success of the Unplugged Activity

The questionnaire related to the activity contained four multiple-choice test questions and two open-ended questions. The test was completed by all of the participant students (N = 18). The questions cover computer knowledge, of which only the concept of a "*program*" appears in grade 4. The other concepts (loop, sensor, peripheral, processor) are only included in the digital culture curriculum for grades 5–6 (Education Authority, 2020b/c). The goal was for students to have some clarity about these concepts, even after only one lesson. In the following, we will go through the results of the tasks one by one.

Question 1. What is the processor for?

Out of the 18 respondents, only one person gave a wrong answer, marking the third option. The other respondents correctly marked the second option (Fig. 4). It can be concluded that the group understood the basic role of the processor.

Question 2. What the sensors do?

In this case, the understanding was made more difficult by the fact that only the concept was mentioned verbally, its presentation did not take place within the frame-

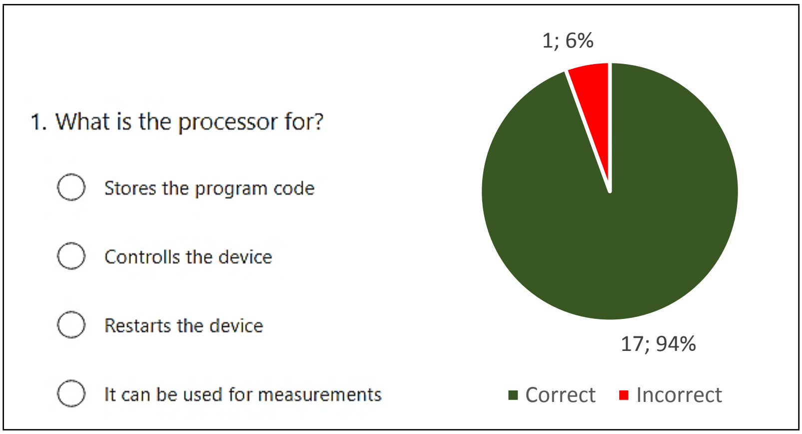

Fig. 4. Question 1 and the distribution of responses.

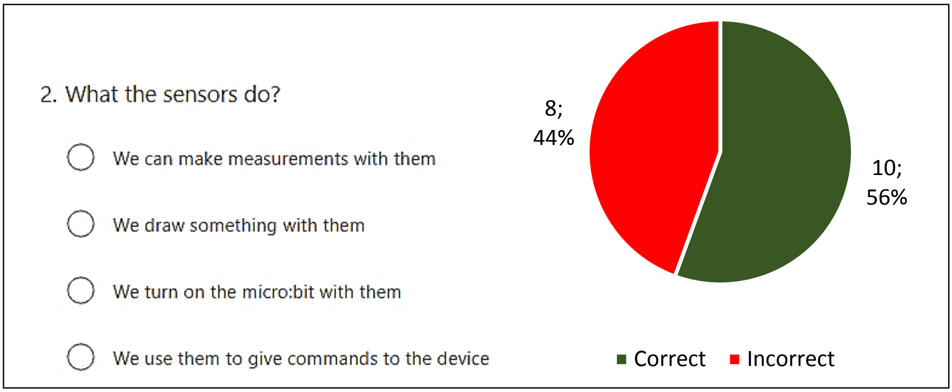

Fig. 5. Question 2 and the distribution of responses.

work of the unplugged activity. Since learning did not take place through experience, it was expected that we would get a weaker result. Accordingly, 8 students gave incorrect answers out of the group. Of these, 5 students marked the second, 2 the fourth and 1 the third option. 10 students correctly gave the first option as an answer (Fig. 5).

Question 3. What peripherals are the buttons?

Question 4. What peripheral is the display?

The next answers are closely related to each other, as they had to decide on the different parts of the micro:bit (buttons, display) whether they are input or output peripherals. At these questions, convincing results were also achieved. Most of the children correctly distinguished between input and output peripherals (16 correct answers for buttons, 15 for display) that are on the device. Distinguishing this is still difficult not only in grade 4 but in grade 5 according to our experience. Two students gave wrong answer to both questions. It can also be stated here that as a result of the activity, they answered correctly in a large proportion to the question asked.

Question 5. What a computer program is?

The next question was an open-ended question. This is, according to the new curriculum, already some knowledge to be learned in grade 4, but as we wrote earlier, the students who participated here, did not have digital culture or informatics as a subject either (Education Authority, 2020b). Considering the age characteristics, we accepted all those answers as correct solutions that included the following expressions: *it contains instructions*, *it gives instructions to the computer*, or *instructions after each other*. The given definition during the activity was the following: a set of instructions given to a computer (Gregorics *et al.*, 2012).

Almost three-quarters of the group, 13 students, gave an appropriate answer to the question, so we think that the activity may be suitable for them to learn what a program is (Fig. 6). In the case of wrong answers, 3 students also wrote that the program is the brain of the micro:bit. This answer may be interesting if we think about how the students thought. Perhaps they tried to solve the problem with something closer to them and drew a parallel with the relationship between human action and the brain, because our brain also gives instructions to our body.

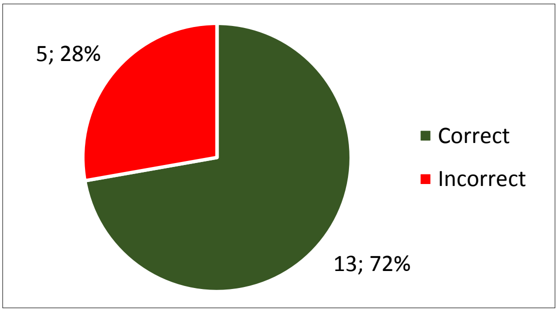

Fig. 6. Distribution of responses to Question 5.

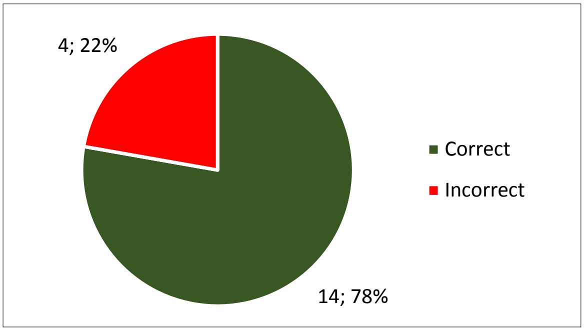

Fig. 7. Distribution of responses to Question 6.

Question 6. What does a loop do?

Similar to the previous question, this was an open-ended question too. The given definition was the following: the loop repeats the instructions it contains several times. (Gregorics *et al.*, 2012). This concept is not part of the grade 4 curriculum, and only appears in grade 5 (Education Authority, 2020c). As correct answers, we accepted the following: instruction repetition, repeating part, repeat something/process, repeat the thing several times.

The result here is also convincing. Out of the group, 14 students gave a correct answer to the question and only 4 students failed the task (Fig. 7). It can therefore be stated that the activity may also be suitable for illustrating the loop.

Success of the activity

The activity was successful according to expectations. It can be said that in every question, at least 70% of the students answered correctly from the questions asked, which we covered during the unplugged activity. Breaking down the results by individuals, everyone reached 50%, even students with weaker digital skills and children who had not used a computer at all before. They were able to distinguish and understand the functions of the different parts of the device, such as button, display, processor. The implementation of the activity can of course also work through another example program, where not only the loop but also the if-else statement can be taught to the students.

Based on the above and the results of the questionnaires, it can be stated that the [H1] hypothesis that By the unplugged activity, students will be able to distinguish the different elements of the micro:bit, and be familiar with some basic concepts that only older age groups know., has been fully confirmed.

4. Results of the Satisfaction

Within the framework of this questionnaire, we were mainly interested in how much the students enjoyed the activity and how the whole activity affected their motivation related to robotics. The response was on a Likert scale ranging from 1 to 5. The questionnaire was completed by 16 students. In the meantime, one student had to leave, and one student instead of filling out the questionnaire started to further develop the program of the lesson. In his case, the activity can definitely be considered successful. In the following, we will deal with the distribution of answers to each question.

Question 1. How interesting did you find the lesson?

For the first question, all the students rated the value five, so everyone found the lesson very interesting. Robotics could play a big role in this, as it is by its nature a subject in which children are more interested. It should also be noted that the teacher's presentation style also influenced the answers. An interesting approach without a committed, enthusiastic teacher is less likely to be successful. Nevertheless, the fact that the students all gave the highest marks shows that the method tested is capable of delivering an interesting lesson for all.

Question 2. How much fun did you have?

The second question was "How much fun did you have?" The average of the given values is 4.9375, as 15 of the students marked grade five and only 1 person ticked the answer option of four, rather yes. The fact that 15 students gave the highest rating of five suggests that a significant proportion of the class had a very enjoyable experience of the activity or lesson. This positive response can be attributed to a variety of factors, such as engaging content, interactive teaching methods or the general classroom atmosphere. The last factor is not significant in this case because the trainer and the group were unknown to each other. This implies that the content of the lesson largely determined the answers.

Question 3. How much would you like to use the device in your free time?

The last question was "How much would you like to use the device in your free time?" In this case, the opinion of students was somewhat divided. If we look at the average, the response value was 4.4375 and the standard deviation was 0.629. The distribution was as follows. 8 students would love to use the device, 7 would rather use it, and 1 person would not use it. Responses for leisure use are less consistent. In our opinion, this is not a problem, since the aim of using the tool is to make classroom activities interesting and to introduce programming effectively. Nevertheless, half of the students found the tool interesting enough to want to use it in their free time.

It may be worth exploring the background of the negative response to find out the personal preference of the student and the underlying content of the negative response.

Question 4. Would you like to use the tools in your informatics class next year? (Yes or No question)

All 16 students responded positively, confirming that robotics has a place in the new curriculum. Consequently, in the group's subsequent informatics lessons, we were able to put a strong emphasis on micro:Bit programming, which was mainly implemented in pairs.

Question 5. Would you like to use the tools in your science class next year? (Yes or No question)

The general unanimous positive answer to this question provided a good basis for further research, focusing on robotics-enhanced science education. The enthusiasm and openness of the students allows the benefits of robotics and micro:bit to be used in other subjects. This question and the previous one were intended to assess the group's openness towards micro:bit in order to determine whether further research with the group would be possible in the future.

Summary of the satisfaction questionnaire

The answers to the satisfaction questionnaire were overwhelmingly positive for all questions. Students enjoyed the lessons and found it interesting, and most of them would use the micro:bit at home in their free time. In addition, all the students were open to using the device in future computer science and science lessons, thus getting to know them better. It can therefore be clearly concluded that the [H2] hypothesis that even just one of these robotics lessons can spark children's interest and motivation to work with robotics, in their informatics and science lessons and even in their free time, has also been confirmed.

5. Conclusion

The integration of robotics into education is inevitable. Therefore, we would like to design an activity that gives students the opportunity to explore the world of robotics in a playful way. During the experimental session, the participating group 4, without any previous knowledge of informatics, was able to write programs on micro:bits and modify them individually during a longer session. The playful introduction of the topic, which introduced and personalised the micro:bit in an unplugged activity, played a major role in this. Its success lies in showing students, through an easy-to-understand role-play, the complex and abstract process of programming and the basic principles of micro:bit operation.

Based on the results reviewed in this paper, it can be concluded that the use of robotics and unplugged methods positively influences learners' understanding and helps learners to acquire knowledge beyond their age, as learning for them is playful and active, where the mechanism of playful learning is implemented.

The beneficial effects of robotics should also be highlighted, as even a single session greatly influences how students relate to the given subject. We encourage all colleagues to use these robots not only within the framework of digital culture, but also to integrate them into natural sciences, as it seems that students would like to see them there as well. With the help of these tools, motivation and skills for STEM subjects can be easily developed, and they also provide a great opportunity to develop soft skills during education with the appropriate methodology, where group- and pair work and project-based education are emphasized. Through such processes, students will have a great opportunity to gain an experience that will benefit them in many situations later in life.

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