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Micro:bit as a new technology in education in primary schools

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Abstract: *Micro:bit as a new technology in education provides the solution for the gap between abstract and often incomprehensible frontal teachings and new wave of practical teaching, which forces individualization and independence of students. At the same time, by teaching students digital-technical literacy in a fun way, it increases interest and strengthens students' will for the subject. The advantages of this device are not only oriented towards the students, but also towards the teachers and the entire school system. Modernization and the introduction of new approaches are paving the way for the schools of the future both in Serbia and around the world. The paper shows theoretical part on the basics of micro:bit, device layout, its specification and programming languages in which it is performed as well as the practical part.*

Keywords: *micro:bit; digital literacy; block programming; Informatics; education*

1. INTRODUCTION

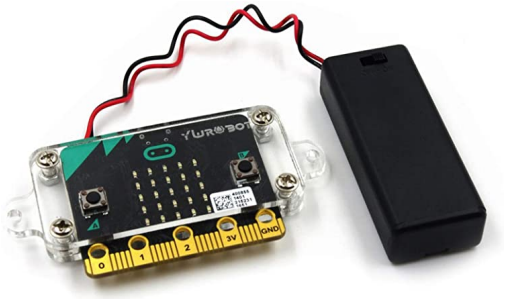
Digital literacy is a key skill of the 21st century. Despite the fact that information and digital technologies have become expressions that we can hear in everyday conversation, the fact is that a large number of adults in Serbia do not have even a basic knowledge of working on a computer. The school system serves us to get to know students from an early age and to teach them to handle different software. The purpose of this is to enable students to grow and develop in the future, as it is inevitable to have computer skills and the use of basic web tools both through schooling and in the business world.

Increased interest in information technologies and their promotion by educational institutions has led to the reform of curricula in Serbian schools. The most noticeable changes are seen in the subjects Engineering and Technology and Informatics and Computing. The focus of this paper is on the description of the micro:bit device, which has found its role in helping students to visualize abstract concepts of programming, as it has been taught since the fifth grade of primary school.

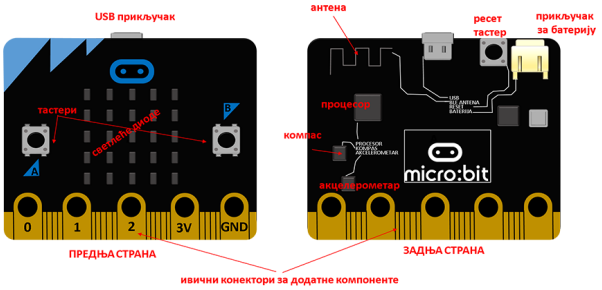
The year 2020 brought many changes in the teaching process and education. The COVID pandemic has brought about the introduction of distance learning. The problem arises because for such teaching, students, as well as teachers, are expected to have a considerable level of digital literacy. Most homework is based on an internet platform, diaries are electronic, classes are held online, and it is simply impossible for someone who is not trained to work on a computer to follow all the events within a subject.

Micro:bit is often described as a pocket computing platform [1]. This device is in fact a programmable microcomputer, intended for simple learning of the basics of programming and electronics. In addition to computer science and technical subjects, it can also be used in the teaching of electronics, mathematics, physics and related subjects because it encourages logical thinking with students. It also encourages learning to solve problems through algorithmic schemes.

Micro:bit was created through a partnership between educational institutions, the BBC as well as software and hardware companies. The device is designed so that it is simple enough to allow a quick start, and yet powerful enough to run applications (Figure 1).



Visually micro:bit resembles a microchip, which was the designer's idea. The core or "brain" of micro:bit is reflected in the ARM processor (Advanced RISC Machine), while on its surface there are twenty-five LEDs that can be individually programmed and that allow communication between users and devices (Figure 2).



The official specifications of micro:bit are [2]:

• Micro-controller: 32-bit ARM Cortex M0 +

• Sensors: accelerometer, compass, gyroscope

• Hardware: two buttons, LED matrix 5x5,

• Communication: Bluetooth, USB, radio

• Connectors: three general power connectors and a JST battery connector

• Dimensions: 43 mm x 52 mm

• Package contents: Micro:bit, USB cable, battery holder and batteries.

The physical components on the front of the micro:bit and their properties are:

• Display – Arranged in five rows and five columns, there are LED lights, which, depending on the program or application, light up as a visual component of the device. They allow you to display text, numbers and images. They can be programmed individually via pins or terminals or by connecting additional sensors to existing code.

• Keys – There are two keys on the front marked with the Latin letters A and B. They allow the device to start, so they serve as a type of detector. They serve to interact with the user.

• Pins – Located on the bottom edge of the device, representing the I/O (input / output) connectors. At the edge of the micro:bit there are 25 leads (pins) - 5 large and 20 small. The five large, base pins are marked with 0, 1, 2, 3 V and GND. Pins 0, 1 and 2 are general purpose input-output pins. Through them, using wires with crocodile clips, we can connect various additional sensors to the micro:bit, but also control numerous devices. Pins 3 V and GND (Ground – ground, ground) are used for power supply. At the output of this pin we get a voltage of 3.3 V in relation to the ground. The other 20 small statements can be used to communicate and manage additional components.

• Light sensor – Allows you to detect ambient light waves. The LEDs can be rotated to become an input component, then the LED panel itself becomes a light sensor.

• Temperature sensor – It is built into the plate itself and measures the outside temperature on the Celsius scale.

• Radio – Wireless component, allows communication between micro: bit devices.

The physical components on the back of the micro:bit and their properties are:

• Bluetooth sensor – Wireless component, allows communication between micro:bit devices and other computers, mobile phones or tablets, by receiving and sending Bluetooth signals. Communication works in both directions.

• USB connector – Connects a micro:bit to a computer. It is also used as an input to power the device.

• Compass sensor – Detects the Earth's magnetic field to determine the direction of movement or in which the micro:bit is facing. In order for the measurement to be accurate, it is necessary to calibrate the compass beforehand.

• Motion sensor (accelerometer) - Measures the change in movement of the device in the x, y and z coordinate system. It can also detect other activities such as tilt, free fall or vibration.

• Processor – The core of the device, powered by, and in addition to LEDs, is the most important part of the micro:bit. Controls the microcomputer, executes commands written in the appropriate program code.

• Restart key – Restart the device.

With the help of a relatively small micro:bit board, we can control a large number of devices, so that in addition to the above subjects in primary schools, micro: bit has found its role in electronics, robotics, and other fields.

2. THE USE OF MICRO:BIT IN TEACHING

The "Schools for the 21st Century" project, funded by the United Kingdom, aims to provide new technologies for use in teaching in six countries of the Western Balkans in three years. At the beginning of 2020, an action was carried out at the Metropol Hotel in Belgrade, where 17,500 micro:bit devices were awarded to 480 primary and secondary schools in Serbia. The project is an ambitious idea of the British Council to help develop skills in students aged 10 to 15 [3].

Micro:bit acts as a mediator between modern and traditional teaching. It is a kind of microcomputer that allows students to design their own projects through online platforms and programming tools. How the micro:bit which is used in teaching can be seen in students' projects. Students of the elementary school "Sveti Sava" from Nis made a meteorological station and in that way connected programming, informatics and physics, while

students of the elementary school "Kralj Petar Prvi" from Nis made a feeder for animals.

For work in micro:bit, the curriculum in the seventh grade envisages only four school hours, and in the eighth grade ten. With the help of various web manuals, teachers can interest students in other projects that can be realized independently using web tools.

In Serbia, the most widespread site is "Petlja", which educates primary and secondary school students in information and technical fields and sets various projects that students can do independently [4]. These tasks are never mandatory, but for those students who have a desire to expand their knowledge, they can be very instructive and interesting. For students, especially those interested in programming, the site describes some possibilities of interactive work with micro:bit connected to a personal computer, which can be very useful during the development of more demanding programming projects. More about them in the chapter on micro:bit in the teaching of Electronics. These tasks are given in such a way as to inspire students to new, original ideas and research work, an opportunity that they rarely get within the school itself.

Learning through micro:bits has become interesting for students, they are more motivated to work and develop logical and critical thinking during classes. Therefore, another 35,000 micro:bit devices are planned to be delivered soon across schools in Serbia.

Research conducted in the Western Balkans in 2018 shows a positive impact of micro:bits on programming lessons. According to their results, as many as 100 % of teachers believe that micro:bit is a useful tool in teaching, and 90 % of teachers believe that micro:bit encourages students to learn programming and computing outside the school [5].

2.1. The use of MICRO:BIT in Informatics

Micro:bit is a device primarily designed to facilitate the teaching of algorithmic thinking and programming to students in primary schools. Each component of the micro:bit enables the realization of a theoretical idea. On the official website of micro:bit, we can see the influence it had on the development of teaching informatics in schools. In addition to all programs that have adapted their interface and entered into partnership programs with BBC micro:bit to the community of teachers both internationally and within Serbia, the introduction of micro:bit in teaching has definitely revolutionized not only teaching programming but also other subjects. Regarding the results of the introduction of this device only in computer science teaching, there is data that indicate that as many as 86 % of fourth grade students in Danish primary schools have expressed a desire to learn about technology and computer science after using micro:bit [5].

The number of projects within informatics is huge and depends on the motivation and imagination of the subject teacher.

2.2. The use of MICRO:BIT in Electronics

Until recently, what made electronics interesting for eighth grade students were the sets provided by the school, where it was possible to make simple electrical circuits, usually connected to a smaller battery.

With the introduction of micro:bits, the subject of electronics in primary school gained a whole new dimension. Connecting additional components to the micro:bit creates new possibilities for creating electrical circuits with a higher level of interactivity. Additional components are connected using twenty smaller pins located along the lower edge of the device. Through these pins it is possible to read values from numerous sensors and control various devices. The application of micro: bits only shows how important, but also simple is the use of programming and modern technologies in solving problems from different disciplines, such as electronics in this case. Just some of the examples of projects that take place in eighth grade classes are:

2.2.1. LED - Light Emitting Diode

LEDs are one of the additional components of micro:bits that are primarily presented to students. The diode consists of two electrodes, one longer, positively charged anode and one shorter, negatively charged cathode. If you want to turn the LED on and off via the micro:bit, you need to connect it so that the shorter pin is connected to the GND pin (ground), and the longer pin receives a positive voltage from one of the micro:bit pins.

In order to achieve a successful electrical circuit, we add a resistor, which we can see in Figure 3 on the left [6]. In more complex projects, in order not to increase the number of conductors, we use a protoboard – a plate with holes on its surface, which are interconnected by metal connections and allow us to easily connect and test the electrical circuit, shown in the picture on the right (Figure 3).

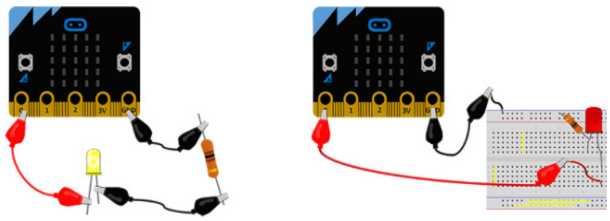


Figure 3. *Example of connecting LEDs to micro:bit*

2.2.2. Photo Resistor

With the help of photo-resistors, it is possible to determine the brightness of the room more

precisely. When the micro:bit is not illuminated, its resistance is high, however, as the illuminance increases, the resistance decreases. Knowing this, we can easily calculate the brightness level through the value of the resistor [6].

Micro:bit actually reads the change in voltage across the photo-resistor, not the change in resistance of the photo-resistor. The photo-resistor is great for projects related to energy saving, security systems with the use of lasers and the like. The connection method can be seen in Figure 4

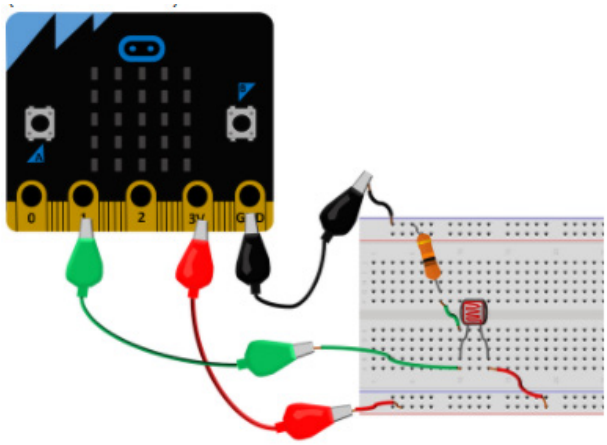


Figure 4. *Example of connecting a photo-resistor to a micro:bit*

2.2.3. Servo motor

With servo motors, it is possible to control the angular position, mostly in the range from 0 to 180 degrees. We connect servo motors with three wires: red, brown and yellow. If we want to control this motor via micro:bit, we need to connect the red wire to positive voltage (pin 3 V), brown to GND, and yellow (signal) to one of pins 0, 1, or 2. Unfortunately, micro:bit without additional equipment and power supply has the power to start only one servo motor, but even that is enough to understand the way it works. The connection method can be seen in Figure 5 [6].

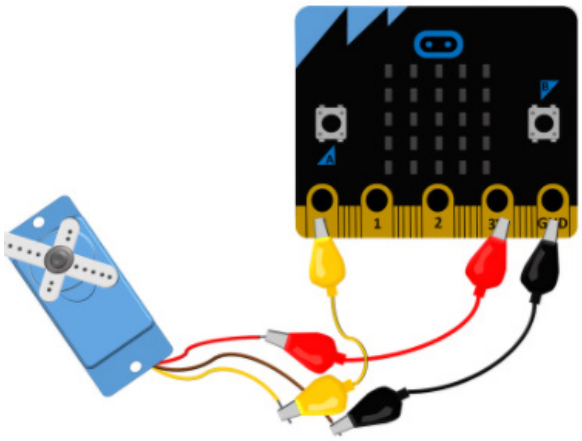


Figure 5. *Example of connecting a servo motor to a micro:bit*

2.3. The use of MICRO:BIT in Mathematics

As a science, mathematics is fundamental for many others, including informatics and programming itself. Thus, the micro:bit can be used not only as a programming tool but also to learn simpler mathematical problems.

For teaching mathematics to second grade students, micro:bit states that students behave like toys according to micro:bit and can hardly wait to teach mathematics.

The greatest benefit was seen when learning the multiplication table. This in-game teaching took place in pairs. Keys A and B were set to display two random numbers after pressing them. The students' task was to guess the product of those two numbers, and by pressing the B key again, they would get the correct answer. The student who received the correct answer received one point and the one who collected the first five points won. This interactive way of teaching allows students to learn the basics of multiplication in an interesting way.

In addition to the multiplication table, there are also programs for teaching division. The principle of the program is similar to the previous one, only instead of pressing the B key again, the quotient is displayed by pressing the A and B keys at the same time, in order to show the students this additional micro:bit function. In the third grade, addition and subtraction programs were made, as well as sharing with the rest. All through play and in a way that increases students' motivation to learn during the realization of classes [7].

2.4. The use of MICRO:BIT in Robotics

Why is it important to teach children robotics and automation? Precisely for that reason, that they are growing up at a time when technology is developing at an incredible speed. More and more devices that surround children use some elements of automation and robotics. For that reason, it is very important to start teaching about these current scientific disciplines at school, so that children can be prepared for all the novelties in the field of technology [8]. The idea is to learn the basic concepts, ways of using and applying robots, and for those who are interested, maybe creating them. The main goal of these lectures is to direct students to the development of cognitive skills for successful solving of technical problems.

It is important to make a clear distinction between robots used in computer science teaching and the basics of programming and robotics within technical education. Different programs such as mBot and Arduino are used for the needs of technique and technology in primary schools. Both programs are built on the Open Source principle and are used to create electronic prototypes. The working environment is similar to a micro:bit, where various electrical circuits are programmed in a visual way via blocks, as well as commands for starting the robot. The main way of programming is through Python, and the program itself contains additional components such as artificial intelligence

and indexes of terms. Within the program, there are also already made simulators of various robots, from cars to robots with "hands" or grips. In addition to the above programs, micro:bit is also used in the teaching of robotics and electronics. Its advantages over others are that there is no need to install integrated development programs, as there is an option for internet programming. The micro:bit components we have already mentioned in previous chapters are very important for teaching robotics and electronics such as accelerator, sensors, compass, etc.

2.5. The use of MICRO:BIT in Nature and society

Although at first glance it is difficult to determine the importance of micro:bits in the social sciences, a review of the literature and various researches leads us to the opposite conclusion. From simple applications of already existing micro: bit components, such as compass and thermometer, to teach students spatial orientation, all the way to some more complex projects. One of the examples of the application of micro:bit in the social sciences is described within the project "Planting digitally", where elementary school students were introduced to a new way of using information and communication technologies in everyday teaching [9].

The task of this project was to monitor the growth and development of the bean plant using micro:bit. The device would inform students about weather conditions, soil moisture and control the watering of the plant. The project was also done in cooperation of upper grade students with lower grade students. Many educators agree that sometimes students learn best from other students, their peers, rather than from teachers or authorities. The students were then divided into two groups: one that watered the plants in the standard way and the other that controlled the flow of watering through micro:bit. The second group, although technologically equipped, had problems with programming, because the challenge was to make the program so that the plants get the exact amount of water they need. Despite these difficulties, the students found this interesting because it was actually a real challenge to learn from their mistakes and correct them. In addition to micro:bit, in collaboration with a computer science teacher, students recorded their results in Excel spreadsheets, and photos of progress were transferred to the One Drive map, which only they had access to.

In addition to cooperative learning, the introduction of technological aids also made a great contribution to the positive results of this project. In this way, the students learned not only programming, but also responsibilities towards the group and the project and tolerance towards other participants. Connecting subjects such as Nature and Society with Informatics and Computing has led to even greater interest of students in both subjects, to the satisfaction of both subject teachers. These students were shown that each subject is important and that they depend on each other as one big coherent whole of the school system. No teaching topic is one-dimensional and can be expanded in different ways, which can only lead to even better results.

2.6. Visual block editor - JavaScript Blocks

Micro:bit executes instructions given to it. The set of these instructions are called programs, which we print using programming languages or writing code. For the purposes of micro:bit programming, as already mentioned, several programming languages can be used, one of which is JavaScript [10]. There are options for text programming or block programming. It is easier for younger students to get acquainted with block programming. The blocks are of different colors that can associate them with the function they perform. JavaScript Blocks belongs to the group of visual block editors [10]. Coding is done using blocks of different colors that indicate their role. The advantage is that it can be done in the offline version, but if it is distance learning or a school is not provided with micro:bit devices, there is also an online mode. More experienced users have the ability to encode in the JavaScript itself, which belongs to text editors (Figure 6).

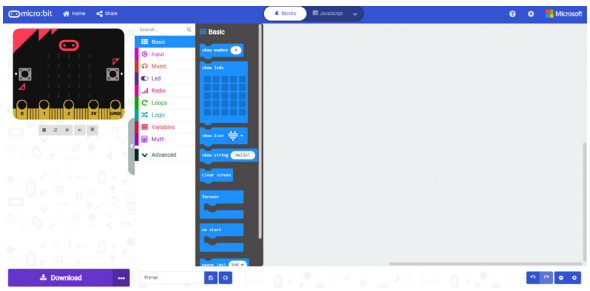


Figure 6. *JavaScript Blocks desktop environment*

2.7. Editor - MicroPython

MicroPython is another environment that is most often used in schools in Serbia. The fact that a special manual was made for both teachers and students speaks of its popularity. Micropayton is actually a version of Python used to work with micro:bit and other similar platforms [11]. Micropayton is a text editor and is intended for seventh and eighth grade students. The basics of the Python programming language are taught in the sixth grade in Serbia, so programming in the same program on the micro:bit is somehow a natural transition for students.

The focus is on the mechanisms of learning micro:bit using Micropayton as a form of textual programming, which indicates its advantages and disadvantages over block editors, but also introducing readers to one of the most used ways of teaching in our primary schools. The first

difference that can be seen is that testing the program requires an external editor **Mu**, which is designed so that even beginners can easily navigate the program (Figure 7). **Mu** is the simplest programming environment in Micropayton. Although it is suitable for beginners, some basic knowledge of the Python environment and its commands is expected. **Mu** is used in our primary schools only as a text editor but contains additional options. First of all, it is necessary to install the **Mu** environment. After the routine installation, the window from the image below opens, which shows all the possibilities of the **Mu** editor. The BBC micro:bit option is selected and resumes operation.

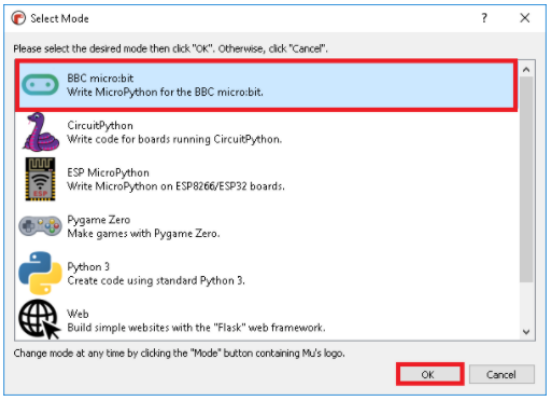


Figure 7. *Mu work environment*

3. CONCLUSION

In addition to its educational role, the school also has a development aspect. Teaching young people for the future and independent living is an important part of the education system. At a time when computers and other electronic devices have become part of everyday life, it is necessary to prepare the younger generations for life in the new digital world. Practical teaching shows better results, because students can be in direct contact with various devices and software. Numerous professional literature indicates several advantages of micro:bit, which were confirmed by the results of research conducted in this paper, based on independent conclusions.

Micro:bit as a new technology is largely implemented in primary schools. High schools are lagging behind, which leads to the conclusion that it is necessary to pay attention to the incorporation of micro:bit in professional environments. Micro:bit has increased the quality of teaching. The advantages of micro:bit are, according to teachers, improving students' individuality, better understanding of related subjects, improving logical thinking and problem solving, achieving originality in students, activating meaningful-active-perceptual thinking and facilitating teaching to teachers.

One of the rare shortcomings of micro:bit is that it is not suitable for students in the system of inclusive thinking and that it does not attract huge attention of students visually and interactively. The solution to this problem is to change the curriculum and adjust it in order to achieve inclusion and successful application of micro:bit towards inclusive students. As for the visual component, it can always be upgraded in the production itself, but the students' answers say that micro:bit it is aesthetically interesting enough that they would like to have it in other subjects, but also at home.

ACKNOWLEDGEMENTS

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