THE ROLE OF MICROSOFT PLATFORMS MAKECODE AND TINKERCAD IN STEM EDUCATION

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Abstract: Modern education is evolving as quickly and dynamically as digital educational resources. Invariably in recent years, there is more and more talk about the integration of STEM learning in schools. The challenges surrounding his teaching are varied. On the one hand, every teacher must be familiar with the basic principles and ideologies embedded in STEM education, and on the other hand, how to implement it in the available educational base. The interweaving of different science, technology, engineering and mathematics is the key point that a teacher should organize and implement in a lesson. This approach is relatively new for Bulgarian teachers, which also leads to its slower entry into practice.

In order for this training to be applicable, by the end of 2026 it is planned that STEM classrooms will be built in every Bulgarian school with the help of the Ministry of Education and Science and the financial support of the European Union. This will enable each teacher to use an environment in which to build each student's basic problem-solving skills from life and practice.

Thanks to the already established STEM centers, some schools have opened new majors through which graduating students acquire a modern STEM profession. Such specialties will continue to be revealed, because the creation of narrowly profiled specialists no longer meets the requirements of the modern labor market. Each STEM center is equipped with different educational resources, depending on the goals and capabilities of the school. Programmable devices such as Lego, Arduino, Micro:bit, makey makey and other educational resources are largely present in these specialized classrooms. In the process of their work, teachers see a problem that can hardly be solved. Most programmable devices require an environment in which the codes can be programmed and tested before use. For some devices there is an official working environment, but for others not. Another challenge for the teacher is how to set homework when students don't have the programmable devices they work with at school at home. Independent work with platforms where each student could create his own code, simulate, test and edit it, will enable him to upgrade his knowledge and competences. The experience of the COVID-19 pandemic shows that working in a shared educational environment is most suitable for working between students and teachers. Using learning platforms that can demystify all of these issues is a step forward in STEM education.

Keywords: STEM education, STEM platforms, Project-based learning, Middle school, STEM technology.

1. INTRODUCTION

STEM education in Bulgaria is entering as everywhere in the world is a new challenge for the modern teacher. This new approach to this day remains misunderstood by a large number of teachers, principals and pedagogical specialists. Such training requires the use of digital resources, programmable devices and many other things that most teachers are not prepared to work with. Teachers face many challenges for which they lack the necessary experience and competencies. The simultaneous application of natural sciences, technology, engineering and mathematics in relation to the age group of the individual students presents a great challenge to the teacher, which in some cases passes into specialized training.

The article examines two educational platforms with which teachers and students could create educational STEM projects using some of the most popular programmable devices Micro:bit and Arduino.

2. STEM EDUCATION

STEM is an acronym for Science - Technology - Engineering - Mathematics, but due to the rapidly developing technologies and their implementation to this approach, we can meet its varieties STEAM and STEAME. STEM education has a long history, although in Bulgaria it is being talked about relatively recently. According to (Kozhuharova, Zhelyazkova 2021), three main periods of development can be distinguished, the period around the 90s of the last century being considered fundamental. "STEM is an approach to learning that is based on the idea of educating students in four specific disciplines - science, technology, engineering and mathematics in an interdisciplinary and applied approach" (Garov, Peykova 2019). According to many authors (Ivanova--Nedelcheva, 2022), this modern approach creates a collaboration between different academic disciplines, so that students use

their knowledge directly on practical tasks, and not tasks solved on a piece of paper. If the teacher manages to choose appropriate tasks and projects, this will change the attitude of students in class and "instead of being passive listeners, students become active participants in the educational process" (Stefanova 2024). The activity of the student depends on what he will achieve at the end of the project, whether he will work alone or in a team, and on what educational technologies and resources he will use. The use of already acquired knowledge and the acquisition of new ones in the form of fun game approaches determine his future motivation and desire to attend classes in the STEM classroom. The main problems of the teacher, who is placed alone to deal with this kind of training, are several. On the one hand, the lack of sufficient literature in the Bulgarian language and on the other "a ready-made set of situations that they can apply directly or after slight adaptation in their work" (Pavlova, Toncheva 2022). According to some authors, „what is missing is perhaps their systematization, structural arrangement and quick access to specific practices, resources, forums for information exchange“ (Uzunova 2022).
In recent years, thanks to the NP "Building a school STEM environment" of the Ministry of Education, 252 small and large schools were funded to create their own STEM centers. This made it possible to create the first innovative classrooms dedicated to STEM learning. Teachers, students and, last but not least, parents, were delighted with some modern halls, adequate for a modern education.

3. PLATFORMS FOR STEM EDUCATION

The learning process related to STEM is gradually evolving and becoming more accessible to teachers. The “STEM lesson focuses on finding a solution to a real problem and providing an understanding of the relationship with the real world by students. “ (Velikova, Mierlus-Mazilu, Vasileva-Ivanova, Georgieva 2018). The continuous opening of new STEM centers in schools enables teachers to discuss, comment and work together in no small part, and publish scientific articles with the results they have achieved. As STEM education evolves every day, there are daily open teacher lessons, student achievements or developments that may be of interest. STEM training makes it possible to achieve educational goals even for bilingual students, who are largely isolated from the learning process. Many educators "go outside the framework of traditional learning, using different active teaching methods in their practice" (Harizanov, Georgieva 2018) to adapt these students to the learning process. . However, how can the teacher organize independent work or student work in a distance form of learning? Many of the projects slated for work are related to programmable devices such as Micro:bit, Makey Makey, Lego, Arduino, and more. During the COVID-19 pandemic, each student had a shared environment where the teacher organized the learning process. And as (Peytcheva-Forsyth, Aleksieva 2022). state that „e-learning is a significant prerequisite for the formation of positive attitudes towards e-learning in both students and teachers“. Here, this challenge can have a solution if platforms are used that support the possibility of creating, simulating and sharing the working files to these devices.

MakeCode for Microbit

MakeCode is an open source educational platform developed by Microsoft for programming micro:bit devices. Microbit is a little programmable board and there is “sensors touch, accelerometer, magnetometer, temperature, as well as Bluetooth, the antenna, microphone and speaker, give great latitude to act in the construction of STEM projects” (Mustan, Harizanov 2023). The platform is designed for both beginners and more advanced users. It does not provide an option to choose different roles, so all users have equal rights.

Fig. 1 Support Javascript in MakeCode

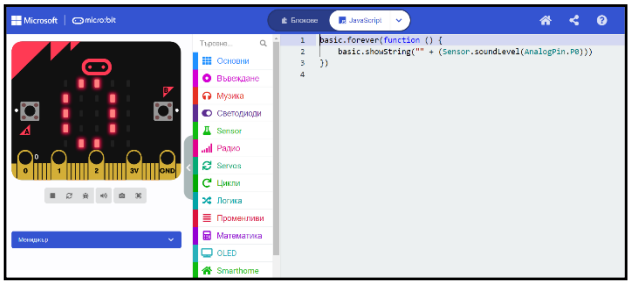


Fig. 2 Projects, tutorials in MakeCode

Source: https://makecode.microbit.org/#editor, Mustan, S.

The advantages of the platform are:

- Easy to use interface;
- Supports multiple programming languages. It has the option of visual programming or text programming in JavaScript (Fig. 1) or Python;

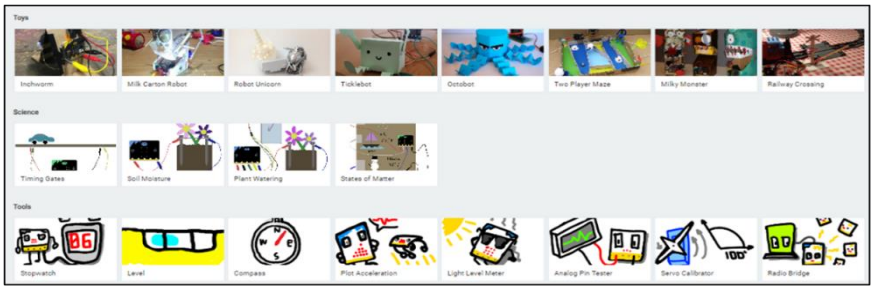
- Offers the ability to switch from visual to text programming;
- The MakeCode platform features a simulator that allows users to test their programs without having a physical micro:bit board on hand;
- The platform has a wide community and many ready-made resources, such as ready-made projects, tutorials (Fig. 2), as well as examples, which can facilitate the work with MakeCode;
- Ability to create a project without logging into the system. It is an advantage for those who are interested and want to see the possibilities of the MakeCode platform;
- Automatic saving of the project;
- It is possible to share the projects via a link, QR code or direct sharing on Facebook, Google Classroom, etc.;
- The platform offers language translation for work, which facilitates users who have language difficulties;
- There is a mobile version available that allows operation through a mobile device as well.

Disadvantages of the platform are:

- The platform is only designed to work with the micro:bit boards;
- when sharing, the program code is not updated.

The MakeCode platform has many ready-made projects, which are located in a variety of categories: startup projects, games, fashion, science, music, toys, tools, and more (Fig. 3). When users want to view finished projects, they can search for them by selecting the appropriate category. With some of the finished projects, it is also possible to see the steps for the implementation of the respective project, and each step must be correctly completed in order to move on to the next one. An excellent feature for novice users who are interested in programming.

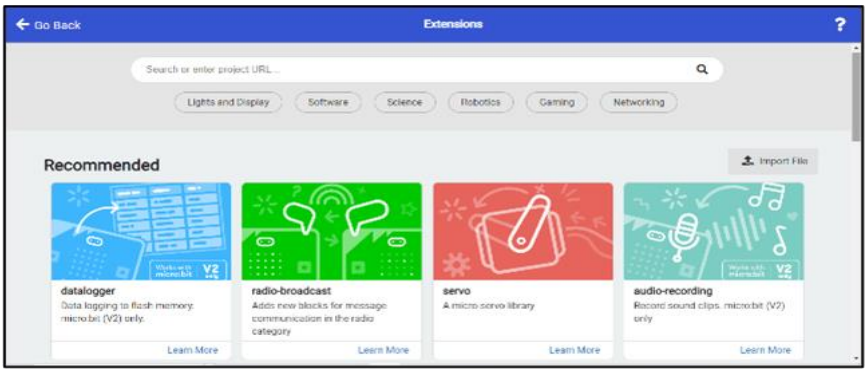
Fig. 3 More shared projects



Source: https://makecode.microbit.org

When working with a specific project, additional robotic devices or educational projects can also be sought to be included in the project. To do this, the user must select "Extension" (Fig. 4), browse and search in the recommended or use the search engine.

Fig. 4 Supports Extension robots' devices



Source: https://makecode.microbit.org

Tinkercad

Tinkercad - is an online platform that provides tools for 3D modeling and simulation of electronic circuits. Created by Autodesk, Tinkercad is aimed at beginners and students who want to learn and have fun with design, programming and electronics.

The advantages of the platform are:

- Easy to use interface;
- Large library of ready-made projects and models;
- Opportunity for teachers to organize online learning classes;
- Programming languages Python (for Micro:bit) and C++ (Arduino);
- Create 3D modeling;
- Ability to share projects with other users.

Disadvantages of the platform are:

- No supported bulgarian language

In Tinkercad, 3D models can be created and animated using blocks. There is also a so-called "Sim Lab" laboratory, where the laws of physics are activated and the elements begin to move. In the Components section, Tinkercad supports Arduino and Micro:bit board programming,(Fig. 5) providing the ability to write C++ code and visual programming using blocks. In addition to 3D modeling, Tinkercad also offers an environment for designing electronic circuits. Users can create and simulate electronic circuits using various components such as resistors, electric motors, LEDs, transistors, and more (Fig. 6).

Fig. 5 Supports Arduino and Micro:bit board

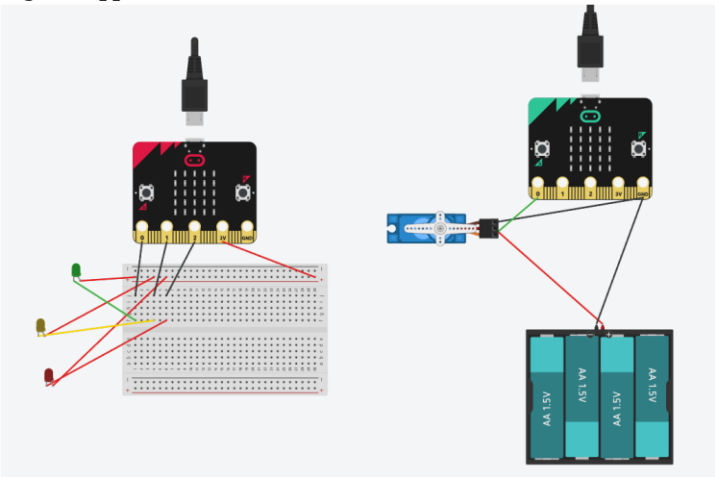
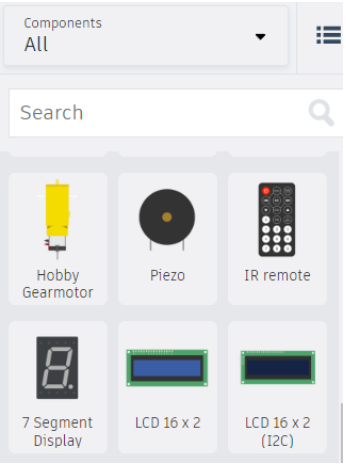


Fig. 6 Support electronic components



Source: tinkercad.com, Harizanov, Kr.

In Table 1, we will present a brief analysis of the two platforms used in the creation of STEM projects.

Table 1 Analysis by platforms Makecode and Tinkercad

Specifications	MakeCode	Tinkercad
Block coding	**Yes**	**Yes**
Script Coding	**Python, JavaScript**	**Pyrhon, C++**
Hardware support	**Micro:bit**	**Arduino UNO 3, Micro:bit, ATtiny**
Simulator	**Yes**	**Yes**
Shar project	**Yes**	**Yes**
Bulgaria Language support	**Yes**	**No**
3D models	**No**	**Yes**
Target	**Kids and Teacher**	**Kids and Teacher**

Source : Harizanov, Kr.

4. CONCLUSIONS

With the development of information technologies, education is becoming more and more dynamic and non-standard. The application of STEM education gives every student the opportunity to present his views, possibilities and look at science as an interesting and useful field for him. To a large extent, teachers and the school will have the main role to present STEM education as a factor that can determine the best opportunities and professional development of students. On a global scale, there is daily talk about the demand for specialists in the field of STEM professions, which will lead to the discovery of new specialties at all levels of education.

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