

USING THE TINKERCAD SERVICE IN EDUCATION

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Annotation: The article discusses the organizational and methodological aspect of the use of the Autodesk Tinkercad virtual environment in teaching robotics based on the Arduino Uno microcontroller in a secondary school. The advantages and disadvantages of using the proposed tool are analyzed in detail and the conclusion is made about the expediency of its use. The article provides links to projects created in the Tinkercad virtual environment.

Keywords: Tinkercad, Arduino, robotics, sensor, resistor, LED, RGB LED, button, potentiometer, capacitor, diode, photoresistor, ultrasonic distance sensor, temperature sensor, piezoelectric element.

The Tinkercad environment is free, available on the Internet at: <https://www.tinkercad.com/>. After mandatory registration, the user gets access to a personal account, which has a section of Circuits (schemes), equipped with tools for virtual

Let's pay attention to the fact that working with the Tinkercad environment is carried out by the user through a web interface, which makes it completely indifferent to the hardware and the operating system installed on it. Thus, a wide range of personal computers running UNIX operating systems (Linux and FreeBSD), Windows, Mac OS, Android, iOS, etc., under which the browser is available, is suitable for using the Tinkercad environment. This is a significant advantage for the use of Tinkercad in the educational process, since in educational organizations and among the home computers of students studying robotics, you can find completely different hardware configurations and operating systems.

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In addition, a sufficient amount of educational and methodological literature has been published at present devoted to teaching robotics based on Arduino family microcontrollers (see, for example, [3]), so that the educational process in this area using the Tinkercad environment is also provided with appropriate methodological support.

Considering the numerous advantages of using the Tinkercad virtual environment in the educational process of a secondary school, it is impossible to ignore the fact that the distance learning form of robotics can be used as a means of social adaptation for children with disabilities, which is described in detail by a teacher from Barnaul I. E. Stepkina in the article [4].

First of all, we will try to understand at what age it is optimal to start teaching robotics to schoolchildren based on Arduino family microcontrollers. There is an opinion of authoritative researchers such as A. Y. Fedosov [5] and V. N. Khamamov.

Thus, from our point of view, it is rational to devote the study of robotics based on the Arduino microcontroller to the period of study in primary school.

In the case of classes using the Tinkercad virtual environment in the course "Fundamentals of Robotics", when studying the topic "Programming of the Arduino Uno micro controller", it is proposed to use a Scratch-like block programming language, since for students of grades VI-VII it is more intuitive than

the procedural C—like Wiring language and you can devote more time to the process of assembling electrical circuits and microcontroller programming, rather than learning procedural programming languages, what would be more correct to do in computer science lessons, and not robotics. Table 1 shows the work program on the subject "Fundamentals of robotics".

Table 1

Working program on the subject "Fundamentals of robotics"

Number of lessons	Themes	Watch
1-2	Arduino and its capabilities. Practical lesson No. 1. Turning on and off the LEDs using the program.	2
3-4	1-project work. Preparation of the traffic light. Control work No. 1.	2
5-6	Practical lesson No. 2. Introduction to the Serial function.	2
7-8	Familiarization with the conditional IF operator. Practical lesson No. 3. Creating a program to display the clock in the Tinkercard environment.	2
9-10	Practical lesson No. 4. Familiarization with the sensor that senses temperature and humidity.	2
11-12	Practical lesson No. 5. Motor control using the program. Control work No. 2.	2
13-14	Practical lesson No. 6. Control of the servo motor using the program.	2
15-16	2-project work. Creating a smart greenhouse.	2
	Total:	16

The Tinkercad virtual environment has the following advantages in terms of using it as the main means of teaching when organizing robotics training in a secondary school:

- Tinkercad is a completely free learning environment;
- work in the Tinkercad environment is carried out by the user through a web interface, which makes the learning process independent of the hardware and the type of operating system installed on students' school and home computers;
- An Arduino microcontroller with a fully open system architecture is emulated in the Tinkercad environment;
- in the Tinkercad environment, a large number of different electromechanical components and ready-made circuits with the connected Arduino Uno microcontroller are available to the user;
- programming of the microcontroller in the Tinkercad environment is available in three modes, including the possibility to program in parallel in block and procedural programming languages, which in itself is an effective methodological approach. Taking into account the above advantages of a virtual environment.

Tinkercad would like to note the obvious need at the moment for teachers of computer science, robotics, teachers of additional education implementing technical programs related to robotics, knowledge of the methodology of using the virtual environment of Tinkercad in the educational process, as well as the inclusion of students' acquaintance with this tool in the appropriate work programs.

Based on the work program on the subject "Fundamentals of Robotics" for the 6th grade of a secondary school of the Republic of Uzbekistan, we have developed all the projects listed in Table 1 using the Tinkercad environment. Students of secondary schools listened to the lessons with interest and participated in the design of tasks using the Tinkercad environment. The proposed method undoubtedly increases the efficiency of training.

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