

USING FREE WEB APPLICATIONS FOR DESIGNING MOBILE ROBOTS IN GENERAL SECONDARY EDUCATION INSTITUTIONS (GSEI)

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Abstract: Using free web applications for designing mobile robots in general secondary education institutions is an important step in developing STEM education. These tools allow students to create and program mobile robots without significant financial costs, gaining practical skills in electronics and programming. Programs such as Tinkercad, Fritzing, VEXcode VR, and others provide opportunities to learn the basics of robotics, from 3D modeling to programming. They are suitable for different levels of complexity, offering access to modern technologies even in challenging conditions like limited resources and remote learning. The choice and implementation of such tools helps stimulate interest in technical sciences and provides access to innovative learning methods for students across Ukraine.

Keywords: free web applications, mobile robots, STEM education, Tinkercad, programming, robotics, education, learning tools.

ВИКОРИСТАННЯ БЕЗКОШТОВНИХ WEB-ЗАСТОСУНКІВ ДЛЯ ПРОЄКТУВАННЯ МОБІЛЬНИХ РОБОТІВ У ЗАКЛАДАХ ЗАГАЛЬНОЇ СЕРЕДНЬОЇ ОСВІТИ

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Анотація: Використання безкоштовних web-застосунків для проєктування мобільних роботів у закладах загальної середньої освіти є важливим кроком у розвитку STEM-освіти. Ці інструменти дозволяють учням без значних фінансових витрат створювати та програмувати мобільних роботів, здобуваючи практичні навички в електроніці та програмуванні. Програми, такі як Tinkercad, Fritzing, VEXcode VR та інші, надають можливість для вивчення основ робототехніки, від 3D-моделювання до програмування. Вони підходять для різних рівнів складності, забезпечуючи доступ до новітніх технологій навіть у складних умовах, таких як обмежені ресурси та віддалене навчання. Вибір та впровадження таких інструментів допомагає стимулювати інтерес до технічних наук та забезпечує доступ до інноваційних методів навчання для учнів по всій Україні.

Ключові слова: безкоштовні web-застосунки, мобільні роботи, STEM-освіта, Tinkercad, програмування, робототехніка, освіта, навчальні інструменти..

In the context of the Russian Federation's aggression against Ukraine and the constant threat of war, secondary education institutions (SEIs) in Ukraine, especially in regions close to the front line, are facing numerous difficulties in organizing the educational process. In such conditions, distance learning is becoming the main way to support the educational process, and it is free Web-applications for designing mobile robots that are becoming an important tool. They allow not only to continue their studies, but also provide students with access to modern technologies, which is important for the development of engineering and technical skills in difficult conditions. Mobile robots designed using these tools can be used in various areas, from training laboratories to research, which is an important aspect of STEM education. In areas close to the front line, where resources are limited, such tools

provide an opportunity to receive education and develop new skills that are important for students' future professional activities. The use of free online resources helps to significantly reduce the cost of education and makes modern technologies accessible, which is important in conditions of financial constraints.

- Tinkercad is one of the most popular free web applications for designing mobile robots. It offers an intuitive interface for creating 3D models, designing electrical circuits and basic robotic systems. The platform allows students to design robots by integrating components such as motors, sensors and other elements, and simulate their behavior in a virtual environment. Tinkercad also supports Arduino-based programming, allowing students to learn to code in a visual editor or using text code. The web application runs in the cloud, making it accessible for distance learning, which is especially important for regions where access to physical resources is limited. Additionally, Tinkercad provides an extensive library of ready-made components and tutorials to help with project creation.

- Fritzing is a free tool for designing electronic circuits and prototyping, which can also be used for developing mobile robots. Fritzing allows you to create schematics as well as design PCBs (printed circuit boards), allowing students to learn the basics of electronics and understand how different components in a robotic system work. The Fritzing interface makes it easy to create circuits using the drag-and-drop feature, making it user-friendly for beginners. The platform also supports physical prototypes, allowing you to combine virtual and hands-on learning.

- VEXcode VR is a free online platform for programming and controlling virtual robots in a 3D environment. The platform supports both block and text programming, making it useful for students of different levels of knowledge. VEXcode VR allows you to program virtual robots to perform a variety of tasks, such as navigating mazes or collecting objects. This allows students to learn robotics and programming in an interactive and engaging way.

- Robot Virtual Worlds is a 3D robot simulation software commonly used to teach robotics and programming. The platform allows you to build, test, and program robots, especially using the VEX Robotics platform. Students can design robots, test them in different environments, and learn the tasks they need to perform without the need for real equipment.

- Scratch for Robots Scratch is a popular programming language for beginners that has extensions for robotics projects. With platforms like ScratchX, students can connect Scratch to various hardware platforms, such as LEGO Mindstorms or micro:bit. Scratch allows you to create programs using a drag-and-drop interface, which is great for introducing students to programming and robotics.

The above-listed Web-applications for designing mobile robots provide wide opportunities for educational institutions working within the framework of STEM education. They allow not only to study the basics of robotics and programming, but also to implement real projects without the need for expensive equipment. This is especially important in conditions of distance learning or limited resources, allowing students to access the latest technologies and develop their skills in the field of robotics. Table 1 compares the advantages and disadvantages of Web-applications for designing mobile robots within the framework of STEM education.

Table 1. - Comparison of advantages and disadvantages of web applications for designing mobile robots within STEM education

Web applications	Advantages	Disadvantages
Tinkercad	Easy interface for beginners Support for 3D modeling and Arduino Ability to create circuits and robot simulations Cloud-based platform accessible from any device	Project complexity limitations May not be suitable for more advanced users

Continuation of the table 1

Web applications	Advantages	Disadvantages
Fritzing	Convenient for creating electronic circuits and PCBs Suitable for learning the basics of electronics Intuitive interface	Limited support for robotics projects Does not support 3D modeling and more complex robotic systems
VEXcode VR	Virtual robot for programming Supports block and text programming Suitable for different levels of knowledge	Limited capabilities for complex projects Requires stable internet connection for real-time work
Robot Virtual Worlds	Robot simulation in 3D environment Suitable for learning robot programming and design Highly realistic environment	Requires a license for the full version Lack of support for more complex hardware platforms
Scratch for Robots	Suitable for beginners Simple visual interface Easily integrates with LEGO, micro:bit and other platforms	Limited functionality for complex robotic projects Not suitable for more technically complex tasks

The choice of software for designing mobile robots in secondary schools within STEM education depends on the level of preparation of students and learning goals. Tinkercad is one of the best tools for beginners, as it combines 3D modeling, electronic circuit creation and Arduino programming in a single interface, allowing students to work with robots at all stages of their design. For teaching the basics of electronics and creating simple circuits and prototypes, Fritzing is a good choice, but it does not support complex robotic projects. If the task is to program virtual robots to perform simple tasks, such as navigation or manipulation of objects, then VEXcode VR will be an ideal choice for students who want to learn programming in real time. Robot Virtual Worlds is useful for teaching robotics in a 3D environment, although a license is required for more complex projects. For students just starting out in programming, Scratch for Robots is a great tool due to its simple visual interface, but the limited capabilities for complex projects can be a drawback. Considering these factors, Tinkercad and VEXcode VR are the best programs for designing mobile robots in secondary schools, as they support different levels of complexity and have a feature-rich interface.

The programs listed above allow you to create robotic systems and develop programming and electronics skills using free resources, which is important for learning within STEM education, especially in resource-limited environments.

CONCLUSIONS. The use of free web-based applications for designing mobile robots in secondary schools is an important tool for the development of STEM education, especially in conditions where access to physical laboratories or expensive software products is limited. These tools allow students to develop skills in areas such as electronics, mechanics, and programming, even in remote regions or during distance learning. Programs such as Tinkercad, Fritzing, VEXcode VR, and others offer different levels of complexity, which allows taking into account the needs of students with different levels of training. They help not only to master the basic principles of robotics, but also encourage further study of more complex aspects of engineering and programming. The selection and integration of such programs into the educational process allows to increase students' interest in technical sciences and promotes the development of critical thinking and a creative approach to

problem solving. In conditions of economic and resource constraints, these tools are an affordable and effective way to integrate modern technologies into the educational process, which opens up new opportunities for students across the country.

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