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APPLICATION OF 3D PRINTING TECHNOLOGIES IN THE EDUCATIONAL PROCESS AS AN ELEMENT OF STEM EDUCATION

In the twenty-first century, more and more countries realize that scientific and technical talent is quite an important indicator for assessing national competitiveness, and it requires people to have access to new knowledge and skills to quickly solve complex problems. Therefore, it is important to create and expand opportunities for all children to receive an education that will enable them to navigate and manage the 21st-century world they will inherit. To thrive in our technology-driven age, students need to be supported in building their skills in science, technology, engineering and mathematics (STEM). Educational practice shows that STEM education can help students develop scientific research ability, innovative consciousness, critical thinking, skillful use of information technology and other necessary skills for the future.

The development of STEM education in Ukraine is gaining momentum today. This is evidenced by the government's adoption of a number of regulatory and legal documents that ensure the efficiency of the industry.

It is also important to include modern industries that are rapidly developing in the main components of STEM education. These areas include robotics and 3D technologies. Recently, 3D printing in education has gained wide popularity. Despite the fact that 3D printing is relatively new to the educational space, more and more 3D printers and their applications are finding their place in education and everyday life. Therefore, the need to reveal the possibilities of 3D printing technology and its application in various spheres of the educational activity has intensified.

We made an analysis of Ukrainian and foreign scientists who researched the use of 3D printing in educational fields. Thus, we discovered that the range of applications of 3D printing in various educational areas is not sufficiently studied.

We conducted research on the use of a 3D printer at Chernivtsi multidisciplinary Lyceum No. 4, which received a STEM physics laboratory, which includes robotics and 3D printing kits.

In the institution, the teaching of the "Fundamentals of robotics" group was introduced for students of grades 5-6. Children who attend the circle have the opportunity to get acquainted with 3D printing technology, in the process of implementing a research and educational STEM project. The STEM lab kit includes a 3D printer with a set of eco-plastics, the material with models for printing robot parts that connect to the Arduino Uno board, magnets, and more. Students independently design models and components for robots on the website <https://www.tinkercad.com/> also some 3D models can be downloaded from sites with free access. To implement research projects on 3D technologies and robotics, it is suggested to use materials from open platforms on 3D printing and robotics. One of these is the open platform **Thingiverse.com**.

Research projects include the design, and printing of robot parts on a 3D printer, and the assembly and programming of a robot based on the Arduino Uno platform. Work in the research project begins with the development of the project and printing of robot details on a 3D printer. Project participants print bodywork, panels, wheels and tires that have been preloaded or created by themselves.

Electronic circuit boards are also used to assemble the robot: Arduino Uno, Bluetooth module, switch, LEDs, holder for 4xAA batteries, spin connectors, shrink tube, plastic clamp, etc.

After successful assembly, the process of programming the robot using the online web editor Arduino (www.arduino.cc) is used. After that, the correctness of the written program is checked.

Other students of the lyceum are also familiar with and actively using 3D printing technologies.

Students of the 9th grade in computer science classes, studying the topic of 3D graphics, have the opportunity not only to create a project in practical work but also to see its implementation live. They get acquainted with the online environment for creating 3D models <https://www.tinkercad.com/> and the Blender software package for creating three-dimensional computer graphics. They learn to work in these environments and create 3D models, take into account the specifics of image construction, and textures, and think through not only design but also create projects that can then be printed and assembled: coloured, moving elements, etc. Students were given the opportunity to print their own 3D models, so they approached this task with creative zeal. As a result, everyone was very enthusiastic about their work, it was interesting to complete the tasks and receive a model that they themselves created.

We conducted an experiment in the 9-A class, which consisted of the fact that in one group lessons were held using 3D printing technology, and in the other, it was not. Thus, in the group where the 3D printer was used, students learned the educational material better and showed creativity and creative thinking. This demonstrates not only the theoretical use and dry assimilation of the material, but also gives a real opportunity to see the entire work process: from the creation of a computer model to printing, which is the main thing in the implementation of STEM projects.

Therefore, the use of a 3D printer in lessons increases students' perception of new material, shows their interest in the learning process, and lays down theoretical and practical skills of modern 3D technology.

Therefore, the use of 3D technologies in the educational process of educational institutions of various levels will allow an increase in the accessibility and quality of education due to the possibility of the physical implementation of the studied objects, development of the design of working projects, digitization of existing details and mechanisms for the modernization of their structure, as well as increasing the visibility of educational and methodological materials.

