3D -printing Studying as a Component of Modern STEAM Education

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Abstract

The world revolves around innovation, new ideas, new products, and new problems solutions. Science, technology, engineering and STEM is the foundation for innovation. The development of STEM education is crucial to the development of modern information society. In Ukraine, the implementation process of STEAM and STEM education is gaining rotation. Courses on issues of Internet-things, embedded systems and other areas of modern engineering are introduced at universities. One of these courses is to teach students of different specialties of 3D technology printing and forming their skills in the use of this technology to create their own innovative projects within their professional competence. In Borys Grinchenko Kyiv University the curriculum and appropriate methodological support for the implementation of such course in the educational process have been created under the support of the Tempus project 544091-TEMPUS-1-2013-1-BE-TEMPUS-JPCR. Development courses on embedded systems using innovative approaches for virtual integration of science, education and industry in Ukraine, Georgia and Armenia and features of training students under these courses have been revealed in the article.

Keywords: STEM, STEAM, 3D-printing, DesIRE, Wiki-portal, wiki-technology, embedded system.

2 INTRODUCTION

A successful economy is based on a way of thinking, based on innovation and creativity, research and development. Many successful entrepreneurs around the world have experience with innovative technologies to help them to create new successful business. As the practice most of them were studying under the STEM education standards. That is why this trend is promising and relevant educational activities today. The exact origin of this area has been lost to education history; acronym was appeared only in the last 15-25 years. Since then, this area has become a key factor in educational policy. In order to meet the needs of a modern technological society and develop the population, especially the youth, desire and ability to engage in science and technology, STEM education should be developed at school, based on a formal and informal basis. This is especially true for education, which is aiming to overcome «STEM gap" - the large number of vacancies due to lack of skilled workers. In Finland it is believed that if the school leavers will have the actual stock of practical knowledge with all the latest computer technology and skills to search information effectively, we can expect that it will benefit not only for themselves but also the state. The experiment of teaching no special sciences has begun but young people from 15 years study professional courses that are directly related to real life [4].

Some researchers argue that STEM is too narrow focus. One of the alternatives is a STEAM which was first launched in 2006 (science, technology, engineering, arts and mathematics).It is considered the founder of this direction is G. Yakman, who expresses the view that "science and technology are interpreted by engineering and art, all this is happening in the calculation of the mathematical elements "[6].

3 LEARNING 3D PRINTING AS PART STEAM-EDUCATION

STEAM-education involves addition to providing domain-specific knowledge related to the development of deductive and inductive and logical thinking - increasing creativity, critical thinking, flexibility, adaptability, social and cross-cultural skills related to art. Thus, STEAM education aimed at creating an intelligent professionals who are STEM-skilled, creative and innovative. In Korea, the Ministry of Education, Science and Technology has received STEAM education as a means to increase the interest of students to STEM subjects and as a result promote science and technology in the Korean society [1].

National Science Foundation (NSF) and the National Arts Foundation (NEA) in the United States after bilateral discussions have believed that the addition of Art (A) to STEM is not enough. You should also add thinking skills embodied in reading and writing. (Eng. English Reading and Writing), since STEAM transformed into STREAM. Competence is an essential component for Science and Technology, as

experts are able to write projects and experiments, writing reports properly communicate and collaborate. STEAM and STEM education provides motivation to study practical synergy of science, technology, mathematics, engineering and the arts. The principles of STREAM education include:

1. Practical integration of science and skilled: model is based on researches using instructions that combine practical training, analysis, synthesis, vocabulary, discuss and organize data.
2. Providing opportunities for learning through research, reading, writing and math skills using a scientific context.

Increased interest in students of all specialties is the use of 3D-printing (in the context of a combination of scanning-printing-design) in the educational process. A distinctive feature of modern society is the rapid development of the IT-industry, robotics, nanotechnology, 3D-printing and the Internet-things, causing the need for skilled professionals in the global arena and at least basic skills in each. Currently 3D-printing in education is novelty in some extent, it is most used in engineering and physics, but creative use of 3D-printing is biology and other sciences is rapidly developing. [8]

3D-printing technology is especially interested in students of specialty "Primary School" and "Design". Students polls at Borys Grinchenko Kyiv University might show the main reasons for interest and combine them into categories:

- Interest in innovative technologies for the production.
- The use of 3D-printing in various fields.
- Ability to create new objects.
- Design work.
- Experience for a future career.
- New knowledge.
- Practical skills.

Students are offered interesting options for using 3D-printing technology - for history, interior design and more. Under the polls it was developed the program of additive technology education for students of different specialties (Table. 1)

Table 1: The training course.

Topic	Description
3D-printers: basic concepts Stages of training models for 3D-printing. Features models. Requirements for 3D models and types of printing	What is a 3D-printer and what types are. 3D-printing technology. Materials for 3D-printing. Areas of use of printed models. New in 3D-Printing
Stages of training models for 3D-printing. Features models. Requirements for 3D models	The concept of the format STL, G-code, raft, Supports, delamination, filling models. Features 3D-model, which will be published
3D design	Working with service Tinkercad. Plane. adding objects, forming holes, ready models import, export

Slicing model and configure print settings	Training models for print, configure print settings (heating table, extruders, rafts, Supports and filling)
Printing and correction of 3D models	Getting to know the printing process models and further correction of finished model
Project work	Implementation of the joint project "Dream University"

During the 2016 in the framework of the international project Tempus DesIRE for implementing technology 3D-printing in the educational activities of the university introduced the appropriate elective course students for different specialties «Technology of 3D-Printing". It was a project on Wiki portal Borys Grinchenko Kyiv University for technical support [5] (Figure 1).

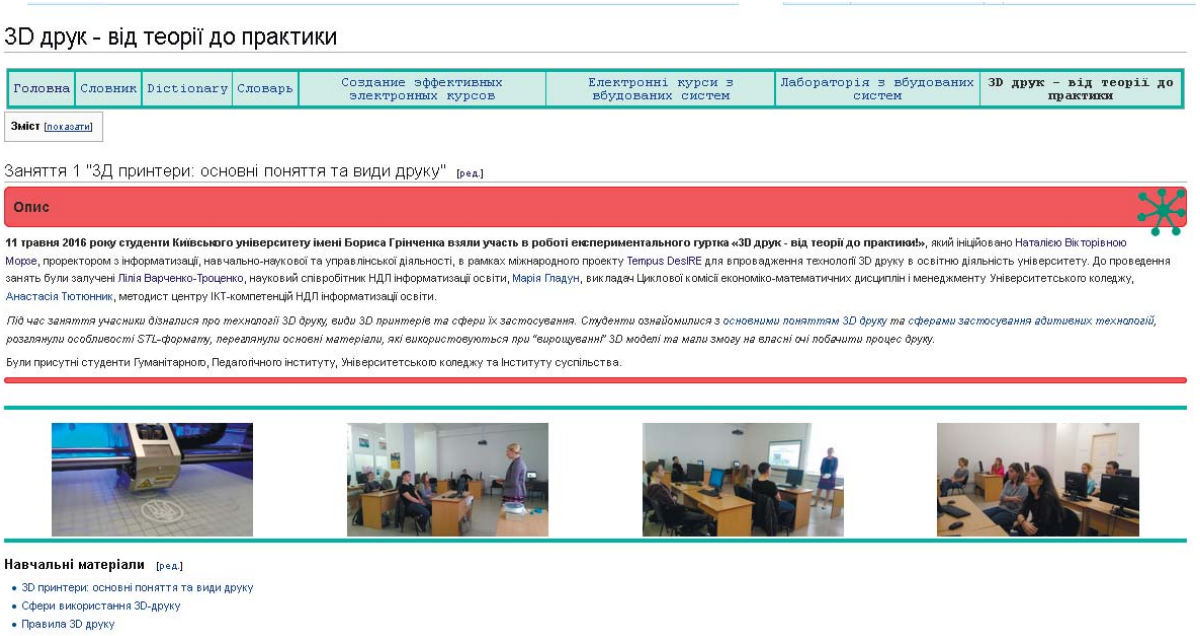

Figure 1: Project on Wiki portal

Wiki-portal was created as a platform for implementation of educational technologies aimed on the active students and teachers, all members of the educational process. Wiki portal operates on the technology «wiki». Using the wiki-technology is possible without any effort to place a variety of educational web resources, share ideas, re-use web resources are based on the contribution of many participants [2]. The main feature of the technology is that any person can register and write in an article for specific requirements. Other members can build upon it and make changes. The history of each article creation is kept. [3] It allows a large number of users to work on one e-resource, add items to discuss, insert images, polls on video, audio, maps, skills and other resources that implement electronic collaboration to create a shared resource.

In this project, students can learn the theory, find its complement, participate in discussions, find plenty of useful references and see the practical problems.

The students' polls showed that students of non-technical specialties study additive technologies and implement them in future professional activities with interesting. The most interesting thing for students is a 3D-design slicing and 3D-printing settings, printing and correction model (Figure 2):

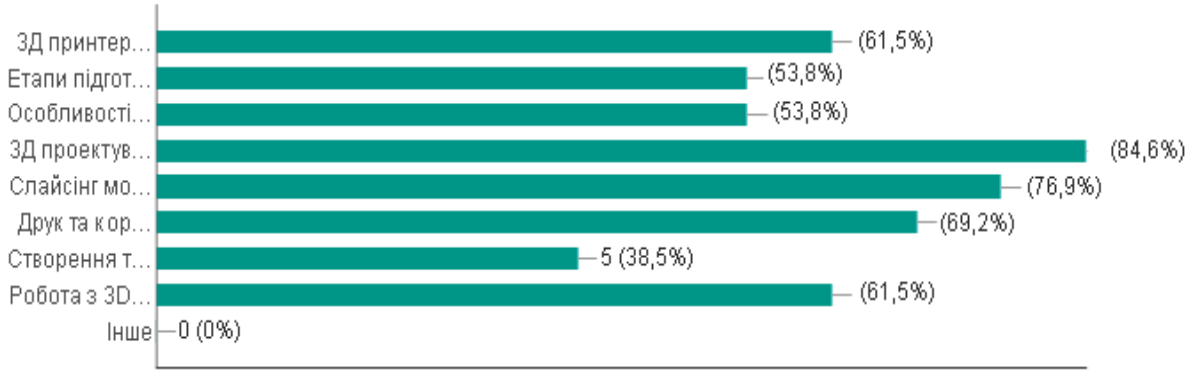

Figure 2: Respondents' answers on topics of interest group.

The most useful for students were activities such as practical exercises, discussions and homework (Figure 3):

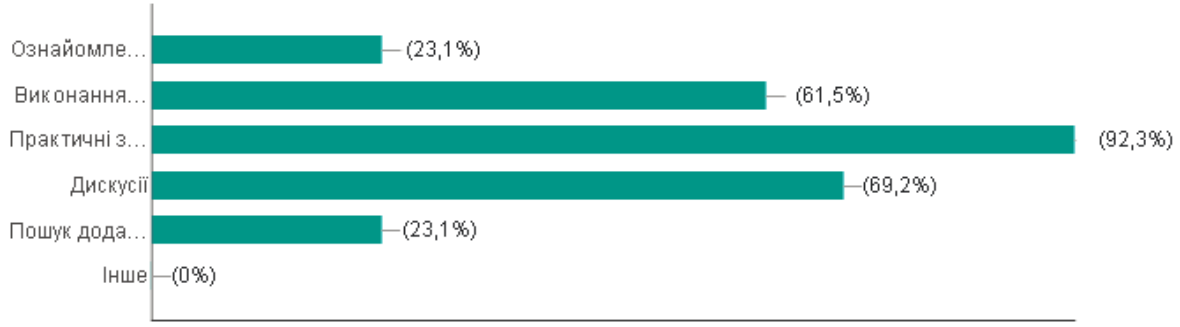

Figure 3: Respondents on learning activities.

Students believe that learning 3D-printing is developing such competencies and skills as abstract thinking, evaluating their own activities and electronic communications mostly (Figure 4):

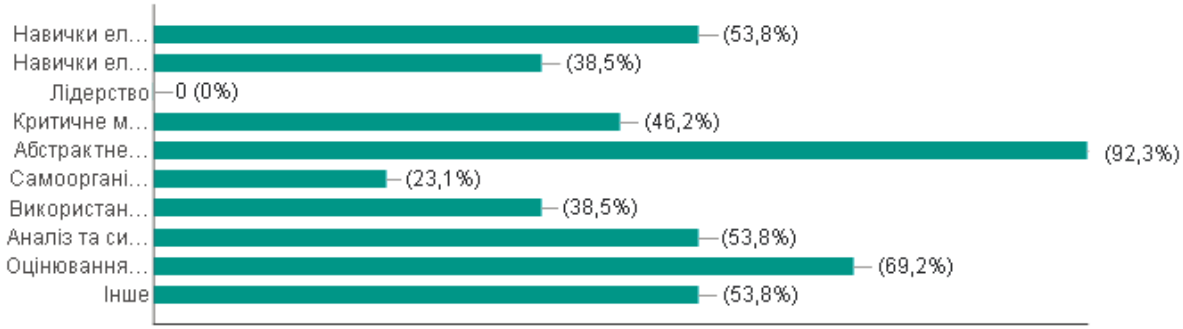

Figure 4: Respondents' answers on skills and competencies that develop 3D-printing study.

All the students said that in the future they would plan to use the acquired skills actively.

Based on surveys of student satisfaction we can draw conclusions about the feasibility of implementing elective discipline next year for students of all specialties - 84.6% answered yes to the question about the need for the introduction of such subjects, 15.4% - difficult to determine.

Students also said that 3D-printing could be used actively in the development of embedded systems for different areas of life and directly to their specialties.

Conclusions

In Ukraine, the implementation process of STEAM and STEM education is gaining rotation. Courses on issues of Internet-things, embedded systems and other areas of modern engineering are introduced at

universities. The modern market needs foresee the possession of such knowledge not only of technical experts, but also in almost all areas. Teaching this course to students of different specialties is very important. Increased interest of students of all specialties is the use of 3D-printing (in the context of a combination of scanning-designing-printing) in the educational process, so it can been established into experiential learning of 3D-printing technology as components of STEAM education and formation of their skills in the use of technology to create their own innovative projects within their professional competence.

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