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ISSN 2719-6550
ISSN 2719-7417 online

"Journal of Education, Technology and Computer Science"
No. 3(33)/2022
www.eti.ur.edu.pl

Received: 22.06.2022
Accepted for printing: 10.11.2022
Published: 22.12.2022
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DOI: 10.15584/jetacomps.2022.3.10

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Possibilities of 3D Printing as Modern Technology Using at Education

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Abstract

The article describes possibilities of 3D printing using at educational process. It focuses attention to alternative creation of new specific teaching aids as well as motivation of pupils and students towards study of: informatics, programming, using of CAD programs, design of new products, etc. Working principle of 3D printer and cardinal information concerned to successful using of new technology is described shortly.

Keywords: education, 3D printing, teaching aid, modern technology for education

Introduction

For the most effective educational process there is need to present knowledge to students by style, so as obtaining knowledge would be desire for students. High quality education is based on knowledge and using of different devices and teaching aids for teaching. Teachers employ didactic equipments and do not rely only to verbal and non verbal communication with students. Material tools and models are basic elements of didactics. It is integral part of teaching process and it has big influence to realization of educational aims. One of the most important didactic principles is principle of object teaching that is realised mostly by teaching aids and models.

An improvement of technologies makes it possible to use them in educational system. 3D printing is one of new methods that can be used to create different products. The technology of 3D printing offers efficient alternative of large amount of models creation by actual needs of education based on natural creative invention, hardware and in bounds of solid expense. An 3D model is

possible to use for assistance at active education with practical manipulation with models at standard teaching. It is possible to make easier learning for pupils with visual in sufficiency or reduced space orientation.

The subject matter of the study. Exploitation of 3D printing at school

3D printing is possible to use at educational system as teaching subject or as component of other related subjects (informatics, construction drawing, designing, engineering, etc.). But also as alternative of creation of teaching aids for teacher (for example for subject as: chemistry, physics, geometry, electrical engineering, etc.). Probably, the most suitable of 3D printing at school is creation of models with pupils that will be used as didactic aids at different study subjects.

It is possible, by 3D printing, to create basically any object. It is reason why different educational aids can be created for different study subjects for basic and secondary schools. There is possibility to teacher to create models that serve to purpose of student motivation. A teacher does not have to create models from the beginning. Today, there are lot of models that are ready. A model can be copied from source, adapted for specific type of 3D printer and printed. Some exhibits from museum can be copied for example by this way as well. There are some fields of learning topics that are not easy for students usually. Mostly it is: models and diagrams that are displayed by 2D version at text boxes. It is usually: different kind of mathematical and chemical models and diagrams. There is possibility for better understanding for students by the possibility of 3D printing and creation of three dimensional models. It brings motivation that is able to change dynamics of all class. It is not possible to avoid changes of size of some parts of models (for example to reduce size of machines or on other hand to expand models of atoms, molecules, etc.). Observations of students can be distorted by the change of dimensions. However, manipulation with model, it is lot of times the only way how to know presented object at least.

Research methodologies and tools

The research was carried out using the analysis of commonly available IT solutions regarding technology and software to support 3D printing. It is convenient to exploit for example projects that support introduction of 3D printing into schools, considering financial status of educational system. These projects are often financed by technological companies or dealers of technological equipment. They organise education for teachers moreover. There isn't obligation to buy expensive software to 3D printers within educational system. Software is oftentimes available to copy free, or there is possibility to use online CAD editors that is not obligation to install. Some producers of commercial software enable special educational editions by bargain prices of cost free.

Analysis of research results. The principle and basic characterization of 3D printing

3D printer uses X and Y axes on plane as standard printer, but adds third axis Z – height. Said very simply, complex future object is decomposed into horizontal slim measures (slices) that are during printing stocked at each other. Each of slices has outside contour in X–Y plane in shape of future object at corresponding height. Material object is created by process that particular segments are stocked on each other step by step. Different restrictions originate depending up used material and 3D printer and other factors. In spite of all restrictions, 3D printing has lot of advantages in comparison with standard methods of production of three dimensional models. Compared to casting – there is for example saving of time and financial resources needed for preparation of cast up, standard machining – saving of waste material. Lot of patterns is complicated to produce by standard methods and 3D printing offers proper alternative. 3D printing method is not universal of course. It is required to consider properly, what will be printed by 3D printer and what is expected from resultant printed models.

A material is supplied in the shape of printing filament. It is extruded by heated nozzle in head of 3D printer – it is the most common technology of 3D printing and also the most cheep alternative. The price of such 3D printers is from hundreds Euro (printers used at home)to tenths thousands Euro (professional). The technology of 3D printing is convenient for printing of functional models and prototypes that are after printing ready to be used immediately. A material for 3D printing is from thermoplastic, twisted in coil. Material is gradually supplied into extruder – printing head.

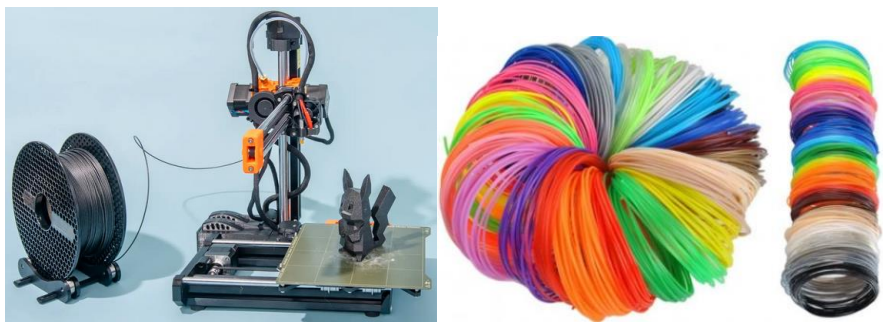

Figure 1. 3D printer and filament with different colours

A plastic is warmed to required temperature in printing head and coated on a base at axis X–Y. When one whole layer is deposited the system is shifted along axis Z and next whole layer is printed. This way of printing is not precise and separate layers are often visible. This can be adapted by adjusting of layer height or by treatment of completed model.

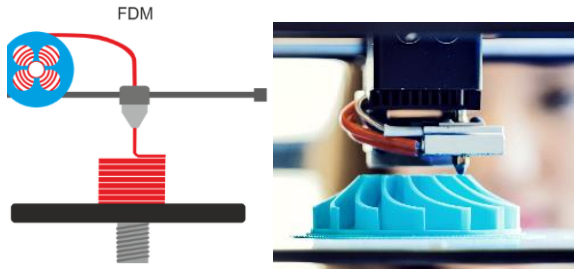

Figure 2. Basic principle of 3D printing (layer over layer)

Specific disadvantage is necessity to create supporting skeletons when plates that exceed fundament of printed model are printed. Advantages are price availability of printers and printing material, proportions of printers that is suitable for using at office or at home. There is possibility to print coloured models thanks to possibility to change filaments during printing. Changing of filament is possible to do by hands (printers of lower cost) or automatically (printers with more feed blocks). Materials for printing are more sorts at present. Materials for printing have different characteristics and are produced from: plastics, metals, alloys of metals, ceramics, concrete, paper, different sorts of bio materials, etc.

PLA is the most frequently used filament probably. Its popularity results not only from low cost but large assortment and good properties for printing moreover. It is efficient for printing of small and detailed objects. Considering small temperature expansion of this material, printed models do not screw, crack and come unstuck from plate. PLA is robust and breakable all at once. It has low temperature resistance – it comes plastic at 60°C. It is least long live material to weather conditions among the most used materials.

PETG combine properties of PLA and ABS properly and it is suitable for recycling. It has lower temperature expansion but it is more stabile to temperature and mechanical stress. Models are soft elastic this is why they do not crack immediately by mechanical impact. A model made from PETG has bright surface comparing to PLA.

The 3D printer is selected by more criteria:

- Technology of printing – what material is used for printed model,
- Largeness of printing plane,
- Speed of printing (mm/s) –it depends on resolution and other facts,
- Resolution – details on printed model makes printing longer,
- Proportions of printer,
- Possibility to print by more colours – usually in separate slices,
- Possibilities of printer connectivity (including connection to data network),
- Using of display to control of printer,

– Software and its upgrade,
– Price of printer, etc.

Process of 3D printing consists from three main steps that follow to each other:

1. Creation of model of printed object in digital shape – obtaining of model from internet, creation of 3D model by using CAD software, transformation of existing matter to digital version by 3D scan or by photogrammetry.

2. Conversion to format determined for printing – the object is represented in it by three dimensional networks of reciprocally interconnected points. The model can be modified and edited at any time. As many points are in the network, that represents object, thereby model is more precise, but resulted file is bigger and operation with it is more complicated and demanding to computer power. Consequently, the file is transformed into format generally used for programming of CNC machines (sequence of text instructions, printer use instructions to provide individual transactions). In the programme, that divide model into separate horizontal segments (slicer) it is possible to set lot of parameters that bear relation with printing. A printing can be modified in light of printing duration, cost, visage and robustness of model. Parameters are for example: temperature of printing head, speed of printing head, thickness of one layer, robustness of surface, format and thickness of filling, format and situation of supports, situation of model on plate, etc.

3. Printing:

– The temperature strait relates with speed of printing and diameter of jet and can be adapted to dimension of printed object. Small precise objects are preferable printed with lower speed and lower temperature then bigger objects that can be printed with higher speed and higher temperature.

– A layer height affects resolution in Z axes. As higher is height of one layer as more visible are separate layers. A height of 0,15mm is used usually, but different values can be used as well. The height of one layer influences time needed for printing significantly. As lower are layers as longer is time needed for printing of the some model. A width of layer relates with its height (100% = width of printing head). Higher robustness can be obtained by extension of width of layer.

– An infill influences speed of printing, filament consumption and robustness of resultant object. An infill density is usually 10–20% (0% is hollow object, 100% is solid object). As higher infill density is as heavy and robust against pressure object is. A shape of infill pattern: line, grid, honeycomb, etc. influences situation also.

– Supports uphold parts of models that without support would suspend in air.

Most of printed models are possible to be used directly after printing. Treatment of printed model makes it possible to improve mostly visual quality of product where are higher demands to this parameter. It is mostly: abrasion, cementing, gluing, smoothing by chemical process, colouring, etc.

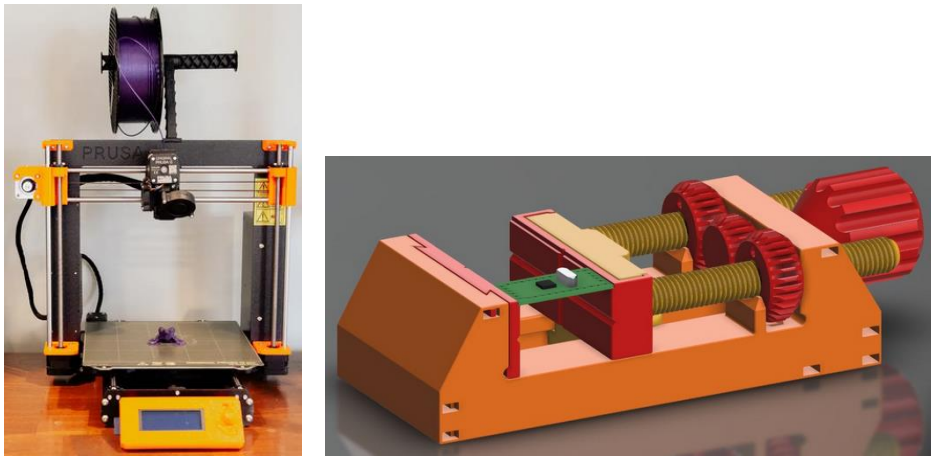

Figure 3. Printer and model after 3D printing

Advantages of 3D printing that are possible to exploit at educational system for preparation of teaching aid are: cheaper and mere quick production, local production by requirement, controllable quality, more clear presentation, competitive advantage, fast economic return of investment, care to environment, etc.

The exploitability of 3D printer at school relates with education, when a printer is didactic instrument studied by students as taught subject, eventually as device used at after school activities to produce different kind of objects. Exploitation of modern technologies increases prestige of the school as an institution, what can be positive at recruitment of new students and pedagogues.

An application of didactic aids is integral component of effective and qualitative process of education. School surrounding should educate modern technologies as much as possible with aim: to prepare students for life in reality of accelerated technological improvement of society.3D printing has its future. It is one of new, useful technologies suitable for using at school. An improvement of educational process on the base of results reached at science, research, advancement and application of effective modern pedagogical approach should be one of basic principles of education.

Conclusion

Basic purpose of the article is to inform pedagogues about possibility to use 3D printing as new dynamically unroll technology in favour of education. There are two basic possibilities – production of new teaching aids and education of students at field of software creation by using CAD programs, principles of CNC machines programming and creation of new design models. Focus is orientated to practical creation and by that motivation to active performance.

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