Using 3D Modeling Software for 3D Printers at Primary (Lower Secondary) Schools in the Czech Republic and Use it for Create Simple Model

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Abstract—This article describes the results of the phone interviews across the Czech Republic at primary (lower secondary) schools focused on mapping the using 3D Modeling Software for 3D Printers. The article contains the second part. The use of these 3D modeling software for 3D printers for create simple model. There is a large amount of 3D modeling software for 3D printers. Most of them focus on professional 3D modeling. This is not useful for teaching 3D modeling at primary schools. There are also very simple software. Schools know about them and use them. The results of the phone interview present that schools use software Tinkercad, SketchUp and Windows 8.1/10 build in software 3D Builder. These 3D modeling software is a typical example of simple software. To create a simple model, these simple software have just been selected. A simple model was created and the creation described in each of these three software. Simple model its mean create a cup. As the cup is mean hollow cylinder with torus.

Keywords— 3D modeling software, 3D rinters, model, construction, CAD, education, Tinkercad, SketchUp, 3D Builder.

I. INTRODUCTION

NOWADAYS 3D printers begin to appear in schools. 3D printing has been used by industry for decades as a rapid prototyping tool. Engineers doing rapid prototyping to study new product designs, to find their flaws, and to improve their features. 3D printing in schools hasn't been around as long, but it's used for many of the same reasons. The technology has proven itself in the classroom as a fun, real world way to teach science, technology, engineering, and math (STEM) skills, to develop creativity, and to encourage teamwork. [1], [2], [3], [4]

As printer prices fall, and as the machines and their software become easier to use, teachers are finding that they can offer 3D printing experiences to students as early in primary school. [1], [5], [6], [7]. [8]

3D printing, also known as additive manufacturing, is a growing field for many professionals, including those in education. [7]. [9]

Using 3D printers is very popular way of providing an interdisciplinary, project-based learning activity, with special focus on STEM (science, technology, engineering and mathematics) areas. 3D printers offer major new benefits to education. [7]

There are a lot of 3D modeling software. These software exist for a long time. Recently, all of these software allow export to 3D printer format. For example, it is a professional software such as AutoCAD, SolidWorks, Inventor, 3DS MAX, Blender for simple use and as freeware. This may be, for example, the recently popular TinkerCAD or more technical OnShape or FreeCAD. First, these 3D modeling software was used in the professional sphere. Later, they began to appear in schools as a means of teaching these software. And for modeling and obtaining technical visualization. Such use of 3D modeling software is mainly at technical schools. Due to the trend of increasing technical and natural education, 3D modeling software is also being used in primary schools. Even 3D printers are beginning to appear in these primary schools. Pupils then immediately succeed in their 3D modeling. Figure 1, 2.

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Fig. 1 3D Printer

Fig. 2 3D Printer

II. MAPPING THE USING 3D MODELING SOFTWARE FOR 3D PRINTERS AT PRIMARY (LOWER SECONDARY) SCHOOLS IN THE CZECH REPUBLIC

A. Research Methodology

The use of 3D modeling software for 3D printers at lower secondary schools in the Czech Republic is based on the use of robotic kits and 3D printers at primary schools in the Czech Republic. [7]. Several things have been identified in this article. One of the findings was the use of 3D printers in primary schools. Mapping of using 3D modeling software for 3D printers at primary (lower secondary) schools in the Czech Republic went way again calling into schools. They called the schools where 3D printers are used. During the phone call, it was determined what 3D modeling software for 3D printers they use.

B. The Results

The results are processed using quantitative research methods and are shown in the following tables and graphs. The result of mapping of 3D modeling software for 3D

printers at primary schools in the Czech Republic was quite clear. Schools use the following software. There are Tinkercad [10], SketchUp [11], 3D Builder (Microsoft) [12].

III. 3D MODELING SOFTWARE FOR 3D PRINTERS AT PRIMARY (LOWER SECONDARY) SCHOOLS IN THE CZECH REPUBLIC

These three 3D modeling software are distinct in terms of license and installation.

Table I shows the licensing options for these software. All three software offer free usage. However, SketchUp has limitations. In SketchUp, however, there is also a license for schools. If SketchUp users want to use all of the options fully, while they are not students or teachers at school, they have to use a paid license.

Table I. Licensing options

software	licence		
	free	**paid**	**schools**
Tinkercad	x		
SketchUp	x	x	x
3D Builder	x*		

Table II shows the installation options. There are two installation options. One option is that the software is not installed and is only online. The second option is that the software is installed. Tinkercad software is online only. SketchUp offers both options. For easy use with limited options, it is available online. For full use, the software must be installed. 3D Bulder software offers the option of installing only. This software is for Windows 10 or Windows 8.1 only.

Table I. Installation options

software	install	
	online	**desktop**
Tinkercad	x	
SketchUp	x	x
3D Builder		x

A. Tinkercad

Tinkercad is a simple tool for 3D design and modeling based on a browser for everyone. It is can imagine anything and suggest it in Tinkercad within minutes. It is used by designers, hobbyists, teachers, and kids, to make toys, prototypes, home decor, Minecraft models, jewelry – the list is truly endless. There is use the shapes as the basic building blocks of Tinkercad. Every shape can add or remove material,

and you can also import or create your own shapes. Grouping together are set of shapes you can create new models to work with. There is a build intricate shapes and create extremely detailed models. Shapes is import and extrude them into 3D models. [13] Figure 3.
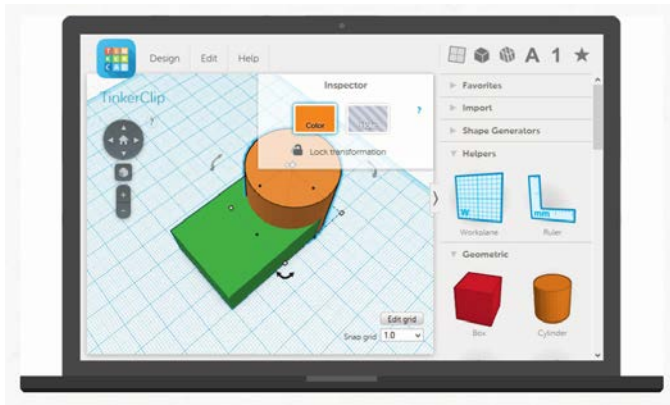

Fig. 3 Tinkercad [10]

B. SketchUp

SketchUp is 3D modeling software by Google. That's easy to learn and fun to use. SketchUp users are architects, designers, builders, makers and engineers; they are the people who shape the physical world, they are important, and they deserve great tools because great tools produce magnificent work.

Tools are ones you look forward to using and they let you do what you want without having to figure out how. help with hard or boring tasks so that you can focus on being creative, or productive, or both and they are, in their own way, beautiful.

SketchUp have best tools to make drawing, Users drawing is thinking, they draw to explore ideas, to figure things out, to show other people what they mean and draw because they love it, and because nothing great was ever built that didn't start with a great drawing. [14] Figure 4.
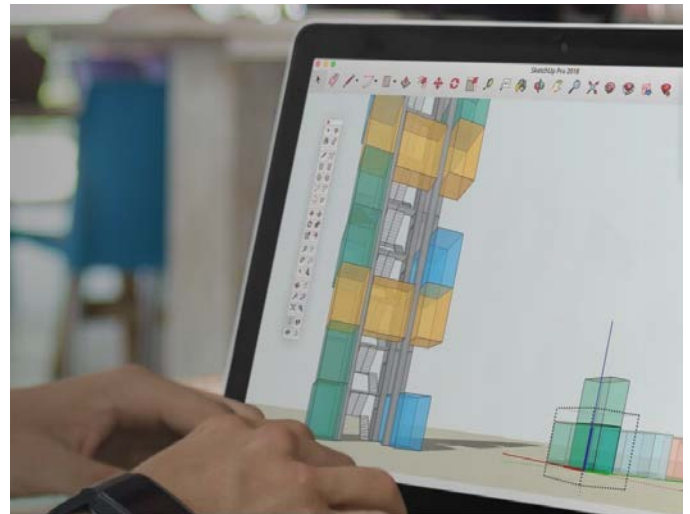
Fig. 4 SketchUp [11]

C. 3D Builder

3D Builder is 3D modeling software from Microsoft. 3D Builder is for Windows 10, Windows 8.1.

3D Builder can display, capture, customize, and print 3D models. There is an option to download different types of 3D files and edit them in three-dimensional model space. It is also take a snapshot using the webcam and convert it to 3D. 3D files can be personalized by embossing or combining models and different parts to create something new. You can create completely new models using simple shapes.

3D Builder provides everything you need to print any 3D object. It can open 3MF, STL, OBJ, PLY, WRL (VRML v2.0) and glTF (v2.0) files. Models can be smoothed out and simplified to make them cleaner. Models are automatically repaired to print them. You get the option to take pictures using a webcam and change them to 3D or use BMP, JPG, PNG and TGA files. The model can be embossed or embossed. Models can be compiled from simple shapes that you drag with the mouse. Objects can be merged, can be intersected, or separated or separated into pieces. For non-uniform objects, you can add a base. It can be printed directly on supported 3D printers using various materials or you can order the model through the preferred online print service: i.materialise.com. Images of 3D objects can be printed on paper. It can store files in 3MF, STL, PLY or OBJ format. [15] Figure 5.
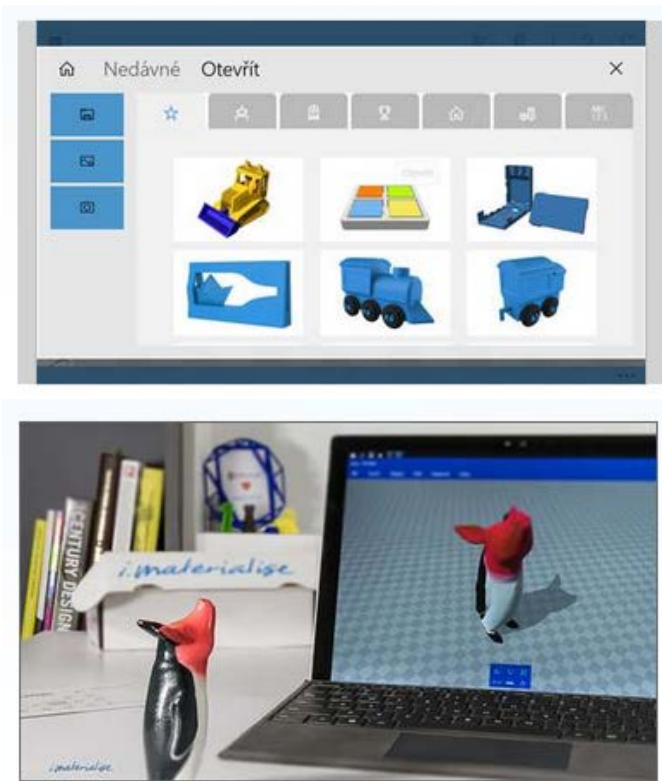
Fig. 5 3D Builder [15]

IV. MODELING SIMPLE MODEL

This section introduces the design and development simple model. The aim is to present the possibilities and limits of selected software on a simple model.

A. Simple model

The simple model was selected by cup. As the cup is a hollow cylinder with torus. The hollow cylinder must be subtracted from the large cylinder and small cylinder. An example of a cup is shown in the following figure. Figure 6.
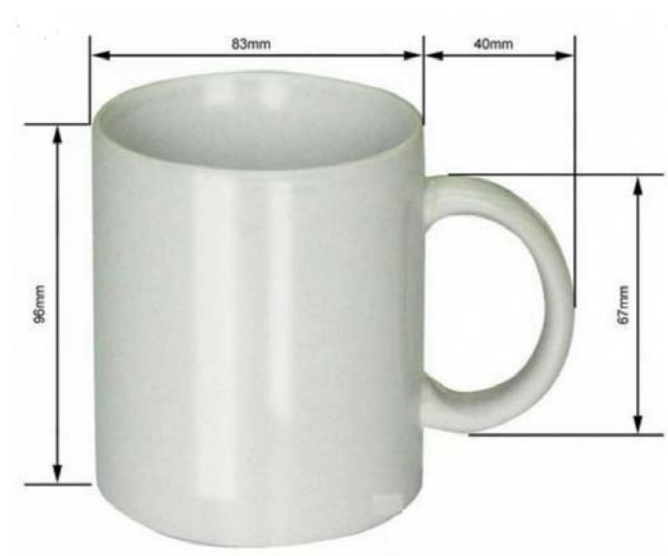

Fig. 6 A cup [16]

Hollow cylinder is a three-dimensional solid bounded by two parallel cylindrical surfaces and by two parallel circular bases cut out from two parallel planes by these two cylindrical surfaces. The shortest distance from the center of the circular base to the inner cylinder is the inner radius r, and the shortest distance from the center of the circular base to the outer cylinder is the outer radius R. In addition the right circular hollow cylinder apothems (of length h) are perpendicular to the plane of a base circle. The selection of measurement Unit is optional. [17] Figure 7.
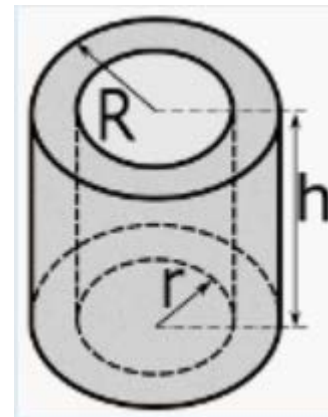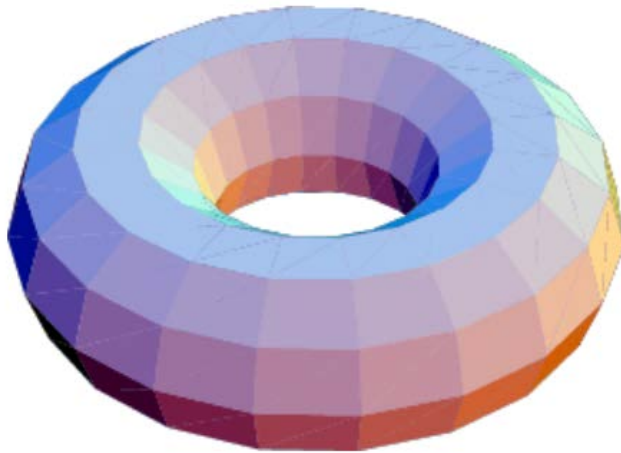

Fig. 7 Hollow cylinder [17]

An (ordinary) torus is a surface having genus one, and therefore possessing a single "hole" (left figure). The single-holed "ring" torus is known in older literature as an "anchor ring." It can be constructed from a rectangle by gluing both pairs of opposite edges together with no twists. The usual torus embedded in three-dimensional space is shaped like a donut, but the concept of the torus is extremely useful in higher dimensional space as well. In general, tori can also have multiple holes, with the term n-torus used for a torus

with n holes. The special case of a 2-torus is sometimes called the double torus, the 3-torus is called the triple torus, and the usual single-holed torus is then simple called the torus. [18] Figure 8.

Fig. 8 Torus [18]

B. Modeling in Tinkercad

Modeling in Tinkercad is very easy. Just select the object and set the dimensions. In the case of the hollow cylinder, two cylinders are used. The inner cylinder is then used as a hole. The torus is then added. Figure 9.
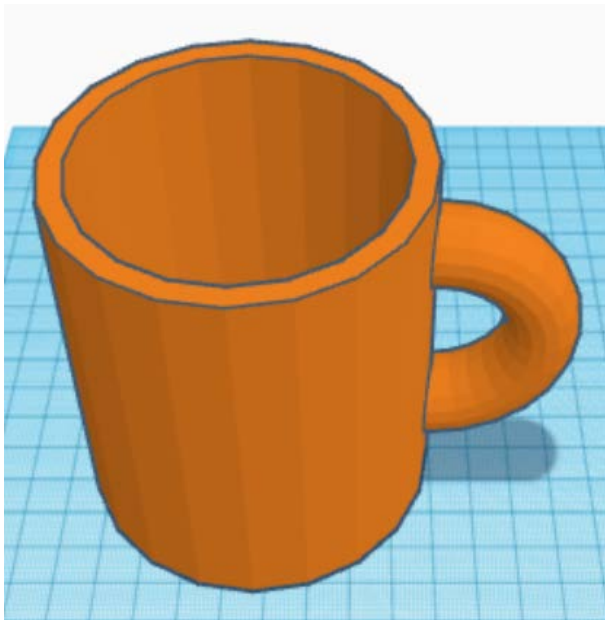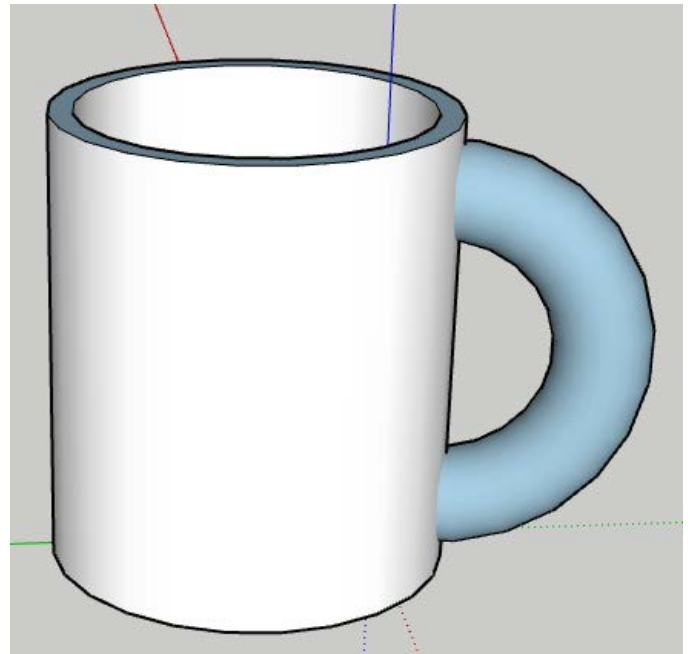

Fig. 9 Modeling a cup - Thinkercad

C. Modeling in SketchUp

Modeling in SketchUp is more demanding than in Tinkercad. Objects must be drawn geometrically. One of the features is to draw a two-dimensional object in a layout view, and then an orotate object. When drawing a mug, it is therefore necessary to draw a L-shaped plan. Subsequently, the L-shape is then rotated. Drawing a torus is done by drawing a circle surrounding a smaller circle. Only then the resultant objects collected in the cup. Figure 10.

Fig. 10 Modeling a cup - SketchUp

D. Modeling in 3D Builder

Modeling in 3D Builder is as simple as modeling in Tinkercad. Objects are available. All you have to do is just select the objects to make the right dimensions and put them together. Figure 11.
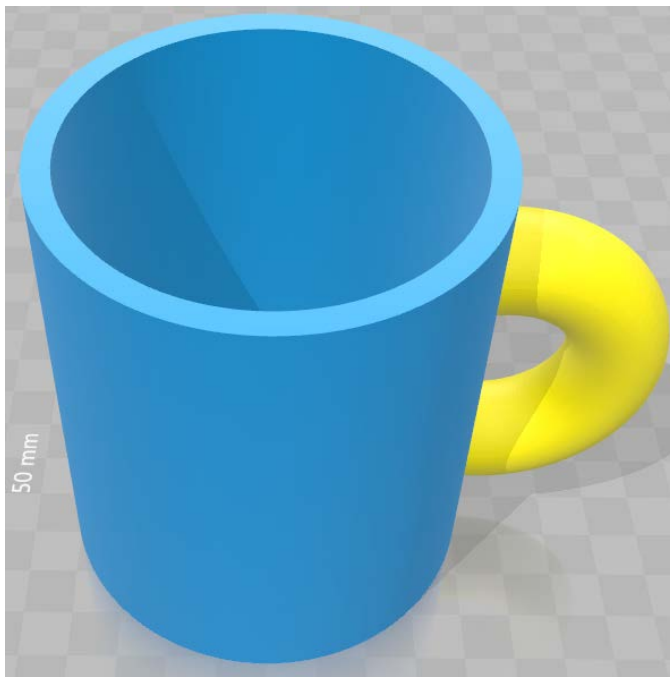
Fig. 11 Modeling a cup – 3D Bulder

V. CONCLUSION

3D modeling and 3D printing are nowadays also available at primary schools. The pupils through the use of these technologies get better, funnier technical skills. Most of the primary schools use simple 3D modeling software. Such are the online software or software included with Windows. The benefits of online software are their multiplatformity. It can even be used on touch devices. The article shows the design of a simple object - a cup. This simple model was created in each of these three 3D modeling software. Creation was very easy with Tinkercad and 3D Builder software. SketchUp, on the other hand, was quite demanding. The advantage of these software is to print an object on a 3D printer to see the resulting product in the real world.

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