Implementation of additive technologies in elementary education

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Abstract. The use of additive manufacturing (AM) in the wider sense at the level of elementary education is not sufficiently analysed in Republic of Croatia at the moment. Partially, CAD/CAM technologies requires far more specialized knowledge than what the Croatian curriculum provides. The application of different technological devices in the educational process, accelerates the teaching process, and makes it more interesting and more acceptable. The knowledge that pupil need to have at the end of schooling is rapidly changing. It is quite possible scenario that most of the knowledge gained during the elementary and secondary education will be obsolete before future student applies to the university. In order to achieve further progress, it is necessary to systematically explain all the possibilities of using these technologies from the elementary level. By developing different strategies, the young generation can focus on the knowledge they will need in their future jobs.

1 Introduction

Technology development has always led to various advances that have contributed to the improvement of living conditions largely. At present, new technological advances have been applied, some even call it the 4th technological revolution. Any change in this direction, besides improving the conditions of life and work, required the users to adapt to new conditions and new knowledge. Robots have already taken up their places in the households as technological devices [1, 2, 3]. It is no longer enough to turn it on or off, but to program it and adapt it to the user habits and needs.

2 Curriculum with iPad and STEM topics included

Taking into the consideration the fact that iPad started to be used in Croatian education for less than two years in the first class, there are many questions about the benefits and disadvantages that students will have when they will complete the elementary school. What it is wanted to be achieved? In consideration that students have not completed their

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education cycle (Figure 1**),** and in all schools, the students do not use the new technology in a sufficient extent [4], the question is rightly whether students will take advantage of, or the use of early learning technology will make it more difficult for them to continue their education. It is considered that through this step, the school develops and strengthens the natural and technological interdisciplinary area and by doing that, it brand itself as well. The learning solution proposed by the authors is reinforcing students in acquiring the ability to learn and apply knowledge in later application.

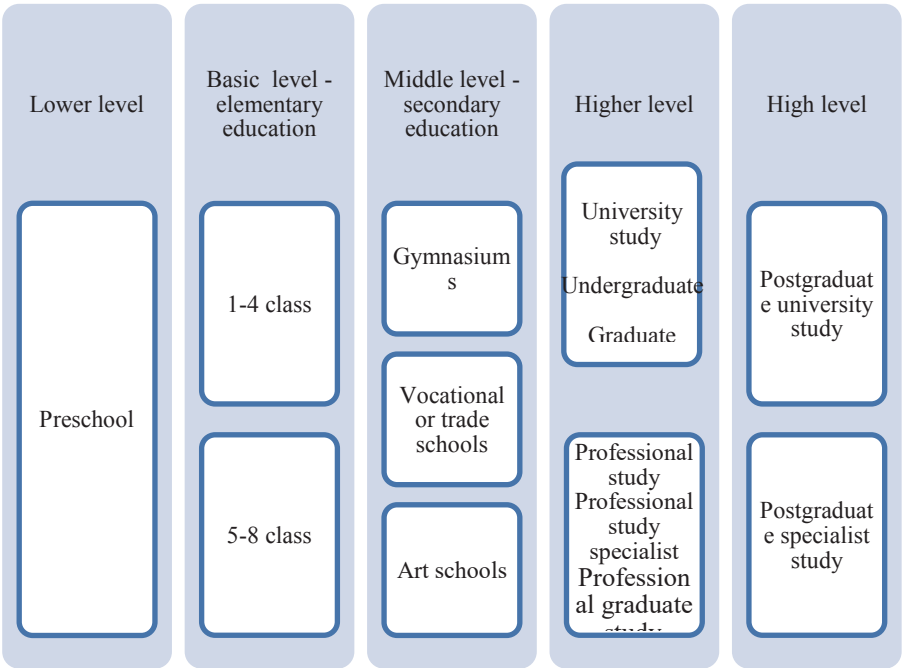

Fig. 1. Schematic overview of the educational system in Croatia. [5].

In the world, teaching with the everyday use of modern technology (computers, tablets, mobile phones) has become the standard. Different strategies have been developed, adapting content and ways of access to self-instruction. In Croatia, this trend is weaker, more sporadic and is left to directors, sometimes to teachers.

And while the usage of an iPad is popular topic and has enough material on using them in the class, the active use of additive technologies in teaching is somehow weaker. Therefore, it is even more important to design and prepare activities and areas of application. Teaching the STEM area is of particular importance in elementary schools. Various initiatives are making different programs for education as a supplement for official curriculum.

2.1 Questions for research

The Croatian Makers Project called on all educational institutions to respond to the equipment of their school with BBC micros bits in 2017. Significant number of universities joined and gained micro:bit as well as the vast majority of elementary schools. (Figure 2).

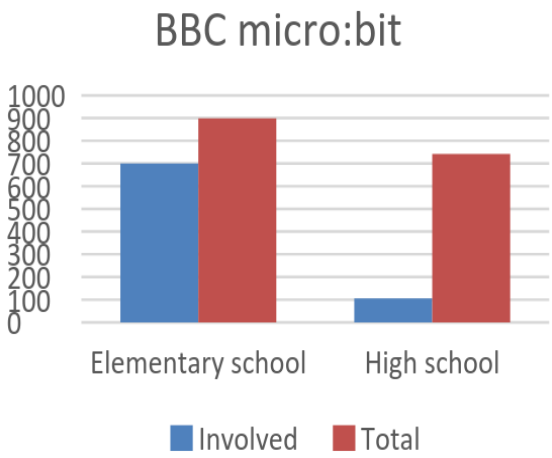

Fig. 2. Involved schools in BBC micro:bit [6].

In high school system the response was somehow weaker. The great response from elementary schools and faculties was the reason for reflection on the next change - the use of additive technology in teaching.

Reflecting on the use of additive technologies in Croatia, besides the current situation of school equipment, one should consider educating teachers to apply them. In this article, it was assumed the fact that all schools are well equipped. In order to make a good teacher education, it is necessary first to devise the area of application and curriculum. The proposed matter will be the use of additive technologies in teaching. In this connection, the following questions arise:

- In which other items could be applied the additive technology;
- What are the ways in which it could be applied?
- What could be positive side aspects related to:
  - Teachers
  - Student
- What could be side-by-side aspects related to:
  - Teachers
  - Student
- What conditions would have to be achieved in order to apply the additive technology in regular teaching (apart from equipping the school).

2.1.1 Subjects and how to do it?

The interdisciplinary construction of robots, which involves motors, sensors, and programming, makes it useful pedagogical tool for all STEM areas [2, 7]. Beside STEM subjects, robotics is usable in every subjects. Darling-Hammond [8] said that effective teachers encourage learning by:

- Creating ambitious and meaningful tasks that reflect how knowledge is used in the field;
- Engaging students in active learning, so that they apply and test what they know;
- Drawing connections to students' prior knowledge and experiences;
- Diagnosing student understanding in order to scaffold the learning process step by step;
- Assessing student learning continuously and adapting teaching to student needs;

• Providing clear standards, constant feedback, and opportunities for work;
• Encouraging strategic and metacognitive thinking, so that students can learn to evaluate and guide their own teaching.

2.1.2 Simple robotic arm design

To illustrate the practical example of what the content proposal and the design looks like, it is possible to describe the following case: CAD design consisting of several phases. In the first phase, the choice of software solution follows. The second phase consists of the design of basic elements, keeping in mind the basic rules for 3D printing. In practice, this means avoiding parts for which a larger amount of support is required in order to speed up the production. In the third stage, parts are analysed by means of a slicer program and made on one of the additive machines. Finally, in the fourth phase, a robotic arm is assembled and demonstration of the basic robotic principles are done. Figure 3 shows an example of a robust robotic arm used for educational purposes.

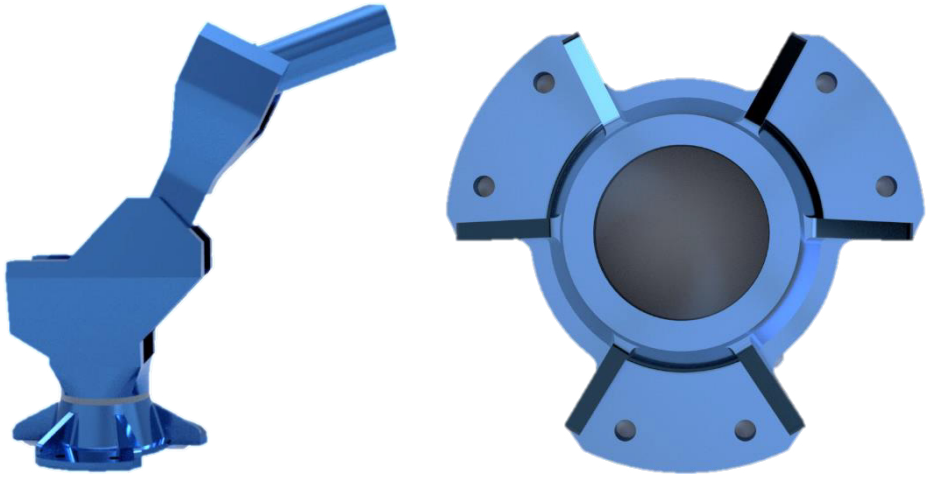

Fig. 3. Sample design of robotic arm modules and base housing.

2.1.3 Additive technology

Although the 3D prints are well known, the creation and application of a robotic hand, especially in education, is area with significant potential (Figure 4).

According to present trends [9], robotic education should be viewed as a means of stimulating important life skills. Educational robots can be divided into several roles: mentor, guardian, colleague, friend, and applied in different topics for learning: foreign language, science, math, physics, geometry and technology, meanwhile the use of the robotic hands for educational purposes needs to be implemented. It was assumed that the robot hand can be included in the curriculum of elementary school as an integral part of all subjects in school in some extent. For the purpose of this research, it was selected one obligatory subject in elementary school.

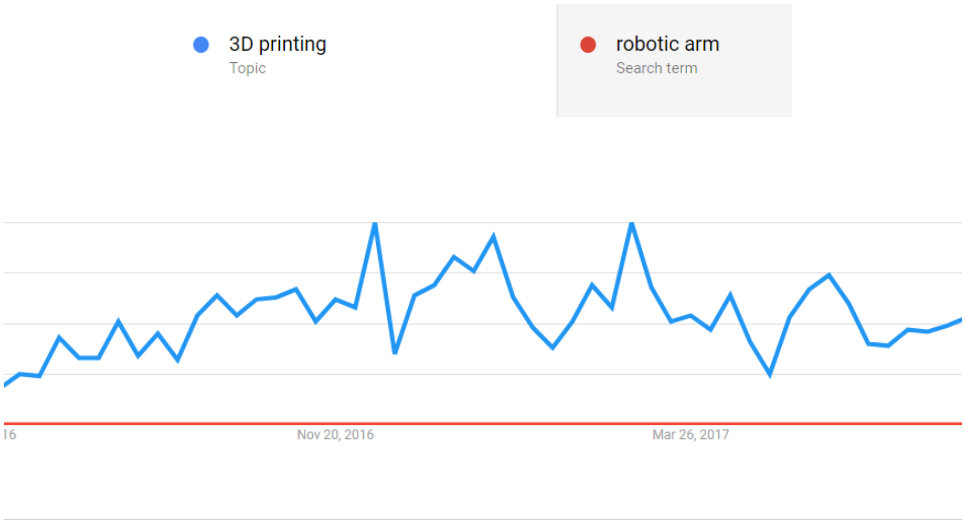

Fig. 4. Google Search Trend Lines.

Table 1. Curriculum options for applying a robotic system to elementary school program.

Class	STEM domain				
	numbers	algebra	shape and space	measures	data handling
1	+		+		
2	+		+		
3	+		+		
4	+		+	+	
5	+		+	+	
6	+		+	+	
7	+	+	+	+	+
8	+	+	+		+

As it is presented in the Table 1, there are many possibilities of application in all mathematical areas. In some mathematical areas, such as numbers and shape and space, it was considered that a robot arm can be applied in all classes. For some domain, such as algebra and data, it was considered it to have fewer options for application. Table 1 shows that a robot hand can be applied in all grades of elementary school in the subject of mathematics. If a robotic hand with AR or VR it is used [10], the possibilities are unlimited.

3 Conclusion

CAD/CAM design in additive manufacturing education system is of great importance. As an obious trend, a robotic systems design for 3D printing represents a challenge for the education system. Johnson [11] said that robotics is timeless. Impact of robotic arm to educational process will be shown in time. Like robots in education, the robotic arm and their application will largely depend on the support of key factors. If quality education is not provided to the teachers, all options possibly will not be utilized. In Croatia, educational robotics is extracurricular and optional for most of the children. By high positive response of all surveyed schools and faculties, education in area of robotics is one of the most

popular topics to enter in each school in the curriculum. A logical upgrade is the use of a robotic arm in at least some subjects in schools in the near future.

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