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Usability of 3D modelling and printing in STEAM education: primary school teachers perspective

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3D printing in STEAM education

With the increasing availability of 3D printers, their impact on various human activities from production to education began to increase (Jiang et al. 2017). In the field of STEAM (science, technology, engineering, the arts, and mathematics) education, there are various approaches to implementing 3D modeling and printing, from printing geometric shapes, molecules and cells to buildings and various buildings and similar. 3D printing has developed as an innovative pedagogical tool for enhancing STEAM learning in a number of contexts and for a variety of objectives (Hasen et al. 2020). So far, research has shown that the use of 3D modelling and printing has the following benefits in teaching: increases the active participation of students in teaching, contributes to better quality and sustainability of student knowledge, increases visualization in teaching, motivating students to learn, increases mathematical and technical skills (Leduc-Mills and Eisenberg, 2011). On the other hand, there is research that emphasizes that if students and teachers are not trained and prepared to apply 3D modelling and printing in teaching and learning, they may experience more failures in this process that can lead to frustration (Nemorin and Selwyn, 2017; Ulbrich et al. 2020). One of the last systematic literature reviews in this area (Hansene et al. 2020) suggests there is a necessity for additional research which will provide a closer insight into the benefits of 3D modelling and printing in STEAM education. This research aims to contribute to the knowledge in this area.

Methodology

We prepare our study in the form of exploratory and descriptive research. Our study uses a qualitative approach based on grounded theory to investigate teachers' perceptions of the usability of 3D modeling and printing in STEAM subject teaching. For data gathering, surveys were used. Data were collected from 200 STEAM teachers who had the opportunity to undergo training in the application of 3D modelling and printing in teaching. Grounded theory was used for data processing. In this process, open coding, axial coding and selective coding were implemented. By recommendation Strauss and Corbin (1998) line-by-line open coding was used to breaking, examining and conceptualizing the data, and gets the researcher off the empirical level by fracturing the data. In the process of open coding, we tried to give an answer on what, how and why is understood by teachers about 3D modelling and printing. As a result of open coding, the initial codes are produced directly from the participant's narrative. The constant comparative method (Strauss and Corbin, 1998) was employed in axial coding and selective coding in aim to develop categories and themes. In the process of axial coding, the relationship between the initials codes are established and they are

classified into categories. In the process of selecting coding developed categories are refined and integrated into the theme. Examples of initial codes, categories and themes are given in the table 1.

Table 1: Initial codes, categories and themes

Theme:	Categories:	Initial codes:
Teaching contribution	Contribution to the students learning outcomes	Increasing the motivation
		Increase visualization
		Increase active learning
		Can prevent students' misconceptions

Results

STEAM teachers' opinions and attitudes about 3D modelling and printing are classified into 5 main categories named: Time, Software characteristics of 3D modelling, technical characteristic of 3D printers, teaching and learning influence, and teacher's skills. The results of our research indicate that STEAM teachers believe that 3D modelling and printing would contribute to the realization of the principles of STEAM education practice. However, teachers of different subjects within STEAM differ in what they see as difficulties in realizing the full benefits of applying 3D modelling and printing. For example, teachers of engineering and informatics have difficulty linking the implementation of 3D modeling and printing with other subjects in order to realize STEAM principles. On the other hand, teachers of mathematics, biology, chemistry, physics and art state that 3D printers require a high level of computer knowledge in order to be used effectively. Teachers agreed the successful implementation of 3D modelling and printing in STEAM education require at least basic knowledge from mathematics such as geometry– which influences students abilities to manipulate with the plane and solid, during 3D modelling, algebra– which influence students abilities to understand relations between the objects, fractions – which helps students to understand on how many parts they need to divide the figure (cube, square, circle) and which part to use for their model. Most teachers felt that good knowledge of the above mathematical areas would allow more efficient use of 3D modelling and printing in STEAM education. These and similar results will be discussed in more detail in this poster presentation.

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