ILLUSTRATING MATHEMATICS USING 3D PRINTERS

Technology in Mathematics Education

Lecture 12 – 12/11/24

Pedagogies

Pedagogies	Definition/explanation
Project/ problem-based learning	Problem-based learning is the process of guiding students through the setting of their own learning objectives. Students could build knowledge, explore and create solutions by themselves/in groups (Hsu et al., 2018).
Maker/design-based learning	Maker/design-based learning is a pedagogical approach where students could pose open-ended problems and opportunities to solve authentic problems through design process and principles (Bower et al., 2018).
Collaborative learning	Learning approaches involving joint intellectual effort by learner groups to solve problems, complete tasks, or create products (Chu et al., 2021).

Learning contents

- most of the studies considered 3D printing as tools to develop geometry concepts

  For example, Huleihil (2017) applied 3D printing to discuss the volume, lateral area and surface area of cube, rectangular prism, and cylinder. Ng and Ferrara (2020) engaged students in inquiry-based learning in which students used 3D printing pens to express and learn the properties of prisms and the cross-sections of 3D solids. Likewise, Choo et al. (2021) designed a 3D printing instruction to examine how students learn spatial thinking skills, total surface area, and volume of 3D models. Through designing 3D models, prototypes and drawings, students could scaffold their geometric understandings and use 3D printing to express ideas, create solutions, and solve authentic problems (e.g., Ng & Chan, 2021; Chiriacescu et al., 2021; Dickson et al., 2021).

Other studies developed students' other mathematical concepts including multivariable calculus (Medina Herrera et al., 2019; Paul, 2018), matrix and vector (Walentyński et al., 2021), polynomial (El Bedewy et al., 2021a), and engineering-related topics (e.g., principles behind 3D printing) (Anastasiou et al., 2013; Lin et al., 2018; Perez et al., 2016). These four studies were conducted at the higher education level.

3D printing is more suitable to visualise geometric concepts and proofs in primary/secondary levels; however, it has the potential to enable university students to explore and learn more advanced mathematics and build graph functions through 3D modelling and printing.

Technologies

Technologies	N	Sample studies
Tinkercad	10	Asempapa and Love (2021), Dickson et al. (2021), Cheng et al. (2020), Song (2019), Anand and Dogan (2021), Cairns et al. (2018), Huleihil (2017)
SketchUp	8	Asempapa and Love (2021), Cairns et al. (2018)
3D printing pens	4	Ng and Ye (2022), Ng et al. (2020)
Autodesk Inventor	4	Walentyński et al. (2021)
Augmented reality	3	El Bedewy et al. (2021a, 2021b), Medina Herrera et al. (2019)
Solidworks	2	Chien and Chu (2018), Huleihil (2017)
GeoGebra	2	El Bedewy et al. (2021a)

Potential of using 3D printing in mathematics education

Three domains of learning opportunity:

- cognitive (i.e., knowledge and digital skills)
- and noncognitive skills.

NON-COGNITIVE SKILLS

Overall, students reported positive experiences with 3D printing. Three major categories of non-cognitive learning outcomes were identified: interest and motivation (thoughts and feelings about 3D printing), satisfaction (how much students liked 3D printing), and other perceptions (such as usefulness, engagement, appreciation).

SketchUp


TIN
KER
CAD