3D printing of components

Secondary: (ages 11 – 14)	Technology (programming, robotics)

Using the topic of bullying as a basis, students design a series of components to be printed using a 3D printer. Based on a preliminary analysis of the information they create a sketch of an object they think can help address bullying. Using this sketch, they design a 3D component using Tinkercad or SketchUp. These 3D components are downloaded in STL format and, using the Repetier-Host programme, converted into G-Code format executable by the 3D printer. The components are then printed and painted.

Time allocation	About 4 lesson periods
Subject content	Use graphic design software to design components Enhance computational thinking Create complex structures based on simple structures
Creative and critical thinking	This unit has a **creativity** and **critical thinking** focus: • Generate and play with unusual and radical ideas • Envision and produce a meaningful output that is personally novel
Other skills	Collaboration, Persistence/Perseverance
Key words	bullying; apps; Tinkercad; STL files; G-Code; design; SketchUp; Repetier-Host programme; geometric figures

Products and processes to assess

Students produce a design of an object which is printed on a 3D printer. At the highest levels of achievement, their output is imaginative with a high level of personal features and their work process demonstrates willingness to explore a variety of ideas and see connections with other ideas and domains. Some ideas have been pushed to the limits before making final choices. There is good awareness of areas of personal novelty and risk and of why final choices have been made. They show a clear understanding of the strengths and limitations of their chosen approach and are open to the ideas and feedback of others.

Teaching and Learning plan

This plan suggests potential steps for implementing the activity. Teachers can introduce as many modifications as they see fit to adapt the activity to their teaching context.

Step	Duration	Teacher and student roles	Subject content	Creativity and critical thinking
1	Lesson period 1	The teacher introduces the topic of bullying and tells the class that their mission is to create an object that can be printed on the 3D printer that addresses the theme of bullying. Students familiarise themselves with Tinkercad, which is an app for 3D design, electronics, and coding. They explore previously created work. The students work in pairs to brainstorm ideas for interesting, unusual, and effective outputs that could address the problem of bullying (e.g. mascots, prizes, objects that symbolize unity and cooperation or can be shared between students etc.). The teacher visits pairs to give them feedback, help generate ideas and encourage students to challenge their own assumptions and review their ideas. Once they have selected a few plausible ideas. they begin to draw simple components and sketches of these ideas.	Review of 3D printing Familiarization with Tinkercad	Making connections between 3D printing, objects, and preventing bullying Generating and playing with unusual and radical ideas for objects that address bullying
2	Lesson period 2	Based on the sketches on the idea of bullying, students select one for each pair. They select and choose some necessary geometric figures and draw their design using Tinkercad.	Using Tinkercad to design components for a 3D printed object	Envisioning and producing a meaningful output that is personally novel
3	Lesson period 3	Students continue to draw and complete their designs, download the design in STL format and upload it to Schoology The teacher circulates and offers feedback and correction	Downloading in STL format and uploading their design	Envisioning and producing a meaningful output that is personally novel
4	Lesson period 4	Once the designs have been corrected, the STL files are converted into G-Code using the Repetier-Host software. They are saved on an SD card and printed. Each component requires between 30 and 60 minutes to print. The students should check the transition from STL to G-Code and experiment with the printer in every stage of the printing process. The teacher may decide to close the activity by setting written work or facilitating a discussion of what students have learned, and how they have used creative and critical thinking to help them. This can also be extended to asking students to present their objects and explain how they were made and their strengths and limitations as a way to address bullying.	Converting STL files into G-Code, saving, checking, and printing	Reflecting on the novelty of a solution and its possible consequences Considering different perspectives on a problem Explaining both strengths and limitations of their final outputs

Resources and examples for inspiration

Web and print

- ➢ https://www.blockscad3d.com/
- ➢ https://www.tinkercad.com/
- ➢ http://ilafuentesegundo.blogspot.com.es/search/label/UD%207%3A%20DISE%C3%91O%203D
- ➢ https://www.schoology.com/

Other

- ➢ Computers
- ➢ Paper and pens
- ➢ 3D printer

Opportunities to adapt, extend, and enrich

- ➢ This could be extended to a wider inter-disciplinary unit on bullying.

	CREATIVITY Coming up with new ideas and solutions	Steps	CRITICAL THINKING Questioning and evaluating ideas and solutions	Steps
INQUIRING	Make connections to other concepts and knowledge from the same or from other disciplines	1	Identify and question assumptions and generally accepted ideas or practices	1
IMAGINING	Generate and play with unusual and radical ideas	1	Consider several perspectives on a problem based on different assumptions	1,4
DOING	Produce, perform or envision a meaningful output that is personally novel	2,3	Explain both strengths and limitations of a product, a solution or a theory justified on logical, ethical or aesthetic criteria	4
REFLECTING	Reflect on the novelty of solution and of its possible consequences	4	Reflect on the chosen solution/position relative to possible alternatives	4

Creativity and critical thinking rubric

- Mapping of the different steps of the lesson plan against the OECD rubric to identify the creative and/or critical thinking skills the different parts of the lesson aim to develop