3D Printing Curriculum Proposal

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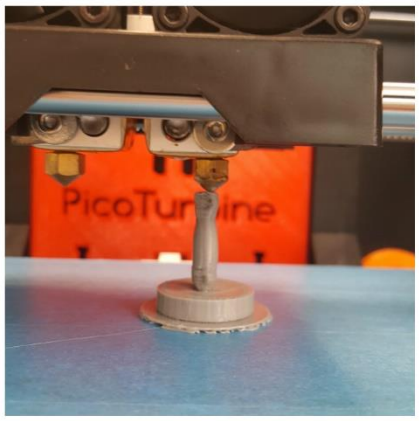
Introduction

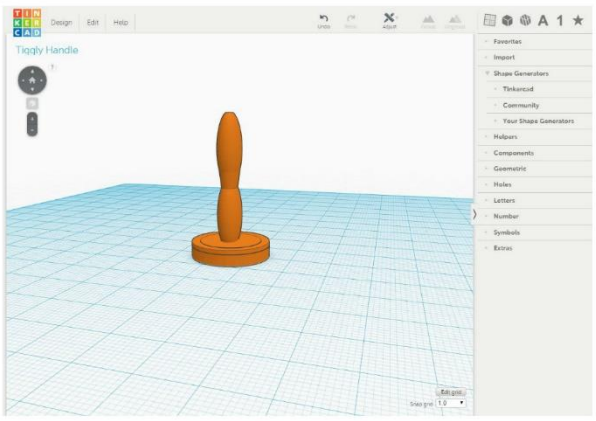
"3D printing is the process of taking a digital model and making a physical product" (MakerBot Education, 2015, p. 8). The use of 3D printers in schools has become increasingly popular in the past few years. They are seen as tools which motivate, captivate, and allow for the creative possibilities that students are craving. Creating a 3D model on the computer is meaningful, however, when students print their design and hold it in their hands, manipulate it, and find its strengths and weaknesses, meaningful becomes powerful. 3D printing facilitates the endurance of adversity and persistence in problem solving (Schaffhauser, 2013).

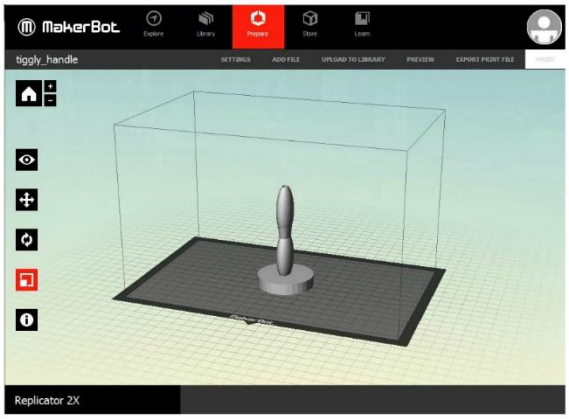
A Proof-of-concept

For this project, I wanted to 3D print handles for one of the shapes available with the Tiggly© App. Due to the unique nature of our physically disabled students, the current shape of the Tiggly pieces can be difficult for some students to grasp. By adding a handle to the piece, we would create an adaptation which would allow for a design that incorporated principles of Universal Design. For this project, I used TinkerCad to design the handle and our MakerBot Replicator 2X printer with the MakerBot rendering software. As you can see from the below pictures, I printed two iterations of the handle. In my first attempt, I neglected to take into consideration the actual size of the product I was producing or use specific measurements. There is certainly a learning curve in both the TinkerCad software and the MakerBot rendering software. Completing the online tutorials for TinkerCad and attending a MakerBot workshop before this assignment gave me the advantage of being able to produce this rapid prototype in a relatively short amount of time. The additional consideration of using 3D printing in the classroom is the time needed for the printer to complete your design. This particular print took

about an hour and twenty minutes to complete. Larger and more complex prints will require a longer print time which will pose a challenge within larger class sizes.







Powerful Ideas

The culmination of this curriculum project is to design an adaptation for a product so that a student with a physical disability will be able to interact with the product in a way similar to his non-disabled peers. According to Bers (2008), "constructionism proposes that people learn better when provided with opportunities to design, create, and build projects that are personally and epistemologically meaningful" (p. 16). Her notion of "powerful ideas" leads learners to new ways of thinking, using knowledge and connecting that knowledge to other domains (Bers, 2008).

Historically, assistive technology specialists have been adapting toys and learning materials for students with special needs. Taking the domains of 3D printing, design, mathematics and technology, students are making cultural and personal connections to students with disabilities and building a project that is both personally and epistemologically meaningful. With this project, I would like students to look at new products or design their own products through an adaptive lens. Can their design be used by all individuals and if not, how can they adapt it? The design is where the mathematical reasoning, artistic feeling, and engineering processes come to the forefront (Thornburg, Thornburg & Armstrong, 2014).

Projects

The goal of this curriculum project is to introduce middle school students to 3D printing.

Project 1

Aspects of Design – For this project, each student will create an account on www.tinkercad.com and complete the tutorials to learn the basic aspects of the 3D software. They will each complete a basic keychain design with their name on top of a shape.

Project 2

How does a 3D printer work? – For this project, the students will understand what 3D printing is and how it works. They will also be able to identify the parts of the printer and demonstrate the processes of loading the filament, leveling the build plate and cleaning the various parts. Working in groups, they will produce a short presentation of their knowledge using any mode.

Project 3

How much filament? – Before a 3D design can be sent to the printer, the file must be prepared for 3D printing using software that will slice your design into many layers. For this project, the students will learn to import their design into the slicing software. They will also discover the differences in print density, number of shells, amount of infill, resolution, the use of rafts and supports. They will import their key chain designs into the software and prepare them for printing.

Project 4

First Print – For this project, each student will print their key chain designs. They will work in groups to decide how many key chains can be printed at the same time on one printer. Using the provided mathematical equation, they will try to determine how much filament was used in each design.

Project 5

Powerful Ideas – Using 3D printing to solve a problem. For this project, the students will work in groups. Each group will be presented with one of the Tiggly pieces. The students will then be shown a short video clip of a student who was having difficulty grasping the piece. They will be asked to design and print an adaptation for the Tiggly piece using the skills they have acquired in the previous projects. They will be required to present their piece to the class as well as discuss additional ways that 3D printing can be used to solve a problem.

Practical and Organizational Considerations and Solutions

The Printer:

Although the prices of 3D printers have drastically declined in the last year, I found one at ISTE for $349 after paying $1000 for our current printer, it may not be feasible to have one in every classroom or even to have multiple printers within a school. When choosing a printer, look for one that will allow wireless printing or the insertion of an SD card. Having the printer tethered to one computer limits its portability. Being able to bring the printer to the class and not the class to the printer may facilitate its use throughout a school building. Limiting the size and density of a print will allow for faster printing and the possibility to have more than one project print at a time. The PLA (polylactic acid) Filament is relatively inexpensive and can be easily purchased. Students also need to be reminded about the safety precautions associated with 3D printing. The extrusion nozzles can heat up to 260º C and have the potential of causing serious burns. Additionally, students will need to use tools to remove the print from the build plate. Safety standards must be established by the teacher.

The Software:

Free online CAD software such as TinkerCad and 3dtin.com allow students to not only complete projects in school but also at home. Schools will need to have access to a computer lab, Chromebooks/laptops or iPads in order for each student to complete individual assignments in the class.

Teacher Training:

Teacher training is essential for successful implementation of 3D printing. While learning to use the online CAD software is relatively easy with the provided tutorials, learning the terminology, nuances and calibration methods of some 3D printers takes a bit of trial and error as well as persistence. Participation in 3D printing professional development is encouraged for all teachers.

References

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