



Using TinkerCAD to Teach Students to Visualize a 3D Form: A 3D Printed Collection of Wearable Objects

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Introduction/ Objective: TinkerCAD is a free online software that allows students to create 3D structures easily within a virtual environment. Using TinkerCAD in the classroom gives students the opportunity to apply their design knowledge in a 3D setting. That is, TinkerCAD is an easy to use and readily available web-based platform that will challenge the way that students learn about form, moving from 2D (i.e. designing in Adobe Illustrator) to 3D design in a user friendly environment (Kelly, 2014). As noted by Sun and Parsons (2014), the inclusion of 3D modeling software in the design process is critical. Students need to be exposed to this type of software as part of their design education. The purpose of this teaching presentation is to show other design educators how they might incorporate TinkerCAD into their courses. A detailed description of the course project, learning outcomes, and benefits/critique of the use of TinkerCAD will be included for other educators to access how TinkerCAD could be used as a design tool in their courses.

Innovative Approach / Practice: Students at both the undergraduate and graduate level who are enrolled in a retail technologies course are challenged to create a cohesive collection of wearable 3D objects using TinkerCAD. Upon completion of their digital design work, students are tasked with 3D printing their collections and presenting their tangible outcomes as part of a class exhibition. This course that this project is part of typically has 15 students and has been taught for 3 semesters. To begin the 3D printing unit, students are required to complete a contextual review of 3D printing processes and applications in the retail industry. Students are encouraged to share digital media (photos, videos) as well as articles that they find with their classmates via a discussion board post. This creates a shared contextual review that all students may access. This is an important step in the project as it helps students to gain an understanding of what is possible and provides baseline knowledge for the students as they move forward with the project.

A student's collection must consist of a minimum of three wearable objects, all of which must be created within the TinkerCAD software. The students have four weeks to complete the project. They spend one week learning how to use TinkerCAD, two weeks designing their collections, and the last week the students spend in the studio 3D printing their objects. Objects must be wearable products. Students create a design brief in which they define their target market and explain their design concepts. "Wearable" is used loosely in the course so that it gives students the freedom to create unique objects. For example, students have created cell phone cases, jewelry, glasses holders, belts, and purses. The main learning outcomes from this 3D design and printing project include: (1) identifying uses of 3D printing within the retail industry, (2) demonstrating spatial visualization skills by turning a 2D design into a 3D object, (3) designing a cohesive collection of 3D objects, and (4) evaluating prototypes to determine functionality and wearability.

One of the benefits of using TinkerCAD, versus other 3D design platforms, in the classroom is that the software developers created TinkerCAD with educators in mind. TinkerCAD allows instructors to setup “classes” within their system. Instructors give each student their own unique login and TinkerCAD creates a class folder which holds all the student accounts. Instructors are then able to see students’ logins, access each of the student’s files, and download/view student work. It also allows for the instructor to do progress checks and easily troubleshoot issues since students’ files are accessible. This is extremely beneficial for providing help to students when learning in remote environments. This proved to be true when the course had to be moved online due to Covid-19. TinkerCAD functions as a virtual lab (Abhuri, Praveena, & Priyakanth, 2021). An additional benefit of using TinkerCAD is that it is free for students and can be easily accessed through their personal devices. TinkerCAD also provides a variety of tutorials for students. Conversely, one critique of TinkerCAD is that it is not available as an app so cannot be easily used on a mobile device (some of TinkerCAD’s competitors such as Fusion 360 have mobile apps). Additionally, TinkerCAD, in my opinion is meant for beginners. This is benefit for students who have never worked in 3D, however for students who are well versed in 3D design, TinkerCAD seems elementary and limited in its capabilities.

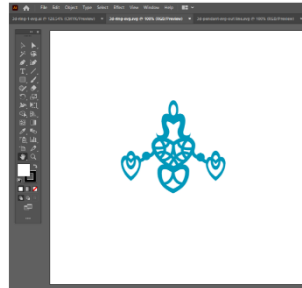
Implementation of Practice: Examples of student work from the past three semesters will be shared during presentation. For instance, one student focused their work on the theme of maternal love and nurturement. The student aimed to create a collection that would visually express the connection between mother and child. The collection consisted of a pair of earrings, a ring, and a necklace. The earrings were remarkable and are a great example of a 2D design successfully turned into a 3D object. The earrings were inspired by a photo (figure 1). The student interpreted this photo into a 2D sketch, in Adobe Illustrator, using hearts as the main shape (figure 2.) The student was able to import this 2D sketch from Illustrator into TinkerCAD. In TinkerCAD, the student took the simple 2D form and build additional components, considering all viewpoints of the object (figure 3.). Finally, the student 3D printed her design (figure 4.). The student printed the final set of earrings twice to be able to adjust the scale. Additionally, students were encouraged to use found objects to make their 3D printed objects wearable. As seen in Figure 4, this student added a metal fishhook.

Description of effectiveness of strategy/Plans for continuation: TinkerCAD is a design tool that over three semesters has proven to add value to students learning. It is an effective, easy to use, readily available tool that gives students the opportunity to practice spatial reasoning and learn how to design a 3D form. I plan to continue to use TinkerCAD for this project, but with a few revisions. First, students in past semesters have not been required to first create their design in Illustrator. Students could start in TinkerCAD and build their collection using the basic shapes provided by TinkerCAD. TinkerCAD does allow for significant changes to be made to the basic shapes provided yielding unique and interesting objects from the students. However, for students to see the direct connection and challenge their design thinking, students in future semesters will be required to start at least one of their objects as a 2D design from Illustrator. Additionally, an extra week will be built into the project to allow students more time to make a second prototype. Correcting errors and allowing for change in scale with help students learn more throughout the process of creating. Overall, TinkerCAD is a tool that many educators will benefit from utilizing in their courses.

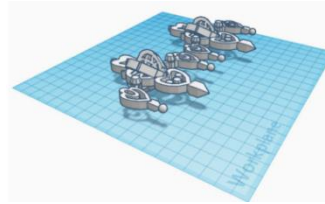
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