“Designers are the mediators of our daily experience. The easier my compost bucket is to use, the more comfortable my ride on the bus, and the more appealing my reusable grocery bag, the more likely I am to participate in environmentally sound practices. Designers carry a heavy responsibility, but at the same time they can offer our future the greatest gift.”

-Gavin Newsom Lt. Governor of California

INTRODUCTION

Last year, the Technology Department at ACS acquired a 3D printer for the computer lab. I set about designing curriculum for a new course that would involve the 3D printer. Originally I planned on offering a 3D Design course that explored designing objects in a CAD program and creating 3D animations using the software Blender.

I began researching ways that other schools had incorporated a 3D printer into their curriculum. I stumbled on the NuVu Studio in New York. The school offers intensive workshops for students in a studio environment to supplement their high school education. They use the Design Thinking model to great success. I became excited over the possibilities that our students could explore using this model and decided to alter the course to focus on the Design Thinking model.

Having never taught a course like this, I jumped into the deep end of the pool. This is a reflection on the first unit I designed for the course. My hope is that through this reflection, I can refine the material I presented in class, and gather feedback about ways I can improve the course.
## DESIGN THINKING

<table>
<thead>
<tr>
<th>EMPATHIZE</th>
<th>In order to innovate, you have to understand who or what you are designing for.</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEFINE</td>
<td>Define the issue that you are trying to solve.</td>
</tr>
<tr>
<td>IDEATE</td>
<td>Brainstorm all of the possible solutions to the problem.</td>
</tr>
<tr>
<td>PROTOTYPE</td>
<td>Design and create solutions.</td>
</tr>
<tr>
<td>TEST</td>
<td>Experiment, refine and improve the prototypes.</td>
</tr>
</tbody>
</table>

### ADDITIONAL RESOURCES
- d.school at Stanford University
- IDEO - Teachers Handbook for Design Thinking
- Capture the Learning: Crafting the Maker Mindset by Lisa Yokana

### LEARNING SPACE

The computer lab has been set up with the computers along the wall. Tables have been placed in the middle of the room so that students can have a meeting space/workspace away from the computers.
I like to start class around the table so that we can all discuss the day's events before heading off to the computers. The open space allows the students to look around the classroom to see what other classmates are working on. I find that this fosters an open community where students can comment on each other's work. Reading the book *Invent To Learn* by Sylvia Libow Martinez & Gary Stager gave me many insights on how to set up my room to support collaboration.

I'm a big fan of music in the classroom. I use an online music service which allows me to play a variety of tunes depending on the mood I'm trying to set. Somedays it's Motown, other days Indie Dance. I think to the casual observer my classes might give the impression of chaos, but to me it's a controlled chaos that, hopefully, stimulates creativity.

**FORMATIVE ASSESSMENT**

I use a [Google+ Community Page](https://plus.google.com) as a way for the students to post their work. Students are able to post text entries, photos, links, conduct polls and easily embed YouTube clips or documents from Google Drive.

Each entry has the ability for me to give immediate feedback on student work and they can comment on each others work as well. Another benefit is that all of the student’s work is on display for the whole class to see. Quite easily, and quickly, I can scroll through a single student’s work, or the entire class. At the end of the semester, the Community page will give a nice overview of the entire class. Students can also use their work for a digital portfolio.

One perk of Google+ is that it’s not Facebook. This means that students view it as something that they use in class rather than a social media outlet. It also gives me the opportunity to discuss being a Digital Citizen and addressing any harassment that may occur on the community page.

**EQUIPMENT**

Students are using [123D Design](https://www.123dapp.com), a free CAD program from AutoDesk. The program allows students to create 3D designs and export a file that can then be 3D printed. The program works on both Mac or PC, so students can put it on their laptop and design outside of class. Our lab also has a [Makerbot Replicator 2X](https://www.makerbot.com) for 3D printing.
UNIT 1 - INTRODUCTION TO DESIGN

The purpose of this unit is to introduce the students to the following concepts:

- Design Thinking
- 123D Design (CAD software)
- 3D Printing

The unit is comprised of three lessons followed by a project that demonstrates their understanding of the topics we’ve covered in class.

LESSON 1 OVERVIEW

1. Students created a Google+ account and joined the classroom community. Students were asked: If you could be any superhero, who would you be? Students had to post a photo of their superhero of choice. This quickly showed me who had access to the community page and it gave me a little insight into the student based on the superhero they chose (I picked Batman, btw).

2. Students were asked to create a Google Doc, label it ‘Clean Oceans’ and ‘Share’ the document with me. This informed me about the level of understanding each student had using Google Docs.

3. Students watched this TedTalk about a high school student that discovered a way to clean the earth’s oceans. The video is an excellent example of using the Design Thinking model and it served as a nice introduction to the concept. On their Google Doc, students had to answer the questions below. This gave me an understanding of how they can assess information provided through the video as well as their writing skills.

   A. What problem did Boyan Slat seek to solve?
   B. What are the challenges of trying to clean the ocean?
   C. At school, Boyan was told to choose a subject to research. What did Boyan decide to study?
   D. How did Boyan research how much plastic was in the ocean?
   E. How long does Boyan think it will take to clean the oceans?
   F. Boyan says, "If you want to do something different, shouldn't you have to...”
   G. What is Boyan's solution to cleaning the ocean?

4. When they finished, I asked students to go to the 123D Design website and begin reviewing the video tutorials for the software.

LESSON 2 OVERVIEW

1. Class began with a review of the Boyan Slat TedTalk and how he used Design Thinking to find solutions to the problem of cleaning the oceans. This served as an introduction to the steps of Design Thinking.
2. Students finished watching the 123D Design tutorials.
3. Students were asked to take a piece of scratch paper and sketch out any object that they wanted. It could be a comb, a robot, a car, etc. I wanted the students to practice sketching out ideas/designs.
4. I asked students to take a photo of their sketch using their cell phone or the camera on the computer.
5. Student’s posted their photo to the Google+ Community Page.
6. Students then had to recreate their object using 123D Design. This gave them practice using the basic tools in the program. It also gave them the understanding of how to convert a 2D drawing into a 3D environment. Students posted their 3D designs to the Community page so everyone could see their sketch and their 3D design.

**LESSON 3 OVERVIEW**

1. An introduction to 3D printing. Students explored how a 3D printer works.
2. Students were given a big pile of legos. Students were asked to design something amazing using the legos.
3. Students then had to recreate their lego designs using 123D Design. This allowed me to assess how well they understood the tools in 123D Design. It also gave me an idea of their level of understanding for translating physical designs into a digital environment.

**DESIGN CHALLENGE - UNIT PROJECT**

For their first foray into the world of Design Thinking, it seemed that a design challenge would be an interesting way to practice the skills they have been learning. The idea behind the design challenge was to image that human beings never had thumbs. How would you design a utensil for eating without the use of a thumb?

**Design Challenge Assignment**

**ASSESSMENT**

The students had limited exposure to using 123D Design, so I opted to assess them only on their understanding of the Design Thinking process. Students had to document all of their work and post it to Google+. I used this documentation, as well as classroom interaction, to determine their understanding of the process. The following rubric was used for the project assessment:
EMPATHIZE/DEFINE EXAMPLES

Using Post-It notes, students wrote down all of their thoughts and feelings about the challenges they would face not having a thumb. They then defined a solution for the problem. Some students felt that the problem was that they didn’t have a thumb. On further reflection, the students realized that under the scenario of the project, humans never had thumbs. The students then understood the problem they were trying to solve was designing a utensil that could be used with only four fingers.
IDEATE EXAMPLES
Students used Post-It notes to begin sketching possible designs. Some of the designs went through a few revisions, other designs changed entirely.
PROTOTYPE EXAMPLES
Students designed their ideas using 123D Design. This was definitely a leap into the deep end. I find that this is a good way to learn software, you just have to experiment with it. My role then becomes facilitator/mentor. There was some frustration from the students, but they were invested in creating their designs, so they found ways to make it work. I was impressed to see how willing the students were to give advice and input to other students.

TEST EXAMPLES
One advantage of a 3D printer is it allows you to quickly print prototype designs. Students were very eager to see their utensils come to life. They would test them, have other students try
them, and then go back and make revisions to their designs. Some students realized that they would have to go back to the ‘ideate’ phase and start over with their designs. Other students went back to the ‘Prototype’ phase and revised their designs to improve their usability.
REFLECTION

I'm a big fan of Design Thinking. It appeals to my background in graphic design. I like the simplicity of it’s approach and that it can be used as a blueprint for solving complex problems. The Design Thinking philosophy works beautifully with the Maker Movement that has been transforming education. Through my research, I have become inspired by the work of Emily Pilloton and her Project H organization. I highly recommend watching Emily’s TedTalk to see the potential of using the design process in education.

One of the inspirations for this project was the amazing work of the Enabling the Future organization. Their open source designs for 3D printed prosthetic hands have changed the lives of countless people all over the world. Part of their mission is to change the connotation of the term disability, which is usually interpreted as a person who is not “normal” like the rest of us. They want to empower all people and show that everyone of us has a different perspective of life and having a disability only means that you interact with the world in a different way from other people. The idea behind the thumbless utensil was that I wanted students to start thinking about their world from the eyes of another person, perhaps a person with a disability. By setting up the scenario that the human race never had a thumb, I could level the playing field, so to speak. My hope is that I can use this project as a reference point for the students so that I can say, “Remember what it was like when you had to imagine that you didn’t have a thumb?”

Looking back, I discovered things about 123D Design that pose a challenge to this type of project. 123D Design would sometimes freeze and crash while a student was working. An unexpected benefit of this was that it taught the students to save their work often. I was new to the software, so it became a learning experience for both the students and myself when tools didn’t work as planned. I found this humbling, but also empowering because it reinforced the idea that I was not their teacher, but rather a mentor and facilitator of the project. I learned along with the students. Ultimately, I think that’s what teaching is all about.