

## **Assisstive Technology for Freshman Design and K-12 Outreach**

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## **Abstract**

This Work in Progress paper presents on the design of project-based learning approach focused on assistive technology as applied in a freshmen level engineering course which also integrates outreach with the local K12 system. The university course targets general education topics as well as an introductory engineering design experience and includes content on the engineering design process, societal implications of engineering design, and a participatory lab-based design project. A partnering class of 5th graders from a local elementary school made use of a daily block of time set aside for academic interventions and individual project-based work to collaborate with the university class. A qualitative assessment was conducted and has thus far has revealed that the university students found the assistive technology theme of the semester-long design project to be meaningful. For the K12 students, the survey results and anecdotal observations suggest that we were only moderately successful in constructing a meaningful and purposeful design experience, from their perspective.

## **Introduction**

This Work in Progress paper describes the design of project-based learning approach focused on assistive technology as applied in a freshmen level engineering course which also integrates outreach with the local K12 system. Project-based design projects in freshmen introductory engineering courses have been shown to improve student engagement, use of divergent thinking, and teamwork skills<sup>1,2</sup>. Assistive technology is a field that provides a rich opportunity for students to engage with their peers, their community, and the world at large in a meaningful way<sup>3</sup>. Broadly speaking, assistive technology provides a means of achieving greater independence and standard of living through the integration of technology with the tasks of everyday life and work. Target populations for the development of assistive technology can include all individuals. However, persons with disabilities and the elderly represent a great opportunity to produce the most good. Assistive technology can enable these individuals to carry out daily living tasks with more proficiency or reenter the workforce. The work described in this paper aims to develop a program for integrating a meaningful assistive technology design experience into the course [course title] and combine that with community outreach for STEM recruitment.

In this paper, we report on the outcomes of this first implementation of the assistive technology project in the freshmen-level engineering course as well as the K-12 collaboration component.

Additionally, we will report on current efforts to develop specific academic learning targets to measure problem solving skills at the K-12 level that will be used for future assessment of this work.

## **Freshmen Design Experience**

“Impacts of Engineering” is a freshmen level general education course that provides students across campus with an entry level engineering design experience. Students learn about the engineering design process, including the societal implications of engineering design, and participate in a lab experience that guides them through a hands-on engineering design project. Previous iterations of the Impacts of Engineering projects have included international service projects designed to expose students to engineering design with considerations for global impact<sup>4</sup>. However, due to the dramatically increasing enrollment in the course, from 35 students per semester to 125 per semester, the service project aspect had to be redesigned to be more manageable with a larger cohort of students. It is through this project that we attempt to meaningfully incorporate an assistive technology design component. In collaboration with the [institute name], an assistive technology design project was devised. Students in this course along with their instructors interface early and often with assistive technologists from the Stout Vocational Rehabilitation Institute (SVRI). The SVRI has access to a large client base and employs several assistive technologists who bring years of experience with the assistive technology field to the classroom. The assistive technologists provided early design inspiration through a presentation on the state of the assistive technology field and their perspective on where the needs are currently. SVRI staff assist with identifying suitable clients who are in need of assistive technology to aid in their daily lives that matches the desired course curriculum outcomes. The needs that these clients have are pitched to the course students as semester long design projects. Then through the rest of the semester, the technologists were able to provide design support to the project teams as well as access to existing assistive technology devices that the students could learn from or build upon.

## **K-12 Participation**

A second component of this course involves collaboration with the local K-12 schools. Currently a single partner has been identified, a 5th grade class at Oaklawn Elementary. This class has integrated a similar design project as is being carried out by the freshmen students. The fifth grade students are highly motivated to participate in an engineering design project.

The partner class of 5th graders consists of 22 students. During their school day, they have a 40-minute period, four days per week, referred to as “WIN Time,” which is an acronym for “What I Need”. This time is set aside for academic interventions and individual project-based work. Many students work on projects of their own choice and design. Of the 22 students in the partner class of 5th graders, nine students worked on STEM-related projects. The other 13 students worked on projects more related to writing or the Arts. Our learning objectives for the cohort of 5th grade students include:



Figure 1: Project groups from the local participating school visiting the design lab to both show off their project work and gather feedback and advice from the freshmen students.

1. Develop an interest in STEM fields
2. Learn the basic principles of the Design Thinking/engineering design process and apply it to a project
3. Increase awareness of community problems and understand that they have the capacity to help solve them

Throughout the semester we provide opportunities for the nine fifth grade students working on STEM projects to interact with the freshmen students by bringing them to campus (Figure 1) at several points to tour the engineering lab spaces (Figure 2), receive mentorship from the university students (Figure 3), participate in design reviews (Figure 4), and show off their work at an end-of-the-semester design show. Through this deep, semester long interaction we hope to spark an interest in pursuing a STEM field and support their current design efforts while at the same time doing design work with a meaningful impact.

### **Qualitative Assessment - Freshmen Design**

Freshmen university students completed a brief survey to collect their input on the assistive technology course design project. Of those students who completed the survey (N=50), 80.0% stated that they found the project meaningful and 78.0% stated that they enjoyed working on a project with the “assistive technology” theme. Of these respondents, some common sentiments in the submitted comments included:





Figure 2: The campus visits included a small tour of some of the engineering lab spaces to help the students better understand the activities that take place in the university's engineering laboratories.



Figure 3: During design reviews, the grade school kids interacted with the college students, discussing design process.



Figure 4: While visiting the design lab, the grade school students met with freshmen engineering students to conduct a design review.

- “Enjoyed the opportunity to help others.” (N=12)
- “The project felt purposeful/had a real-world application.” (N=9)
- “Enough freedom to choose project direction.” (N=6)

Conversely, for those who stated they did not find the project meaningful or the topic enjoyable generally stated that they struggled with too much ambiguity in what they would specifically pursue as a project idea (N=3). Additionally, one student stated that they did not agree with the general theme of helping others and would have rather focused on a topic with “broader appeal and a wider profit margin.”

Students were also asked how well they felt the project fit within the rest of the course and how participating in the project influenced their perception of the engineering design process. For both of these questions, their responses were collected using a Likert scale. For the first question, responses ranged between “5 - Perfectly Aligned” and “1 - Did not align.” The average score was 3.2 with 38% stating that the project was aligned with the rest of the course and 22% stating they did not feel the project was aligned with the rest of the course. For the second question, responses ranged between “5 - Positive Perception” and “1 - Negative Perception.” The average score was 3.6 with 54% stating that they had a more positive perception of the engineering design process as a result of completing the project while only 8% stated the opposite. These results are depicted graphically in Figure 5.

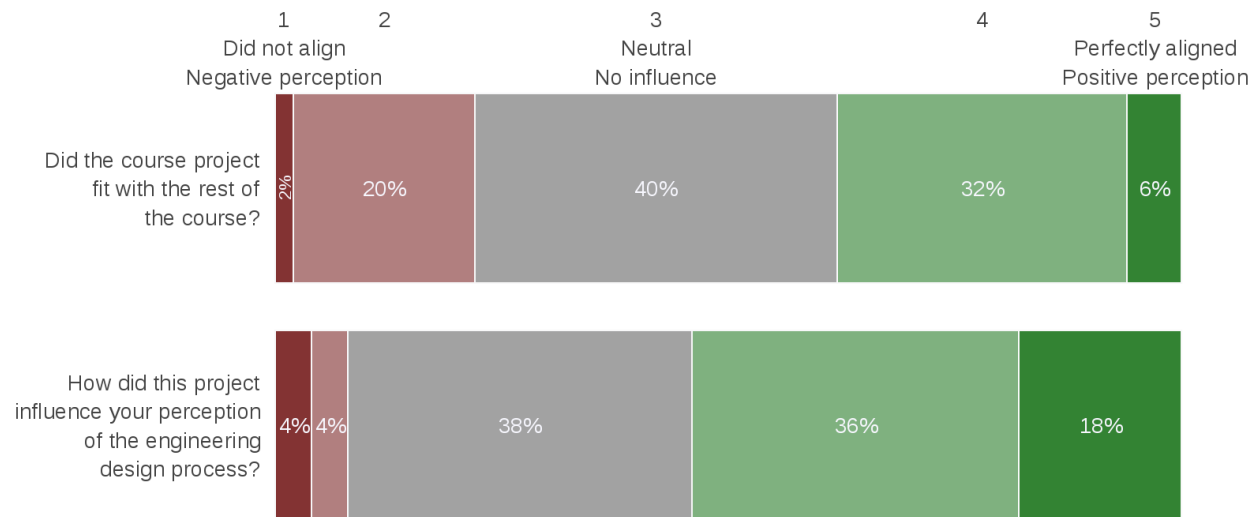


Figure 5: Student perceptions of the assistive technology course design project on course alignment and the engineering design process. Figure files available under CC-BY<sup>5</sup>.

## Qualitative Assessment - K12

For the K12 students, the project structure was originally intended to be something that serves a purpose or solve a problem that humans face. These guidelines were loosely adhered to by the students over the semester, however, and a survey conducted with the students at the completion of the semester showed that only eight of the 22 actually believed their project helped people. Of these eight, six of them were the students who collaborated on this joint effort with the university students. Additionally, only three of the students felt their project was completed within the semester. Several students worked with partners or in groups, and our survey did not collect this information, so it is possible as few as one project was brought to completion.

Out of the 22 students who were part of the WIN time cohort, 17 responded that they would like to visit the university partner program during the next semester. The small-group field trips that were completed by the nine STEM project students were viewed as desirable motivators. As a summative assessment, ten of the 22 students rated WIN time as the best part of their day, however, only seven students described their work as “fun.”

As previously mentioned, at the culmination of the semester, the nine STEM project students had the opportunity to visit the university one final time to present their work at a design show alongside the university students. The STEM projects presented at the design show included: An arduino-controlled, 3D-printed robotic arm based on the InMoov project ([inmoov.fr](http://inmoov.fr)), a robotic fish constructed using littleBits ([littlebits.cc](http://littlebits.cc)), and a stabilizing spoon for tremor reduction. While attending the design show (Figure 6), the K12 students had the opportunity to visit the project displays put together by the university students and interact with their designs (Figure 7).

The 5th grade students were interviewed upon completing their design projects about their experience with assistive technology. A few selected quotes included:





Figure 6: End-of-semester design show where each project group displayed their work.

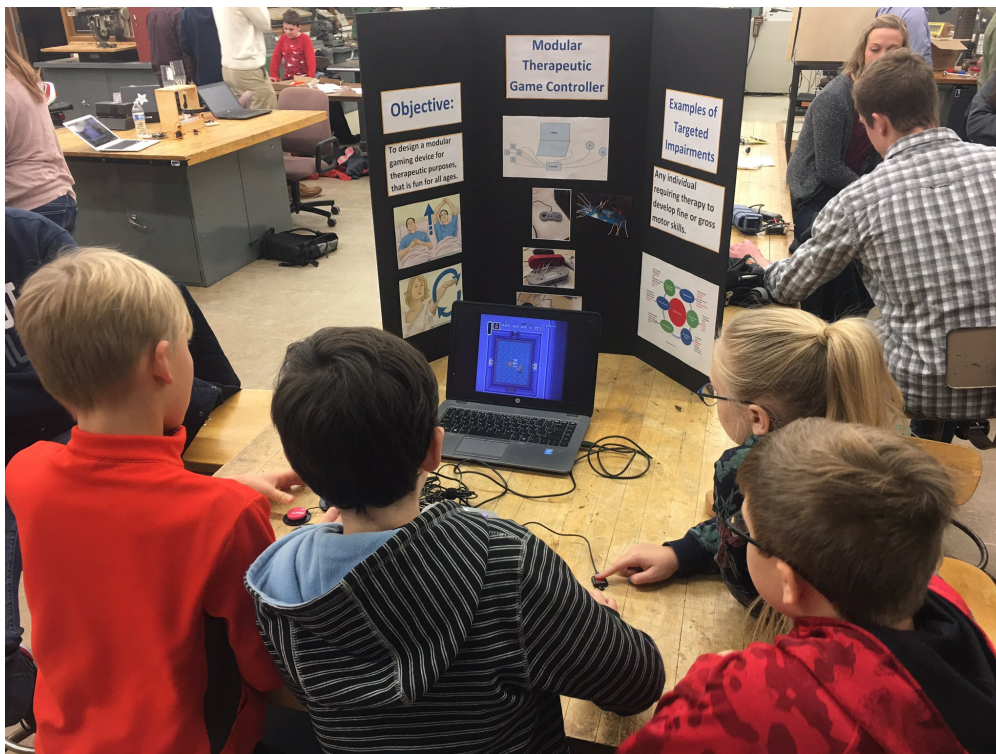


Figure 7: Grade school students had the opportunity to engage with the various design project during the design show.



- “I think it makes it more fun to have someone you do it for because then it’s more like social and you have to talk to them about it - it just more fun.”
- “It puts more pressure on you but it makes you feel good about yourself that you are actually solving a problem instead of making something for yourself if makes you feel better like you’re not being selfish because you solve their problem but not your own problem.”
- “I care that people are helping each other. A total stranger could fix a problem that she has.”

In general the students seemed to appreciate the fact that their designs had real world applications and helped others.

## Discussion

The qualitative assessment conducted thus far has revealed that the university students in general found the assistive technology theme of the semester-long design project to be meaningful. Additionally, those that did not enjoy the project primarily objected to the ambiguity of the design process. The instructors will investigate providing greater structure to the design project while recognizing that sometimes ambiguity is a necessary part of the process that must be recognized and worked through. Throughout the study, university students were reluctant to volunteer to assist the 5th grade students with their projects and provide mentorship outside of scheduled class times. Many stated that they didn’t feel confident in their abilities to provide such mentorship as they were learning much of the material at the same time.

For the K12 students, the survey results and anecdotal observations suggest that we were only moderately successful in constructing a meaningful and purposeful design experience. While the K12 instructor has been using a project framework such as this for many years, this was the first attempt at guiding students through a process aligned more closely with an engineering design project and with the purpose of designing something meaningful and useful.

With the next iteration of this project, we are attempting to enhance the project with two additions to the framework for the K12 students:

1. Students will now reflect on their project weekly, in the form of a written blog posts. The goal is to encourage the students to have better focus in their planning and prototyping by providing time to think<sup>6</sup>. It is developmentally appropriate for 10 and 11-year-olds to have trouble sticking with projects to completion, and giving focus to a project over time. We believe some intentional reflection time will help combat this tendency. These blogs will also serve as a way for the university students to stay connected to the 5th graders’ work and provide ongoing mentorship.
2. Students will be provided more dedicated instruction around the engineering design process and about a Design Thinking framework<sup>7</sup>. Students will be challenged to define and defend their work on each node of this process, and speak in terms of a the process as they develop their solutions. Defining a “Client” in the empathy stage will go a long way in clarifying their work, and provide them with better feedback and heightened purpose.

Early indications suggest that these additional focus areas will lead to greater success in providing a meaningful design experience for the K12 students. Students have defined their clients - mostly people and classrooms in our elementary school building. Many students are simply looking at problems in our own classroom to solve - which will allow for immediate feedback. They appear highly motivated, excited, and creatively engaged. One example project is on the issue of battery recycling. It was discovered that the elementary school building does not recycle batteries, and teachers and students often throw them in the garbage. A team of 5th graders is designing a solution for collection and transportation to a recycling center. They have run into a problem that their solution will not work past this spring, and they have therefore been forced to re-evaluate their ideas, returning back to a previous step in the design process.

In comparing the methods by which the 5th graders and the university students approached a design challenge, a few observations stood out.

1. The 5th graders were much more comfortable with ambiguity at the start of the design process. Generally they took the approach that issues they didn't understand would get sorted out over time.
2. The university students waited longer to begin prototyping their designs. They were more comfortable working on ideas on paper before starting to build anything. The 5th graders by comparison started constructing prototypes almost immediately. They had greater comfort with the design process when they could build a low-fidelity model and visualize how it might work physically. The university students generally skipped this step and their first prototype was typically a much closer representation of their final design.

A study of how each cohort approaches engineering design challenges is a good subject for further investigation.

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