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# Service-Learning through Student Generated Tutorial Videos

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I received my Mechanical Engineering undergraduate degree from the University of Wisconsin-Madison. During my schooling, I explored many opportunities to apply my engineering degree. I was involved with the Formula One Racecar Team, did a semester long co-op working on fume hoods, did a summer internship at Kimberly Clark designing a HVAC system, and did another summer internship at General Electric designing anesthesia equipment. As a senior, I got involved in research doing finite element analyses of a prosthetic foot. This immediately got me hooked on applying engineering to medical applications.

I obtained my Biomedical Engineering PhD at the University of Wisconsin-Madison. My work focused on computational biomechanics. More specifically, developing musculoskeletal models of the body to simulate movement and see how surgery and soft tissue injury affects movement. During my graduate work, I was also a teaching assistant for Introduction to Biomechanics where I developed a love for teaching. I then did postdoctoral research at the University of Kentucky where I experimentally measured movements (e.g running form), which provides data that can be used to validate the models I build. Here at Gannon University, I will continue building computational models with a focus on the knee to optimize surgical techniques (e.g. ACL reconstruction) to restore normal function after injury. When I'm not doing research, I enjoy going swimming and playing my violin.

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# Service-Learning through Student Generated Tutorial Videos

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## Abstract

More and more, engineers need to able to convey highly technical information to a non-technical audience. However, opportunities to develop these skills are often limited in the undergraduate classroom setting. To help develop students' ability to communicate to a non-technical audience, we implemented a service-learning project whereby students in a biomedical engineering class produced tutorial videos that demonstrated how to construct the Foldscope Microscope, an inexpensive paper microscope developed at Stanford University. The videos were then used in a STEM outreach program for middle school students, in which the middle school students constructed and used a Foldscope. The majority of students felt the project enhanced a number of communication skills and broadened their perspective of how they could use their engineering skills to serve others.

## Keywords

FoldScope, Origami Microscope, STEM Interest, Presentation Skills

## Introduction

Employment is dropping in manufacturing cities, deeming them the Rust Belt [1]. Rather than deteriorate, these cities have started to develop workforces that foster innovation and the development of science, engineering, and technology. Now, these once-flailing cities are being renamed Brain Belts. Our university resides in Erie, Pennsylvania, a city where many manufacturing facilities have shut down. In fact, Erie is often cited as a typical Rust Belt city. As a first step toward enhancing the local workforce, our university offers a week-long camp dedicated to stimulating interest in college attendance in underserved middle schoolers. To encourage students to enter into science, technology, engineering, and math (STEM) workforce and help move our region towards Brain Belt development, we have added a day-long experience to this camp. During this outreach, middle school students construct a Foldscope, a paper-based origami microscope with the guidance of an engineer. Students then explore the optics of and view samples with the microscope with a physicist and biologist, respectively. This outreach not only provides a valuable service to the community, but presents a unique opportunity for undergraduate engineering students to engage in service learning.

Engineers create innovative solutions to problems, which is an important skill to have when converting a city from Rust to Brain Belt. However, for these solutions to be implemented, engineers must be able to effectively communicate with a diverse audience and must participate in increasing the general scientific and technical literacy of non-professionals. As part of our outreach program, we wanted to provide our middle school students with tutorial videos on how to construct the Foldscope. Therefore, we implemented a service-learning project in an undergraduate engineering course in which students would produce a tutorial video on how to assemble the Foldscope. The goal of the project was to engage undergraduate engineering students to apply their engineering skills and develop their communication skills to support a real-world community need.

## Methods

*Instructor- Provided Materials*. We implemented a service-learning project whereby students in a biomedical engineering class produced tutorial videos that demonstrated how to construct the Foldscope Microscope, an inexpensive paper microscope developed at Stanford University. To create these videos, students were given a handout that contained the following information:

- Background for the service-learning project: the STEM workforce, middle school outreach program, and need for tutorial videos
- Foldscope article [2]
- Links to websites containing schematics for printing the FoldScope components
- Links to websites containing instructions for building the FoldScope
- Milestones for completion of the service-learning project throughout the semester
    - Milestone 1: collect all the FoldScope components needed (i.e. parts printed and cutout, acquire lens, etc.)
    - Milestone 2: have a fully built and functioning FoldScope
    - Milestone 3: Video of step-by-step instructions for building a FoldScope

Students were given the links for Foldscope schematics and assembly instructions only as a starting point. This was done intentionally to meet a secondary learning objective, which was to promote life-long learning by providing a chance to pursue information relevant to the course material that may not be specifically addressed in lecture.

*Requirements and Assessment of Tutorial Videos.* Students were given instructions as to how to make their videos. Specifically, they were instructed that their videos should be geared toward a middle school audience, be short in length (approximately 10 min), and should be easy to understand and avoid technical jargon. We purposely kept the instructions minimal to encourage creative thinking. For our outreach program, we chose the one video that we felt was the most engaging and best explained the construction of the Foldscope. Most of the student created videos can be found on YouTube.

- Picked for outreach program: https://youtu.be/wHtVDxxKBx4
- https://www.youtube.com/watch?v=Jjfvh82pv08&t=56s
- https://www.youtube.com/watch?v=e2fpUViXdsI&feature=youtu.be

*Assessment of student uses of technology, communication skills, and attitudes towards service learning.* At the end of the project, students were given a survey to help us identify the following:

(1) the types of technology used to produce the videos and the motivation behind choices for specific technologies
(2) motivation for type of format used in video (real-life demonstration vs. still slide animation)
(3) presentation and communication skills used
(4) outcomes on students' attitudes toward importance of effective communication with each other and to diverse audiences
(5) outcomes on students' attitude toward service-learning

In addition to the survey, we used information from students' final report to assess the above and the overall goal of the project.

**Results and Discussion**

*Students can produce effective tutorial videos using everyday technology.* Students were allowed to choose any form of technology to create their videos. Although video recording equipment from the university was made available, we found that students had few if any issues with producing videos using technology that was readily available to them. Indeed many students chose to use their camera phones to the record the video and could even edit the video on their phone using a downloadable app such as Apple Movies or Wondershare. Fewer students chose to use additional technology, such as animation software (Powerpoint) and graphics software (Adobe Illustrator) to create or enhance their videos (Figure 1A). Thus it is not surprising that enhancing professional quality was not a significant factor in choosing technology as nearly all smartphones include high quality imaging and recording technology (Figure 1B).

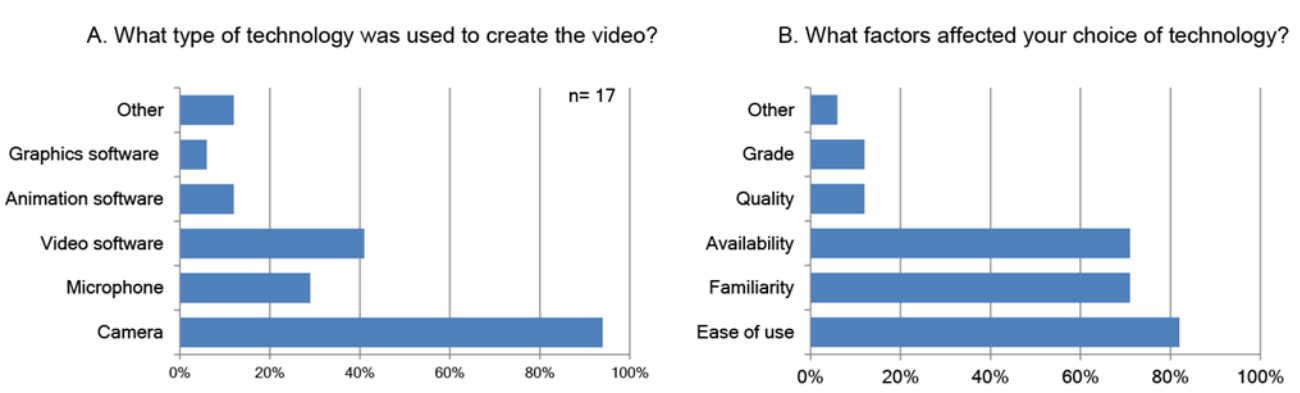


*Figure 1. Identification of typse of technology used (A) and factors affecting choice of technology (B) in production of tutorial videos. n = 17 students*

Students followed the guidelines given in the assignment, with one exception. Most videos were actually three to five minutes long, much shorter than that recommended 10 minutes. Upon

viewing the videos, we found that this was actually a positive change over our recommendation as a longer video would likely have been less engaging to middle school students.

Some students chose to make videos that demonstrated the actual assembly of the Foldscope by a real person. Other groups chose to present their video as a series of still slides with steps written out, figures showing each step, and little voice over. We found that both formats could be used to produce effective tutorial videos. Ultimately though for our outreach program, we chose to use a video where the steps were presented as still images as we felt the still images made it easier to visualize the individual steps and pause and rewind the video during assembly.

*Students develop multiple communication skills through producing tutorial videos.* One of the major goals of this project was to enhance student communications skills in multiple realms. In addition to the technical aspects, the production of the tutorial video allowed many students to utilize written, oral, and graphical communication skills (Figure 2A). Importantly, many students felt that the project was an excellent opportunity to integrate all of these communication skills (Figure 2B).

In addition to the skills above, students felt that the project enhanced their interpersonal skills (Figure 2C). Students have to be able to effectively communicate with each other to accomplish the various steps in making the videos. These include finding and testing the Foldscope template; writing a script; and recording, editing, and enhancing the video.

Another important learning outcome from this project was to develop students' ability to communicate complex technical information to lay audiences. As science and technology becomes ever present and permeating in our everyday lives, it is essential that those working in STEM fields help to promote science literacy through effective communication with non-professionals. The majority of students felt that that the project improved their ability to explain complex concepts and instructions to lay audiences, and specifically middle school students (Figure 2D).

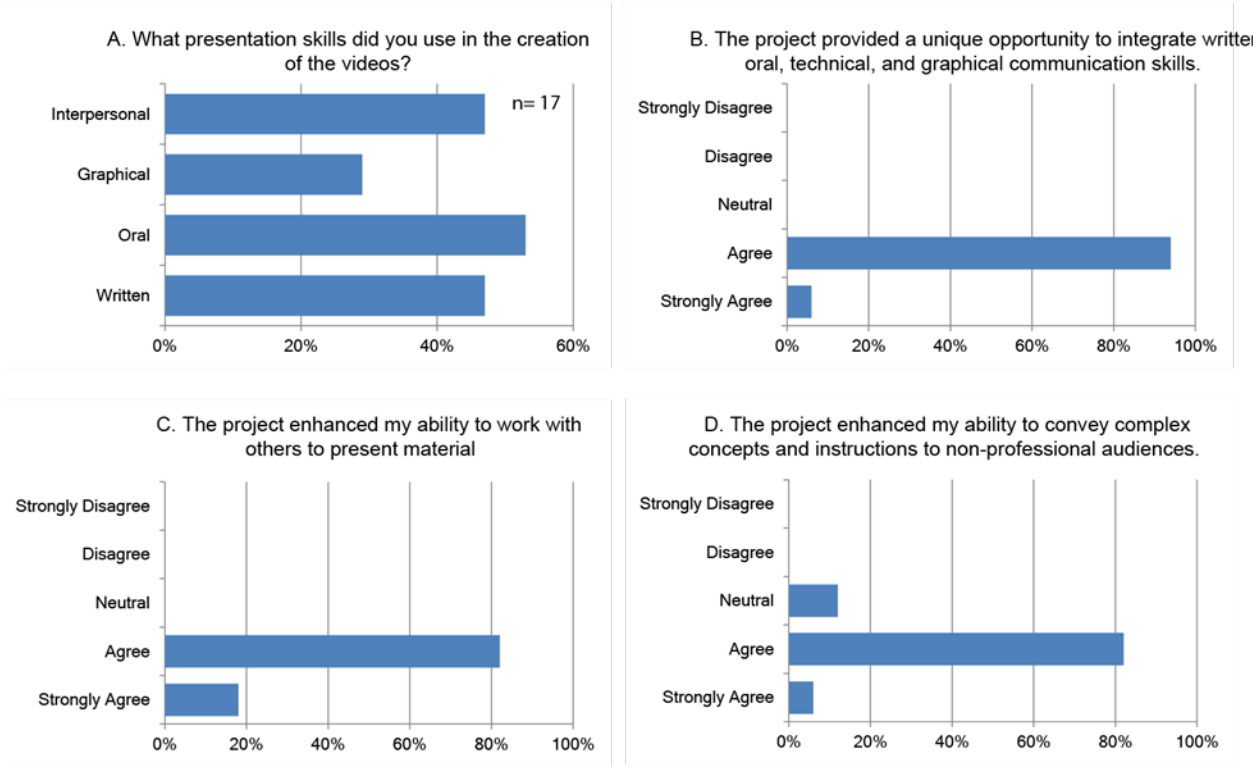


*Figure 2. Identification of communication skills used (A) and student attitudes of development these skills (B, C, D). n= 17 students*

*Service-Learning independent of contact.* Service learning is defined as an educational approach "that integrates meaningful community service with instruction and reflection to enrich the learning experience, teach civic responsibility, and strengthen communities." (National Service Clearinghouse) STEM outreach programs are ideal outlets for service learning; however, our outreach program took place in the summer when students are unavailable. The major goal for this project then was to develop a method for students to take part in service learning, even if they are unable to interact with the population being served. As part of the introduction to the project, students were provided with information about our middle school outreach program and the underrepresentation of students from low-income, first-generation, and minority backgrounds in STEM fields. This information was incorporated into many of the student reports about the project and students discussed the importance of having accessible and inexpensive technology, such as the Foldscope, in underserved regions locally and globally. Furthermore, students felt that this project improved their awareness of how they could use their skills to serve others (Figure 3).

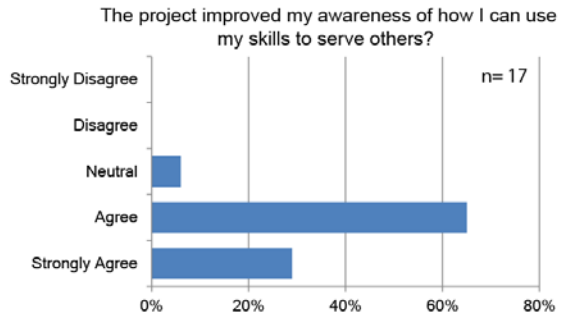


*Figure 3. Student attitudes about service-learning through the producing tutorial videos.*

## Conclusions

In this project, we have demonstrated how students can participate in service-learning through means that do not require them to have direct contact with the population being served. Given the high quality and ease of making videos using technology that is readily available, students can easily produce tutorial videos for a range of STEM outreach projects. The videos can be easily uploaded to YouTube and made accessible to many audiences. Although there were multiple videos that were of excellent quality, we chose only one video to be used in the STEM outreach program. During our program, several students commented on the excellent quality of the video and we observed a number of students referring to the video during the construction of the Foldscope. These results demonstrate that the production of tutorial videos can provide a meaningful, service-oriented learning experience for students to develop communication, collaborative, and critical thinking skills.

## References

1. Sisson, P. *From Rust Belt to Brain Belt: Can Former Industrial Cities Turn Into Future Innovation Hubs?* Curbed: Urban Planning, 2016.
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Anne Schmitz has a doctorate in Biomedical Engineering from the University of Wisconsin-Madison. Currently, she is an Assistant Professor in the Biomedical Engineering Program at Gannon University. She teaches bioengineering lab courses, biomechanics, and research methods. Her research focus is computational joint modeling.

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## Quyen Aoh

Quyen Aoh has a doctorate in Cell Biology from the University of Virginia. She is currently an Assistant Professor of Biology at Gannon University. She teaches Molecular & Cellular Biology and Genetics. When she is not in the laboratory studying the cell biology of disease, she spends her time engaging the public in science through various outreaches.