

Work in Progress: Multidisciplinary Learning between Engineering, Communication, and Fine Arts Majors through the Creation of Movie Special Effects

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Abstract

Over the past two decades, there has been an increased interest in using multidisciplinary learning as a means of addressing twenty-first century skills to remain globally competitive in the knowledge economy. These twenty-first century skills can be fostered through design-based learning (DBL), a pedagogical approach where knowledge and skills are developed through the construction of a design-based task. Recent movements towards multidisciplinary learning in higher education have called for the design process found science, technology, engineering, and mathematics (STEM) to be blended with the artistic and creative process of the arts. Often referred to as STEAM or STEM + Art, this approach aims to pique student interest through opportunities to engage in creative thinking and artistic techniques while simultaneously exploring mathematics and scientific concepts. Due to the wide variety of disciplines that engage in design, DBL has a great deal of untapped potential as a pedagogical approach to address the calls for multidisciplinary learning between the arts and engineering. This study followed 23 undergraduate fine arts, communication, and engineering majors who worked in multidisciplinary teams to design, create, film, and edit practical movie special effects (i.e., a special effect produced physically without the use of computer-generated imagery.)

Pedagogically framed as DBL, participants engaged in traditional fabrication, such as sculpting clay, casting/molding, metal working, vacuum forming plastics, and woodworking, as well as digital fabrication, including 3-D printing and laser-cutting, to bring their special effect to life. Participants were followed over a period of 14-weeks in multiple fabrication environments, including a theater design studio, fine arts makerspace, and engineering makerspace. Preliminary findings from this work-in-progress qualitative study found that this multidisciplinary project provided an outlet where both engineering and fine art majors could put theory into practice in a safe environment where the outcome did not have to be perfect. Working in multidisciplinary teams provided an opportunity for both engineers and fine art majors to gain an appreciation that both majors work hard but in different ways. The artists described how the experience humanized engineering, but gatekeeping did emerge when it came to engineers painting and making creative choices on the project. While the project did provide opportunities to exchange skills and knowledge between the majors, it also led to some resentment from the artists about the abundance of resources provided to engineering majors by the campus. Based on these findings, instructors teaching a multidisciplinary courses should be aware of the existing stigmas, possibility for resentment from artists towards the resources available to engineering, and potential gatekeeping that may take place between the disciplines.

Introduction

Over the past two decades, there has been an increased interest in using multidisciplinary learning as a means of addressing twenty-first century skills to remain globally competitive in the knowledge economy [2], [3], [14]. These twenty-first century skills, which include critical thinking, communication, collaboration, and creativity [6], [12], can be fostered through design-based learning (DBL), a pedagogical approach where knowledge and skills are developed through the construction of a design-based task. Often, DBL is challenge driven, where learners seek to find a solution to a complex problem through a project-based approach [5], [7]. The use

of DBL tends to be within a single discipline (e.g., only electrical engineers) [4] or as means of “unifying” or mixing sub-disciplines (e.g., electrical, mechanical, and civil engineers) [11]. Recent movements towards multidisciplinary learning in higher education have called for the design process found science, technology, engineering, and mathematics (STEM) to be blended with the artistic and creative process of the arts. Often referred to as STEAM or STEM + Art [1], [8], this approach aims to pique student interest through opportunities to engage in creative thinking and artistic techniques while simultaneously exploring mathematics and scientific concepts. Due to the wide variety of disciplines that engage in design, DBL has a great deal of untapped potential as a pedagogical approach to address the calls for multidisciplinary learning between the arts and engineering.

This study followed 23 undergraduate fine arts, communication, and engineering majors working in multidisciplinary teams to design, create, film, and edit practical movie special effects (i.e., a special effect produced physically without the use of computer-generated imagery.) Pedagogically framed as DBL, participants engaged in traditional fabrication, such as sculpting clay, casting/molding, metal working, vacuum forming plastics, and woodworking, as well as digital fabrication, including 3-D printing and laser-cutting, to bring their special effect to life. Participants were followed over a period of 14-weeks in multiple fabrication environments, including a theater design studio, fine arts makerspace, and engineering makerspace.

This work-in-progress paper focuses on the preliminary results of participant perceptions of working in multidisciplinary teams. These teams consisted of three or four participants and included at least one engineer (electrical or mechanical) and two members from an arts-based discipline (arts, entertainment, and technology [AET], radio, television, and film [RTF], studio art, or theatre and dance [T&D]). This research is guided by the following question: 1) How did multidisciplinary learning shape the participants’ perception of the arts and engineering?

Methods

Methodology for this study is primarily qualitative, drawing inspiration from case study [9], [14], [16], and grounded-theory [15]. Both of these research traditions emphasize the importance of the real-world experience and recognize the need for detailed description to represent the complexities that cannot be captured as a set of factors or variables.

Participants

Participants include a convenience sample of 23 undergraduate students enrolled in a course focused on creating practical movie special effects called *Facilitating Interdisciplinary Learning through Movies*, or FILMs. This course took place at a large research institution in the southern United States during the fall of 2018. In order to enroll in the course, participants completed an online application and were approved by instructors. Active recruitment was done in the College of Communications, College of Fine Arts, and School of Engineering in an effort of creating a cohort that reflected a diverse set of design disciplines. Participants included 7 Theatre and Dance (T&D) majors, 7 Engineering majors (4 mechanical and 3 electrical), 4 Arts, Entertainment, and Technology (AET) majors, 3 Radio, Television, and Film (RTF) majors, 1 Studio Art major, and 1 double major in French and Design Arts & Media (see table 1). 12 females and 11 males were enrolled in the course. Of the engineers, six were male (3 electrical, 3 mechanical) and one was female (mechanical).

Table 1

Participants' Undergraduate Majors

Undergraduate Major	Total
Arts and Entertainment Technologies	4
Engineering	
Electrical and Computer Engineering (E+CE)	3
Mechanical Engineering	4
French / Design Arts & Media	1
Radio Television Film	3
Studio Art	1
Theatre and Dance	7

Data sources

Consistent with descriptive case study methodology [9] this case is bounded to the students, instructors, and other stakeholders involved with the FILMs course being offered in Fall of 2018. In order to capture a rich description of this case, documentation, archival records, interviews, direct observations, surveys, and both physical and digital artifacts were be used for data collection and analysis. Data collection included direct observations of participants using field notes, photography, and audio/video recordings. Both physical and digital artifacts where collected throughout the study including planning documents, the final “demo reel” of the movie effect, blogs, Slack conversations, Trello project boards, and student-generated photos/videos that were shared in a course repository.

Analysis

Analysis for this work-in-progress paper focuses on findings from exit interviews and end-of-course survey. All interviews were transcribed and analyzed in NVivo 12 qualitative analysis software. Following Miles, Huberman, and Saldaña’s guidelines for qualitative coding [10], two rounds of open coding were completed to establish primary and secondary codes. An Excel spreadsheet was then created to perform a cross-case comparison to allow for a more in-depth analysis of what artists said about working with engineers, and what engineers said about working with artists.

Findings

In the section below I report the findings of from artists and engineers working in multidisciplinary teams. These findings represent a work-in-progress from a larger study that is serving as the author’s doctoral dissertation. All names of participants are pseudonyms.

“It’s not supposed to be perfect”

Working on a multidisciplinary project provided an outlet where engineering majors did not have to be technical all the time. According to Sam, a third-year mechanical engineering major, “A lot of engineers won’t get this, it’s not supposed to be perfect. You’re not supposed to calculate tension and strain, unlike engineering where there is an emphasis on calculations and modeling before production.” William, a fourth-year, theatre and dance major described the difference as, “Artists are more fast paced; you get out there and see what sticks. While engineers are slower and more methodical.” Other engineering participants described working on an arts-based project as being laid back, fluid, and visual as opposed to the analytical and methodical approach used in their engineering coursework.

Putting theory into practice

Several engineers specifically sought out this course since it provided an opportunity to do project-based learning. April, who was the only female engineer in the course, purposely enrolled since she wanted to do more projects instead of “theoretical stuff.” She had been disappointed with the lack of hands-on projects in her engineering program and did not want to wait until her capstone to develop project-based experience. Working in an art-based project provided her an opportunity to shift her focus from function to aesthetics. In addition, working in the art space allowed engineers to do projects that they could not do in a traditional engineer space, such as casting a molding, which were deemed as too messy for the engineering building.

Humanizing engineering

Artists working with engineers expressed that this experience provided an opportunity for humanizing engineering. Tina, a fourth-year theatre and dance major stated, “Artists romanticize how hard it is to be an engineer... Anybody can paint. Anybody can build... Working together humanized engineering by bringing everybody down to the same level.” Multiple participants described working within their discipline as being within a bubble, and that this project allowed them to, “Get outside of your bubble to work with other people.” Several artists who studied AET expressed that, “the course felt normal, just working with other people.” This was partially attributed to how audio-video technicians frequently use the same tools and schematics as electrical engineers. Kevin, a third-year theatre and dance major, had additional opportunities to work with engineers outside of the course who were cast as actors in theatre productions. Kevin enjoyed working with engineers since they provided relief from being surrounded with overly melodramatic peers in the theatre department.

Different perspectives

Participants valued the different perspectives that both artists and engineers brought into the learning environment. Participants express that both the artist and engineering disciplines engaged in problem solving, but each had different approaches and ways of thinking about finding solutions since their problem solving came from “different realms.” Michael, a fourth-year electrical and computer engineering major stated, “When working with other ECE [electrical and computer engineers] they know the same stuff as me, often even more. As a result anybody can do the tasks on an ECE project. Working with artists allowed everybody to bring their own strengths to the project.” These different perspectives sometimes caused tension due to challenges with communicating ideas. April, a fourth-year mechanical engineering major stated, “It was hard for me because I couldn’t really make assumptions. Then if I did make assumptions

it was kind of like I was explaining too much. You know what I mean? It was kind of hard to find that balance.”

Engineers using paintbrushes

According to Kevin, “Painting became a rallying point for the class.” Due to the importance of the finish on many of the props being developed for the practical special effects, there was a great deal of emphasis put on painting to create a desired finish. One of the instructors, Susan who had over 15 years experience as a scenic painter, provided painting and finishing demonstrations to all groups during their lab time. One engineer, Chris a fourth-year mechanical engineering major, became the poster-child for engineers using paintbrushes after spending several weeks painting and texturing a 3-D printed boat hull (see figure 1). In their exit interviews, five artists specifically mention seeing Chris painting along with his work ethic towards the project as have a significantly positive impact on how they viewed engineers.

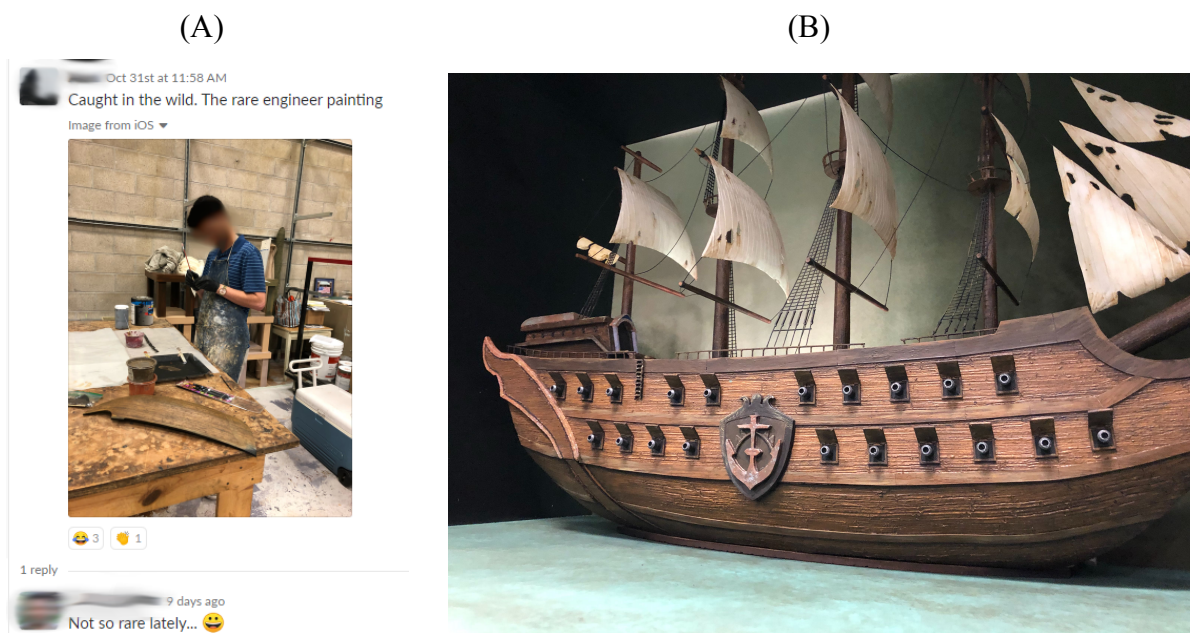


Figure 1. (A) Photo posted on Slack taken by AET major commenting on engineering major painting in the Scenic Design Studio. (B) Ghost boat consisting of a 3-D printed hull that is coated with Jaxsan and painted with acrylic paints.

Gatekeeping

Painting was also used as a form of gatekeeping for the artists. Curtis, a fourth-year theatre and dance major who specialized in costume design stated, “I would rather see the engineer paint than being trusted with making some of the other creative choices.” Anita, a third-year theatre and dance major joked, “All engineers are allowed to paint, except Sam” as a result of him making several painting errors during the project such as not keeping all strokes in the same direction when trying to create a smooth finish. Engineers also engaged in gatekeeping when it came to decision-making. Justin, a second-year electrical engineer described that it was difficult for the engineer to relinquish authority, stating “It’s a lot harder for the people on the artistic side to be trusted to make judgment calls. Engineers have the information, so let’s trust them.”

Addressing stigma about the arts

Multidisciplinary learning between artists and engineers helped to break the stigma about artists doing less work than engineers, with multiple participants stating “the amount of work is same, but different.” Several engineers expressed that they were unaware how much time theatre majors spent running productions and performances on campus. Sam, the fourth-year mechanical engineering major expressed, “There’s so much work that goes into an art major or theatre major and a lot of engineers don’t like to acknowledge it.” Parallels were drawn between how engineers might stay up all night to study for an exam, while artists might stay up all night to keep their project from falling apart. Engineering was seen as exam heavy, while art was project heavy. Two engineering participants identified as artists, but when asked about why they pursued engineering stated that they did it for financial reasons. For example, Oscar a freshman electrical engineering major stated that he ultimately chose engineering because “with a computer engineering degree, you can at least feed a family of four.” However, he added that he had developed a new appreciation for how much artists struggle to succeed and admired those who had found a way to make a living doing their craft.

Fostering resentment

As part of their interviews, the artists also expressed resentment against the engineering program. Anita, a third-year theatre and dance major who described herself as a “mildly disgruntled artist”, enjoyed poking fun at the engineers “because I’m jealous of their fun toys. The engineers with their fancy tools and everything like that, but at least we can paint.” However, after spending a semester working with Sam the mechanical engineer she expressed that, “I might be a little more warm towards them [engineers].” Kevin described that he was “bitter” after walking away from a class meeting in the engineering building since, “They have everything. We have nothing.”

Developing and exchanging skills

The multidisciplinary learning space became a forum where artists and engineers could develop existing skills while also exchanging knowledge about new skills. Engineers were able to further develop their digital fabrication skills by developing 3-D printed prototypes for their projects while also teaching some of the artists the basics of 3-D modeling. In exchange, the artists helped take the 3-D printed models and treated them as a canvas while working with the engineers to paint, texture, and finish their movie props. In some cases, engineers were able to use their skills to make the project progress quicker. Oscar, the freshman mechanical engineer, worked in the engineering makerspace and was able to 3-D print while he was assisting other students. However, 3-D printing became the proverbial hammer that turns then whole world into a nail (i.e. the *law of the instrument*.) With Aaron, a fourth-year RTF major commenting, “Engineers 3-D printed everything instead of using cardboard.” He continued, while referring to a rectangular block used by a different team as part of a robot, “Why would you spend 8-hours 3-D printing such a simple object?” (see figure 2).

Implications

This work-in-progress paper helps share preliminary findings help contribute to our understanding of how DBL can be used in multidisciplinary settings to bring the arts in conversation with engineering education. These findings indicate that multidisciplinary learning is beneficial for both engineering and arts-based disciplines in terms of address stigmas,

developing new and existing skills, providing an opportunity to work with other who have a different perspective, and creating an environment that fosters both aesthetics and function. Based on these findings, instructors teaching a multidisciplinary courses should be aware of the existing stigmas, possibility for resentment from artists towards the resources available to engineering, and potential gatekeeping that may take place between the disciplines.

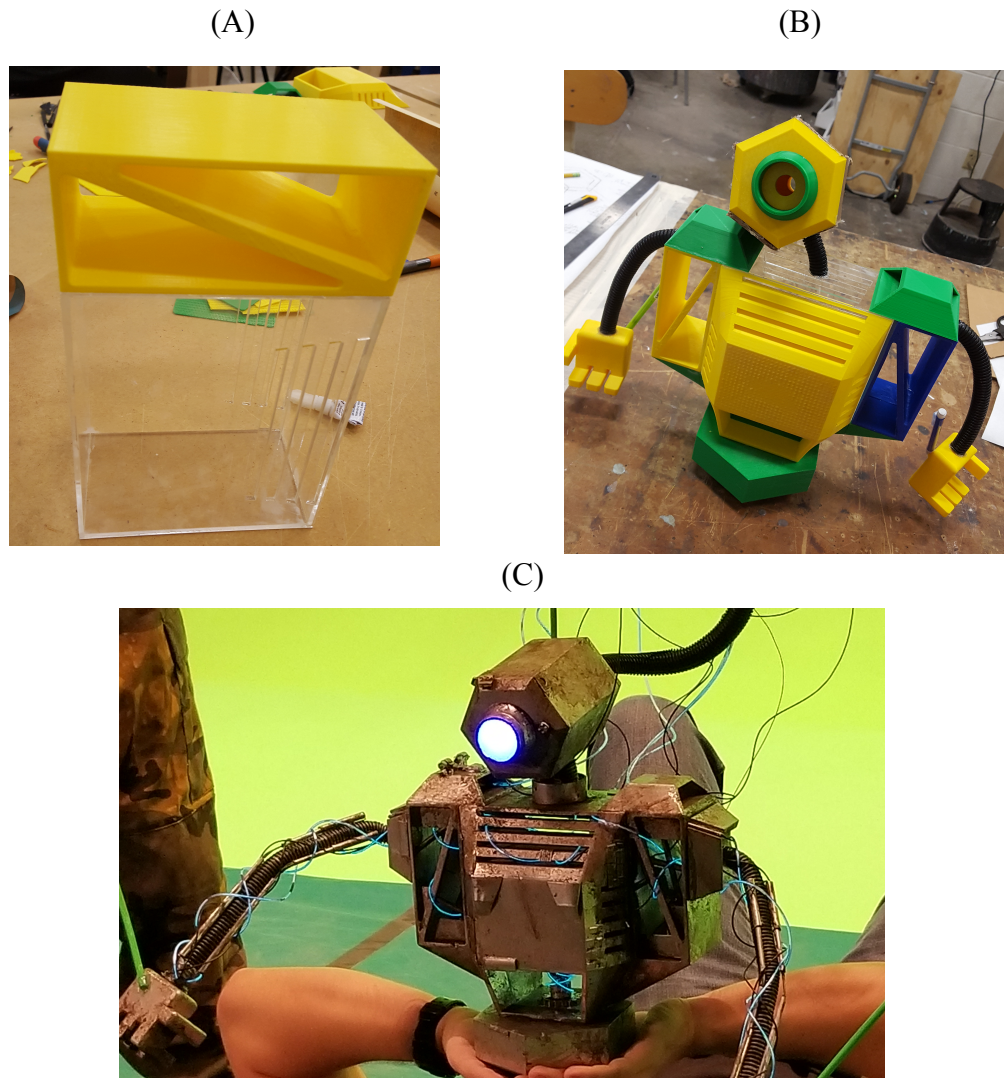


Figure 2. (A) Example of 3-D printed block that took 8 hours to print. (B) Assembled 3-D printed robot puppet prior to adding primer, paint, and weathering effects. (C) Finished robot on day of shooting in front of a green screen.

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