Implementing design thinking into summer camp experience for high school women in materials engineering

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Abstract

Although women make up a significant portion of the college educated population, there remains a sizable gap between the number of men and women pursuing degrees and careers in science, technology, engineering and math (STEM) fields. The gender gap begins at middle school and widens considerably in later high school years. One major factor for this gap is the lack of belonging women can feel towards engineering. As one approach to developing and improving this sense of belonging, we focused on improving students' comprehension of engineering topics during a weeklong materials science and engineering summer camp for high school girls. We took a two-prong approach: a unifying paradigm and a design project. The purpose of this was to allow for transfer of learning throughout the week, allowing the students to build and showcase their own comprehension. The paradigm, the materials science tetrahedron, provided cohesion throughout an otherwise broad and seemingly disconnected field, while the design project allowed for students to implement what they learned during the week in a group setting. This approach concomitantly enhances confidence and their sense of belonging within engineering. In this paper we highlight lessons learned from incorporating this approach into our program, including our perception of its effectiveness and feedback from the girls. The preliminary results show that our summer camp is a unique and well-suited opportunity to study how comprehension can engender a sense of belonging amongst female students with the ultimate goal of closing the gender gap in engineering fields.

Introduction

There is still a sizable gap between the number of men and women pursuing degrees and careers in science, technology, engineering and math (STEM) fields[1]. Over the past decade much research has been done to understand the phenomenon known as the gender gap[2,3] . This issue is complex; one main factor being gender stereotypes. By the time women reach high school; negative stereotypes are fairly well ingrained. They have received messages about gender identity and expectations, intentional or not, from parents, teachers, and even through more feminine extracurricular activities such as Girl Scouts[4]. This can lead to a more critical self-assessment in math and science as well as the belief that young women must have exceptional performance in the STEM fields in order to be successful[5], which is detrimental and can deter women from pursuing these areas.

Furthermore, women who demonstrate high levels of math or science proficiency often possess similar levels of verbal proficiency[6], leading to greater career flexibility. Feelings of isolation lead many of these women to favor non-STEM career paths and result in more career fluctuations as a whole[4,7]—especially as they progress further in their careers[6]. This lack of a sense of belonging, or sense of having the proper qualifications (especially socially)[8] to be an engineer, is something that will be examined throughout this paper.

There are ways to reduce the gender gap. Several studies found women's career interests during the younger years could be influenced if aspects of the curriculum appealed to women's intrinsic motivation to improve the lives of people in their communities[4,7,9]. Engineering outreach is a good avenue for tapping into this inclination; it allows for exploration of different topics in ways often not available in traditional classrooms, granting students the opportunity to explore complex ideas in a group setting. These groups are often focused on a specific age or gender. The environment can help to provide a sense of community for the participants, increasing their sense of belonging within engineering.

Another major benefit is that outreach is more hands on than a typical classroom[10]. As early as fifth grade, girls express preferences for experimental and project-based approaches in the classroom over typical lectures and homework[11]. These avenues also allow for the incorporation of design thinking. In this work, we use Cross's definition of design thinking: a new way of dealing with problems across fields[12]. Design and the design cycle are central ideas within engineering and are becoming much more widespread within collegiate programs at both the freshman and senior level through design projects[13] . Such projects can be used to motivate students and increase retention[13]. Also, design is ultimately social in nature[14]. This gives the young women a chance to further improve their own community within engineering. With an increased sense of community, these girls might be more inclined to continue down the STEM path. Design thinking should also promote better understanding of engineering as whole. If young women still think they need to excel within math and science in order to be successful[5], having outreach programs that increase their overall comprehension of engineering would be more beneficial.

Despite the commonality of engineering outreach programs, especially those that are focused on increasing the number of women in STEM, there is very little in the literature about the efficacy of outreach programs. Design thinking as a part of outreach is mentioned in the literature, but only as a guide for implementation. No comments are made about participants' overall comprehension of the topics covered within the outreach program or how comprehension affects their impression of engineering. Furthermore, no conclusions have been reached on overall engineering understanding or eventual retention of women within engineering. We will examine these topics in this work.

While the outreach literature has focused mainly on general engineering outreach camps, our work focuses primarily on the materials science camp run by the authors. Given the multifaceted nature of materials science, this camp presents an opportunity to use design thinking and teamwork to effectively unify the complex nature of the field while also exploring the impact on the sense of belonging in this age group. This work represents a preliminary look into the role design thinking and unifying paradigms play in improving engineering understanding and therefore overall opinions of engineering in high school women.

Building the Girls Learning About Materials (GLAM) Camp

Motivation for the Camp Structure

Materials science and engineering (MSE) is the study and design of materials and is an integral part of many different fields. The discoveries from this branch of engineering cover everything from the materials used in knee implants to the solar panels on the roofs of buildings. It is this widespread set of applications that makes MSE a rich area for engineering outreach; it is relatable to a student's day-to-day life in ways he/she does not expect. As cited earlier, many of the applications of MSE fit into the intrinsic motivation women have to improve people's lives that was mentioned earlier[4,7,9].

Professor Dallas Trinkle in the Materials Science Department at the University of Illinois Urbana Champaign (UIUC) started our camp, Girls Learning About Materials (GLAM), in 2010. GLAM is part of a larger program at UIUC called Girls Adventures in Math Engineering and Sciences (GAMES). The GAMES camps cover a variety of engineering disciplines. GLAM is a weeklong residential camp, which literature shows to be more effective for improving female retention than day camps[11]. Each year since its beginning, the program has welcomed twenty participants, all of whom are women entering grades 10-12. The girls all apply to be in GLAM. The application requires students to submit their grades, an essay, and a letter of recommendation. Most of the participants self-select to apply and attend this camp.

The purpose of this camp is to showcase this little-known field of engineering through a wide variety of topics. Over the years, GLAM has curated a broad set of hands on activities that the students routinely enjoy. This variety, however, has its downsides. These activities span a huge range of applications, leading to the impression that they are completely unrelated. This apparent lack of coherency can lead to a sense of confusion among the campers, which can, in turn, become discouraging and leave the students with an overall negative impression of engineering. The efficacy of the outreach program could thus be dramatically reduced. For example, campers gave these responses in a survey conducted at the end of GLAM in 2014.

> "There was not much in the way of connecting things - we'd learn a cool thing, do a lab, and then move on to a completely unrelated subject."
>
> "Some things were difficult to follow due to the short amount of time, but the instructor overall explained to the best ability within the amount of time."

These issues within the camp have led the current coordinators, the authors of this work, to change the structure of GLAM to include a tool that explicitly shows how concepts are connected.

The main goal of the restructuring the camp was to reduce this confusion and improve comprehension. To do this, we utilized the transfer of learning theory. The transfer of learning theory states that comprehension of topics can be shown when students have an opportunity to put both new and old information to use when solving a new problem[15]. Royer discusses the idea in depth and brings to light the idea of using transfer of information as an indication that understanding has been gained[16]. Different degrees of understanding can be achieved when transfer occurs in different ways. A schematic explaining the degrees of concept mastery can be seen in Figure 1.

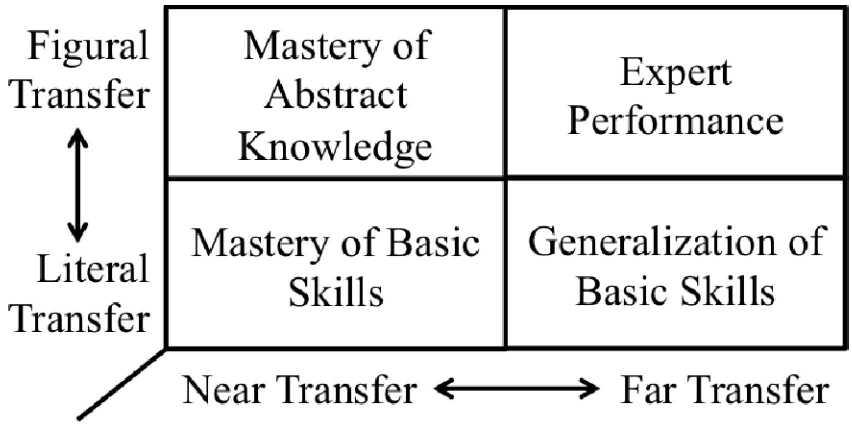


Figure 1: Royer's Varying Degrees of Understanding[16]

Near transfer is being able to identify the need to use a newly learned skill due to contextual clues between instruction and transfer. Far transfer occurs when a newly acquired skill is needed, but that information is not provided to the learner[16]. Literal transfer when applying a new skills to a specific task, while figural transfer involves using a new skills in a more complex problem-solving situation[16]. Figure 1 shows how these different kinds of transfer can work together to lead to different types of skill mastery, varying from basic skills to expert performance.

With this information in mind, two different restructuring approaches were adopted: (i) a cohesive framework to connect the activities together while preserving the diversity of the field and (ii) a design project. Details on the motivations behind these organizational choices will be provided in the following sections.

The Materials Science Tetrahedron: A Unifying Framework
MSE is often described using the materials science tetrahedron (see Figure 2).

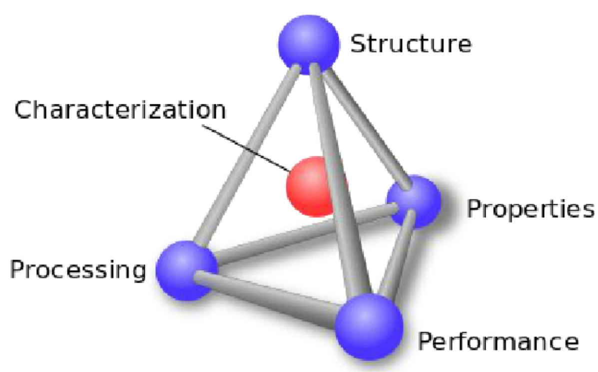


Figure 2: The Materials Science Tetrahedron
Dhatfield/Wikimedia Commons/Public Domain[17]

The four vertices of the tetrahedron describe the four main areas of study within MSE: (i) the structure of materials at the atomic level, (ii) the fundamental properties of materials, (iii) the processing techniques used to create materials, and (iv) the performance of materials in their final application[18]. All of these aspects are interconnected, shown by the gray bars. Characterization is in the middle of the tetrahedron because it is the technique used to study how all of these different topics are interconnected. This connection between fundamental aspects of materials science was the reason the tetrahedron was chosen as an organizational scheme for GLAM. The motivation behind this choice was that by giving the students something to which they can relate every activity; the field of materials science would feel more cohesive as a whole. We hypothesize that using the tetrahedron to unify various materials science concepts could improve overall comprehension of this highly multifaceted field, thus avoiding the potential for confusion to be perceived as inability. Giving the students a chance to make connections between new information and their existing understanding of materials is a chance to show transfer of learning, specifically figural transfer[16]. Details of the framework integration and how learning transfer was built in will be given in the implementation section.

Design Project: Linking Concepts With Application
Another way of connecting a seemingly complex topic is a design project. As mentioned previously, design has been shown to improve student retention at the collegiate level[13]. Despite these findings at the collegiate level, there is little in the literature demonstrating successful extension of this to the outreach level.

2016 was the first summer a design project was added into the GLAM camp structure. We hypothesized that including design thinking, combined with teamwork, would be an effective strategy to increase the girls' confidence in their abilities as engineers and therefore their sense of belonging. The design project is also the ultimate chance for the campers to participate in the transfer of learning. By having the girls go through the design process, they are encouraged to synthesize the ideas and content they have learned throughout the week. This successful application of engineering ideas will leave a positive impression on the participants, showing competency within engineering. Our rationale is that this positive association and proof of competency will increase the sense of belonging, since competency is a key factor in young women's continued interest in engineering[5]. Details of the design project and its strategy to connect the whole camp together via transfer of learning and comprehension will be given in the implementation section.

GLAM Schedule and Overall Structure
The general structure of camp can be seen in Figure 3. There are four main activities that occur during camp: (i) hands on lecture, where lab activities are integrated into lecture, (ii) lecture, where the girls are listening to a presentation from one of the coordinators, (iii) lab, where the students go into a lab environment to conduct experiments, and (iv) design project, where the students are specifically working on their overarching project. Figure 4 also shows how each activity is related to the materials science tetrahedron. Activities that have a blended color indicate the topic incorporated several of the pillars. Each part of the tetrahedron is touched on multiple times, giving the girls repeated exposure to each pillar of materials science and different possible combinations thereof.

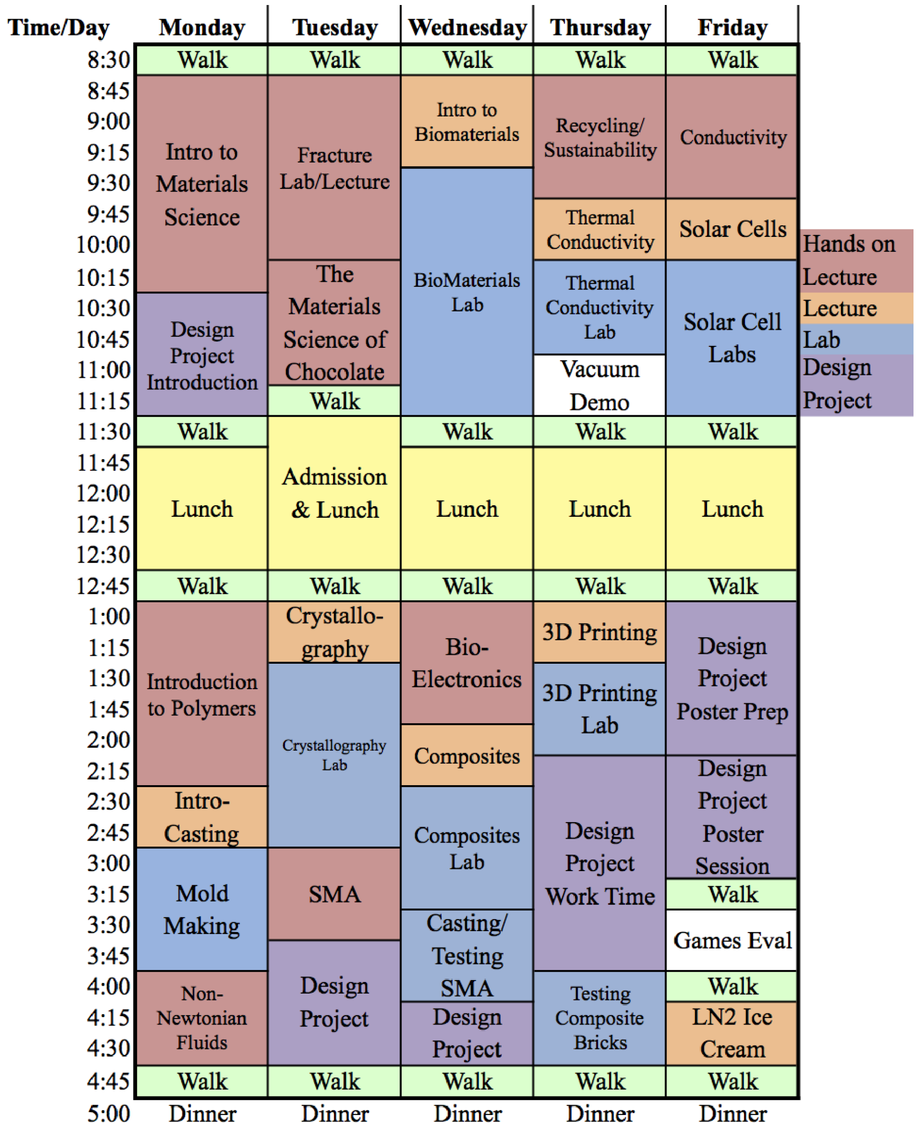


Figure 3: The GLAM 2016 Camp Structure

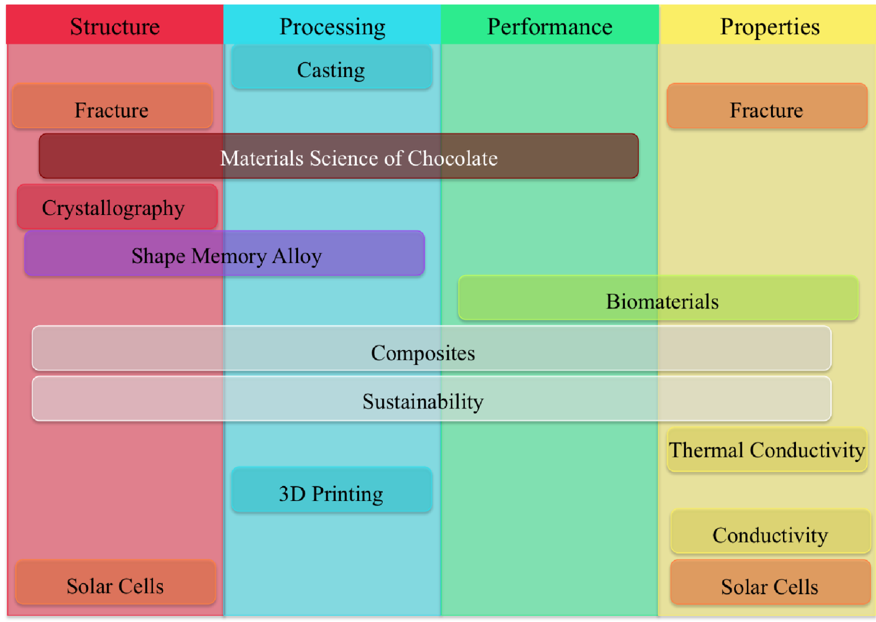


Figure 4: Pillars Of The Tetrahedron (Color-Coded) And The Modules With The Specific Pillars Covered In That Particular Activity.

Framework Introduction Implementation

The first day starts with a longer lecture to introduce the materials science tetrahedron. To try and break up the lecture, hands-on activities and demos were placed throughout to increase student engagement. Interactive questions are also presented via PollEverywhere, an app that allows for students to answer questions via their cell phone. Incorporating cell phones into lecture was seen as a way to include what is normally considered a distraction.

Previous iterations of camp had the same longer intro lecture, but without as many interactive demos and questions. Instead, the information in this lecture was thoughtfully pruned to ensure that all the students were drawing from the same knowledge base in the more focused activities later in the week. Because the students all come from different grades and schools, their understanding of basic chemistry and physics is varied. As a result, feedback from past camps included comments such as these from the end of camp surveys.

> "Some lessons were difficult due to lack of prior knowledge on the topic"

> "I think you need to change the lectures based on the age level of the group. Because the majority of my group took chemistry, some of the material was review"

To combat this, topics that would be considered "review" were always paired with an interactive activity to encourage engagement and discussion from the students who have already seen the topic while still teaching the important information to those who have not.

Transfer of Learning Implementation

Our approach to improving comprehension through transfer of learning was realized in three major ways throughout the week. One way was the design project, which will be covered in more detail in the following section. The second was through small lectures before hands-on activities. PollEverywhere was utilized in these lectures to promote discussion and analysis of the information during the lectures instead of passively listening. These questions were designed to engage in near transfer, since they occur during lecture and give the students a chance to apply newly learned information in that same situation it was learned[16]. Figure 5 gives an example of a PollEverywhere survey result. The question given to the students: Where does Fracture Fit in the Materials Science Tetrahedron? According to the schematic in Figure 4, fracture fit under both structure and properties, which were the number one and three answers the girls provided. Polls like this allowed students' to see each other's answers and come to conclusions about the information for each activity as a group.

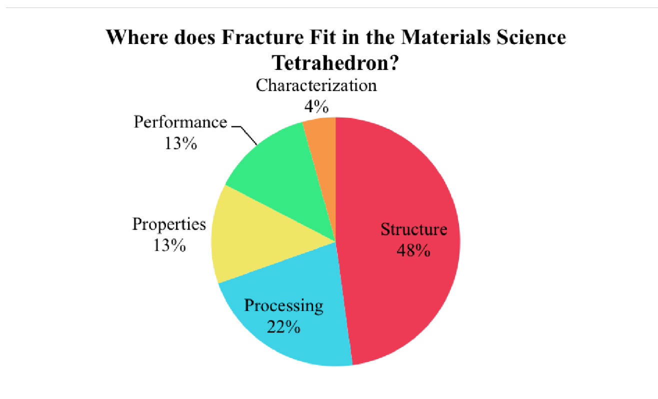


Figure 5: Polleverywhere Responses Regarding The Unit's Place Within The Tetrahedron For The Fracture Unit

The third was through lab handouts. Figure 6 shows an example lab handout. Three major changes were made to promote synthesis of ideas throughout the activity: lab comprehension goals, pre-lab questions, and concept checks. The lab comprehension goals allow students to identify what they should be learning during the lab, giving them context for self-orientation. The pre-lab questions give the students a chance to go through the transfer of learning process by connecting information from the lecture before the activity and what they already know in order to fully comprehend the activity. The concept check further encouraged this synthesis by requiring the students to answer a short question before receiving the final piece of equipment to complete the lab experiment. These questions push the students towards far transfer, since the situational context is changing and forcing the students to apply knowledge to a more complex set of questions[16].

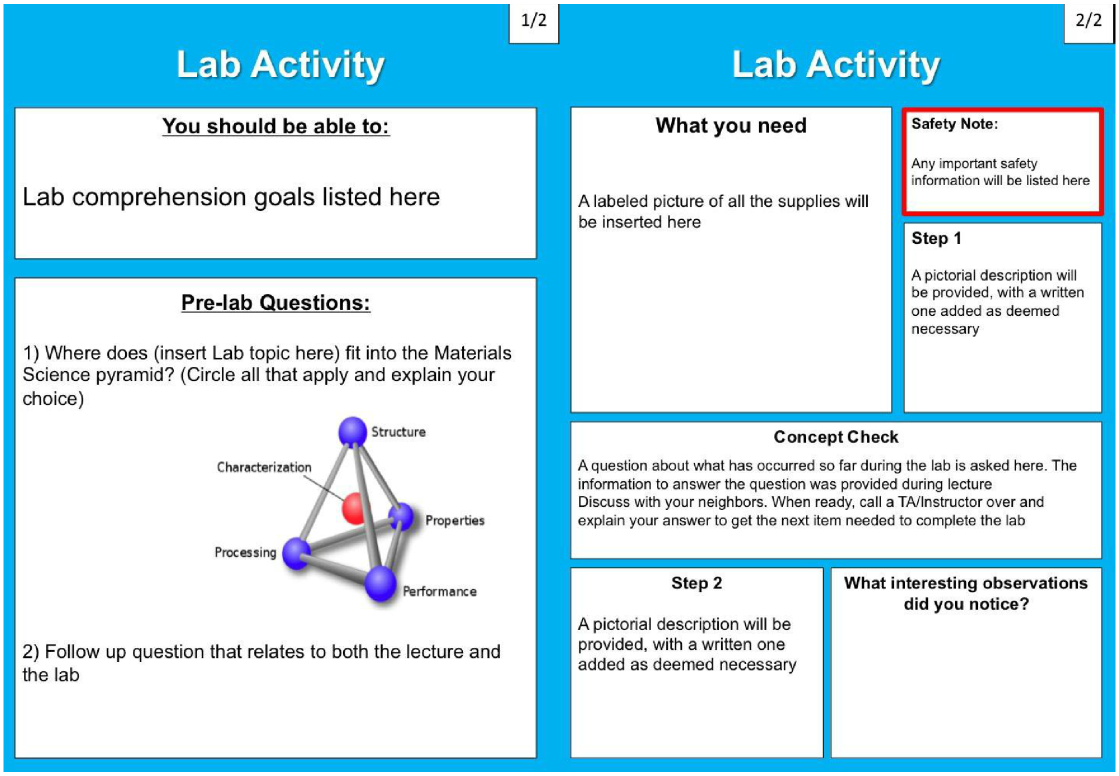


Figure 6: Example Lab Handout

Design Project Implementation

In order for a problem to truly be open ended design, it must follow an innoduction (often called design abduction[19]) way of thinking. According to Roozenburg and Eekels, innoduction is the process of determining a product's final form from a proposed function[20]. This means that a true design problem only provides the final function or application of what is being designed and it is the designer's job to determine both the form of the object and the way it is used or actualized at the same time[20]. Design generally follows five different activities as well. The activities are formulation, representation, moves, evaluation, and management[19]. Formulation is the process of identifying the issues of the problem. Representation is visualizing the problem and solutions in some manner (often sketches). Moves refer to the different design steps taken during the problem solving process. Design solutions are almost constantly evaluated throughout the process to ensure that the end product is meeting the initial requirements. Finally, management alludes to having to balance problem solving with creativity and learning throughout the design process[19].

Our design project needed to follow innoductive thinking while allowing students to synthesis what they have learned during the week (the materials science tetrahedron) with their existing materials understanding. To do this, we gave them the task of creating a new application for a material they would be familiar with already. Campers were split into four groups and assigned one of the following materials: cardboard, plastic wrap, aluminum foil, and duct tape. Each group was required to design this new product while addressing each pillar of the materials science tetrahedron. By including the tetrahedron and the common materials, we felt that the design problem was conducive for learning transfer.

Due to time constraints, our campers are not able to rigorously go through the design process (for example, there is little time for iterations of design choices). Despite these challenges, we designed each day's activities so as to have the students go through the process once in its entirety. This was made easier by the fairly open-ended problem statement; by giving the students less constraints within the problem, they were able to go through the process more quickly. The detailed breakdown of how we guide them through the design process and how each day's activity was connected is provided in Table 1. The coordinators and lab TAs acted as consultants: promoting discussion and asking probing questions throughout the week to help the students through difficult portions of the design project. At the end of the week, a final prototype of the new application, along with a poster, would be presented in front of professors and graduate students from the Materials Science department at UIUC.

Table 1: Design Project Breakdown by Day

Day	Activity	Deliverables	Prompt for the Next Day	Design Activity Connection[19]
1	Brainstorming	Basic information on material	Choose which properties you need to test tomorrow based on today's findings	Formulation, Management
2	Testing Properties	Basic material properties	Take detailed notes of today's experiments for tomorrow	Formulation, Evaluation, Representing
3	Data Organization Application Brainstorming	Prototype idea Organized data for poster	Sketch out prototype and come up with materials list	Formulating, Representation, Moves, Evaluation, Management
4	Prototyping	Build majority of prototype	Organize and begin making poster	Representation, Evaluation, Moves
5	Assembly and Poster Judging	Finish and present poster to faculty	N/A	Representation, Evaluation

As for using this activity for improved understanding, the design project as a whole operates more in the figural and far transfer of learning spaces from Figure 1. The open-ended and complex nature of a design problem lends itself more readily to this higher level learning transfer, giving students the chance to become closer to expert level performance when understanding is achieved [16].

Research Methods

In order to study the efficacy of these changes, a variety of survey methods were implemented. One was a small Likert scale survey at the end of each activity (lecture and lab). These surveys asked students to rate four topics on a scale from 1-5 (one being low, 5 being high): creativity of the activity, overall opinion of the activity, connection between activity and materials science as a whole, and how fun the students found the activity. In our surveys, creativity of the activity refers to how creative the campers felt they were allowed to be during the activity, not how creative the activity itself was. The main purpose of these surveys was to give immediate commentary on the activity while it was still fresh in the girl's memory. That way, the responses are more accurate. Note that in all of these surveys, results are self-reported. In the future, we plan to add further metrics to support claims made by these surveys.

The GAMES camp collects data from the camp as well. Data from the broader GAMES surveys from 2013-2016 are available, as well as the campers who applied to engineering at UIUC for the 2017-2018 school year.

Results

Likert Survey Results
Figure 6 shows the summary of all the Likert surveys given at the end of each activity. The figure includes data from the intro lecture, design project, and all 14 modules. The key piece of evidence from these surveys is the campers understanding of the connection between the activities and the materials science tetrahedron, or the transfer of learning that occurred during the camp as a whole. Overall module opinion and creativity are crucial in designing the different modules to ensure that the students are finding them engaging and interactive. In our results, we consider a 4 or a 5 a positive response.

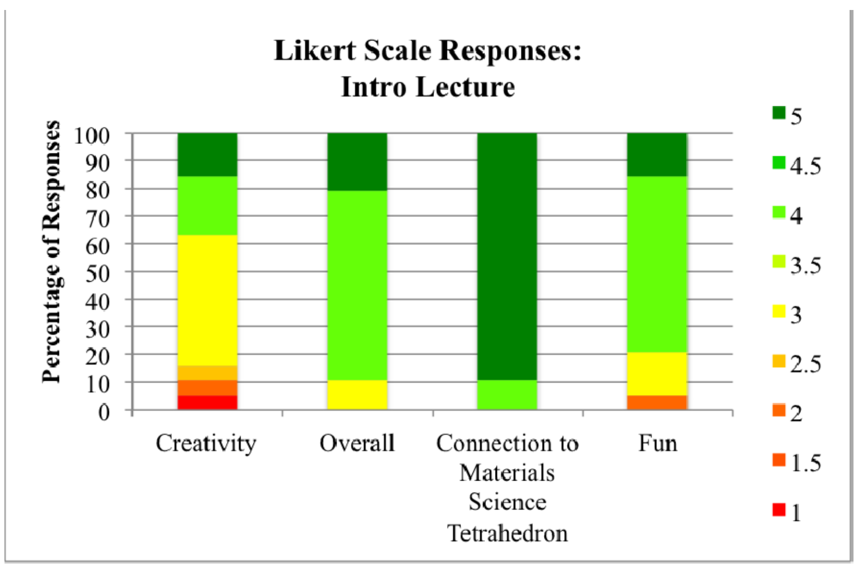


Figure 7: Summary of All Likert Survey Responses for Camp

From Figure 7, it is clear that the campers were able to make connections between each module and the materials science tetrahedron. Over 98% of responses were either a 4 or a 5. Enjoyment and general opinion of the camp were also high (>90%). Creativity was lower, most likely due to the intro lecture and other laboratory activities that did not allow for much choice from the camper due to the nature of the experiment. Overall, these results show that the comprehension of materials science, over all activities, was achieved via our transfer of learning methods.

Looking at the individual module responses gives a more detailed look into how well the girls comprehended each module, as well as how much they enjoyed it.

Figure 8 shows the Likert responses for the Design project module. Based on the surveys, this module was very well received. 100% of girls saw how the activity connected back to materials science and it also got high marks overall and for personal enjoyment. The lower responses for the creativity question were a surprise, since the students had complete control over what application they chose for their material, as well as a lot of creativity in designing poster presentations and the materials property tests on Day 2. It is possible that some students had less input in their groups due to various group dynamics, which could affect this metric. More close attention should be paid during the various activities to ensure every girl has her voice heard. Overall, the design project has been a positive addition to the camp, both for increasing comprehension as well as increasing camper enjoyment.

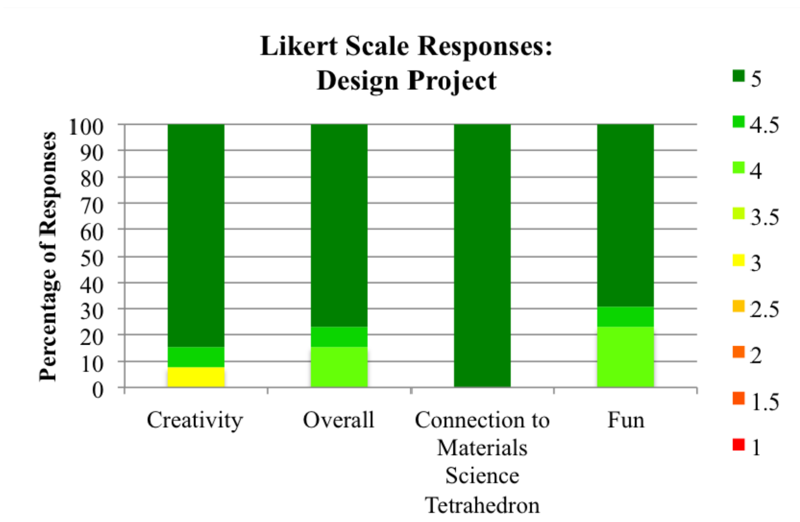
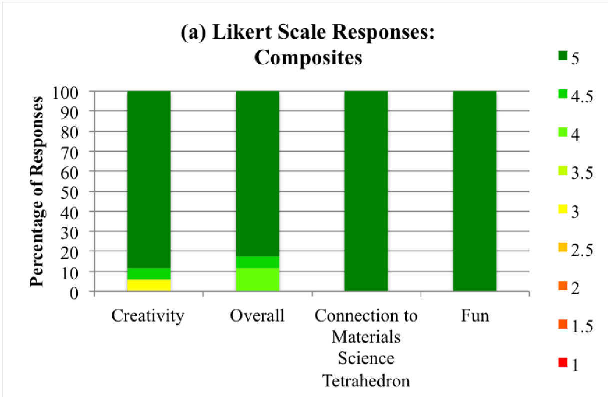


Figure 8: Design Likert Responses

One area of concern that was highlighted by these surveys was the difference between understanding that the module fits within the materials science tetrahedron in some aspect and actually having the girls understand the connection scheme highlighted in Figure 4. Figures 9a and 9b highlight this issue in one specific module: composites.



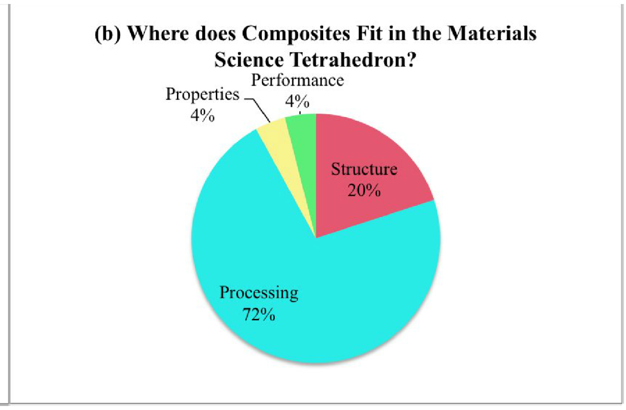


Figure 9: Connection to Materials Science Breakdown
Figure 9a: Likert Scale Responses for Composites Module
Figure 9b: Camper Responses to Composites Tetrahedron Breakdown

Figure 4 shows that the composites module should highlight all aspects of materials science evenly. If one only looks at Figure 9, it would seem that the campers had a complete understanding of where the module fits within the materials science tetrahedron. But upon closer look (Figure 9b), it shows that the students most closely associated this activity with the processing pillar of the tetrahedron. While the main goal of showing that the activity connects back to materials science was achieved, our implementation was less effective in communicating the specifics of *how* the activity was connected to the tetrahedron. Future work to ensure that the information in the lectures and labs more closely depicts the organization in Figure 4 is needed.

GAMES Survey Results
The large surveys conducted at the end of the GAMES camps ask a series of questions to all the campers who attend GAMES both about engineering as a whole and the contents of GLAM in particular. The results for GLAM specially can be seen below.

Figure 10 shows the campers general interest in engineering as whole at the end of the week. Only 5% of campers were still unsure about engineering, while 95% had positive interest in engineering.

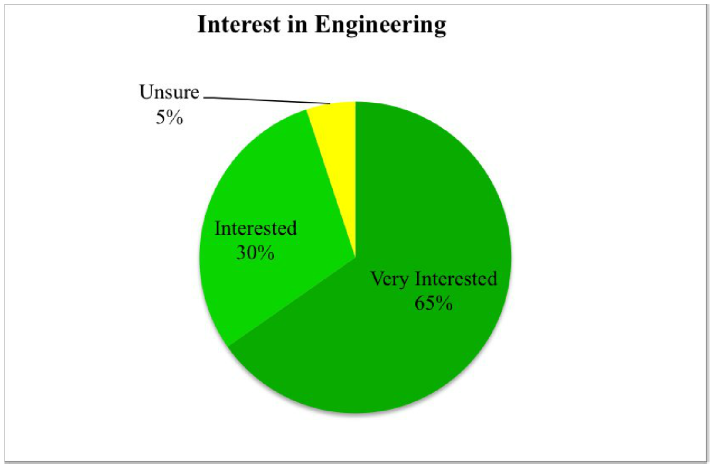


Figure 10: GLAM 2016 Campers Interest in Engineering at the End of Camp

When asked if they wanted to be an engineer when they grew up (Figure 11), all of the campers gave a positive response.

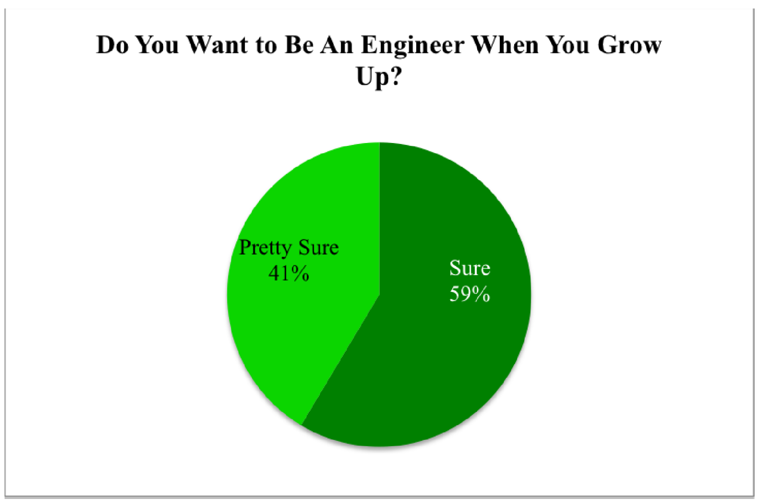


Figure 11: GLAM 2016 Campers Response to the Query "Do You Want to Be an Engineer When You Grow Up?"

The responses from both Figure 10 and 11 suggest that campers left with a positive impression of engineering. The fact that all of the campers wanted to become engineers when they grow up shows they feel as if they belong in engineering. As mentioned earlier in the paper, the majority of these girls self selected to attend these camps. Next year, pre-surveys will be given to give a clearer picture of how many girls' opinions of engineering improved over the course of the camp.

Figure 12 shows the campers responses when asked about the difficulty of the different lessons taught during GLAM. Overall, the campers found the lessons to be at the correct level and did not seem overwhelmed.

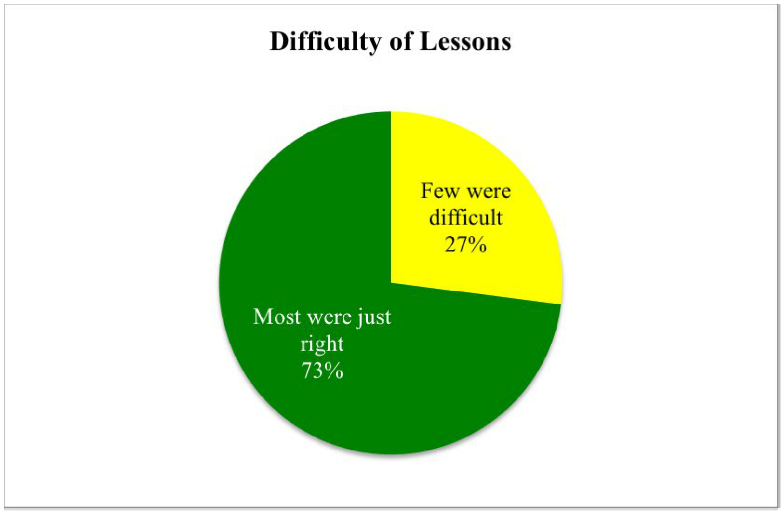


Figure 12: GLAM 2016 Lesson Difficulty

But when asked short answer questions about the difficulty, they had the following responses:

> "Some of the lessons were very difficult to follow and I feel that we did not spend enough time going over the very basics of materials, as I did not know much about them when I came to camp."
>
> "Many of the lessons for me were just very complex. They didn't apply to what we would actually need to know in the lab very much."
>
> "Some lessons I felt were taught too fast or too sparsely, and didn't allow me time to process things before we moved on to the next lessons."

Clearly there is some disconnect between the survey responses and the students' individual responses. Despite the overall enjoyment of the activities and the comprehension of where the activities fit within the materials science tetrahedron, there is still some confusion within the lessons, as well as a disconnect between the lectures and labs that needs to be addressed.

Limitations

While the results collected for GLAM 2016 told us many things about how effective our changes were to understanding connections between the labs and the pillars of materials science, there were some limitations with our various survey methodologies.

One limitation is in the GAMES surveys. The short answer responses we have access to have been designed to answer questions for the GAMES camps as a whole, so they are not specific to our camp. The students are also not asked their opinions of engineering at the beginning of camp in comparison to the end of camp. Next year, we hope to conduct interviews that ask more probing questions about the design project and materials science tetrahedron, as well as conduct longer pre and post surveys to get comparison of the girls' sense of belonging in engineering throughout the week.

Another limitation is our sample size. The camp has a maximum of 20 campers, so we already have a small sample size and cannot make any comment on statistical significance. That, combined with the fact that previous years of GLAM did not conduct camp-specific surveys, means we do not have a lot for comparison. The plan is to continue to gather data longitudinally (across the next few years) as well as laterally (amongst other department's camps) so changes in our camp's structure can be more effectively studied. Additionally, the self-reported nature of our surveys may not give us a true glimpse into their understanding. We plan to administer different metrics next year to bridge that particular gap.

Our final limitation is the lack of data regarding how many of the past campers end up in engineering fields, specifically materials science. One camper from 2013 has since joined the materials science department at UIUC and has worked as a TA for the past two years of camp. We also know that two out of nine seniors from GLAM 2016 applied to engineering at UIUC, but that is the extent of our knowledge as to where the campers go after camp. To truly understand the impact of GLAM over many years, keeping in touch with campers after they leave is beneficial. Plans are in motion to start tracking the campers post camp.

Future plans

We have two major goals for GLAM 2017 based on the results from our surveys from 2016.

One is reaffirming the connection between the pillars of the tetrahedron and the activities themselves. The campers understand that the activities are somehow related, but the actual relationship is tenuous. This will be addressed through carefully tailoring lectures and discussions throughout the week.

Second is focusing on our simulation activities. Simulations are a large part of materials science; they allow for us to visualize things we cannot otherwise see. In the past, campers have expressed interest in computer programing, but had no idea that programming existed in engineering fields outside of computer science. This past year we implemented two different simulation activities (see Figure 3). The Likert scale responses for the simulation and experimental labs for the fracture module can be seen in Figure 13.

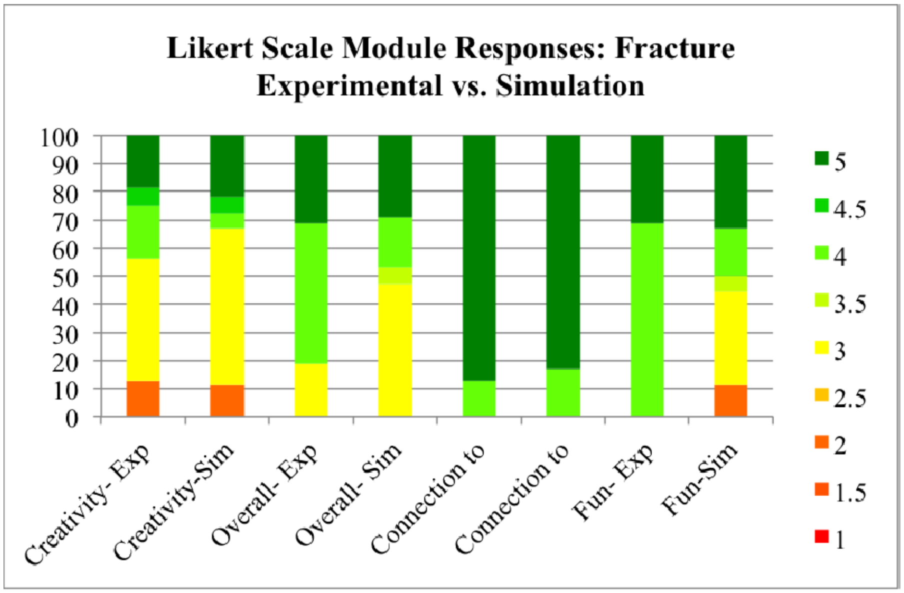


Figure 13: Likert Scale Responses for Fracture Module Labs: Experimental vs. Simulation

The simulation activity clearly has lower marks in all categories than the experimental lab, even though both of them revolved around the same topic and were complementary to each other. Using these results, we can focus on improving these activities to properly highlight the connection between simulation and experiment in materials science. Another benefit of improving the simulation activities is giving the students a positive association with coding and computational tools. Computer science is another field that women can feel a lack of belonging within; exposing girls to this topic at a younger age can help increase their confidence in this area.

Conclusions

In conclusion, we have shown how adding an overarching paradigm and design thinking to a materials science camp for high school girls improves transfer of learning and self-reported understanding of this multifaceted discipline. With understanding comes confidence in the campers' abilities as engineers, thus increasing the chances of the girls entering an engineering field in college and beyond through an improved sense of belonging. This summer camp structure (small modules with an overarching theme and design project) can be used for a variety of disciplines. It has the advantage of appealing to a wide audience with the many topics covered while giving the campers a chance to explore the field through design thinking. In the future, we hope to further study this camp and its ability to positively influence girls' opinions of engineering. Continued improvements of the technical topics covered, such as simulation, will also be addressed with the hopes that this improved understanding will continue to improves students' confidence as engineers. It is the authors' hope that in time, camps such as this one can help close the gender gap.

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