EFFECTS OF FORMAL ENGINEERING EDUCATION ON ELEMENTARY STUDENTS’ PERSPECTIVES

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ABSTRACT

As STEM (Science–Technology–Engineering–Mathematics) becomes an increasingly prominent subject in current education, questions are rising about how to best incorporate these subjects into classrooms and also about how students engage in the material. As a student teacher from Lorax University at Truffula Elementary School, I was given the opportunity to plan and introduce a formal engineering unit for the first time to a group of 5th graders. Through pre- and post-surveys, observations, data from student work, and conversations I held with individual students, I analyzed how student perceptions of engineering shifted as they engaged in formal instruction on the subject. I also analyzed broadly student enjoyment of the subject in order to draw conclusions about the benefits students receive from engaging in a formal engineering unit in elementary school.
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- My 5th grade students and their families
Chapter 1

Introduction

Upon entering my student teaching placement at Truffula Elementary School\(^1\), I found myself faced with the opportunity to teach an engineering unit to my 5th grade students. I have always been very passionate about science, and in particular environmental education. I was incredibly excited to know that my students would be learning about water quality and ecology. When I heard about the engineering unit and that it would be tied to an investigation on the potential effects of a controversial building project on local land, I became intrigued.

Engineering is a subject that I rarely learned about in grade school, and when I explained to other people what my 5th graders were learning, they were shocked that we were going to present 10 year-olds with what they considered to be very advanced material.

This lead me to wonder if the 5th graders themselves believed engineering to be a complicated and advanced subject, or what they thought about engineering in general. Then, how would their thoughts change once they had formally learned about the field in their class?

This question also coincided with a larger research project that my professor, Mary Barbaloot\(^2\), was completing. Her big question pertains to how engineering education is taught in relation to other science units, and it seemed reasonable that a piece of this larger question would be the perceptions and thoughts of the students partaking in the unit.

\(^1\) Truffula Elementary School is a pseudonym for the school where this study took place. It will be used for the duration of this paper.

\(^2\) Mary Barbaloot is a pseudonym for my professor. It will be used for the duration of this paper.
Wonderings

After being introduced to the engineering unit that I would be helping to teach in my classroom and to the research work being done by Mary Barbaloot at Lorax University3, I found myself with a few questions that would guide my research. My main wondering was, How does participating in a formal engineering education unit affect the way students perceive engineering? I know that it is a word students hear and that it has certain connotations with it, so I wondered how learning about engineering formally in school could affect their thoughts and opinions about the field.

From this major wondering, I developed four sub-questions that I believed would help me to determine an answer for the larger question. They were:

1. How does participating in a formal engineering unit affect the way students understand technology?
2. How does participating in a formal engineering unit affect the way students understand engineering?
3. Do students recognize that engineering connects to other subjects?
4. Do students enjoy learning about engineering?

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3 Lorax University is a pseudonym for my university. It will be used for the duration of this paper.
Chapter 2
Review of Relevant Literature

Engineering has long been considered a field that a person could enter primarily only as they approached a collegiate level and moved onward. People formally learned physics, chemistry, environmental sciences, and biology from early childhood, but engineering was seemingly saved for formal instruction until a person had passed through years of schooling. This however, is an idea that is currently being shifted as STEM education becomes more frequently considered in elementary settings.

As the idea of K-12 STEM Education (Science–Technology–Engineering–Math) has become more and more prevalent, questions of how teachers can best integrate those subjects into their classrooms are being raised (Brown, 2011). In asking these questions, it becomes increasingly important to define exactly what STEM means. While yes, in the literal sense this refers to the science, technology, engineering, and math subject fields, researchers believe that even more specificity is required. According to Rodger Bybee (2010), the focus rests in “[increasing] students’ understandings of how things work and [improving] their use of technologies” (p.1). By this Bybee means that incorporating STEM into a curriculum is more extensive than simply teaching students about technology. It is about helping students to further their understanding of the world around them. In an appendix of the Next Generation Science Standards (NGSS), this idea is furthered by explaining that engineering education in particular is more than just teaching students about electronics. Instead, it defines engineering as “any
engagement in systematic practice of design to achieve solutions to particular problems,” and that teachers should therefore focus on giving their students tools to recognize and think critically to find solutions to the world’s problems (Achieve and Lead States, p.1).

Hsu, Purzer, and Cardella (2011) explore the fact that elementary teachers in particular have a difficult time finding effective ways to incorporate a STEM education into their classroom due to the wide variety of subject matter they are responsible for teaching. Whereas many members of technology and engineering fields have fully embraced the concept of including STEM instruction, the teachers who are tasked with executing that incorporation are often unclear of how they can best do that (Brown, 2011). These issues have begun to be addressed in such ways as the introduction of the NGSS, which were established in 2013, and for the first time offer explicit standards and concrete objectives to assist in guiding educators in teaching engineering to young students (Achieve and Lead States). Similarly, curricula such as *Engineering is Elementary!* have been created and proven through research to help students grasp the engineering concepts outlined by the NGSS (Lachapelle, 2007).

In addition to the benefits that come from teaching engineering in elementary school, such as better understanding of the world and increased problem solving skills, engineering curricula have also been found to reach students who may have otherwise not had an interest in the sciences. The National Research Council (National Research Council) released a *Framework for K-12 Science Education* in 2012, which served as the foundation for the subsequent NGSS. The *Framework* asserts that “in many ways, children are natural engineers” (National Research Council, p.2). This is in reference to the fact that from a young age, children will naturally build and test things, both for their own enjoyment and to help solve problems that they may face. Because of this, many students are inherently drawn towards the desire and interest to engage in
engineering activities. Additionally, the NGSS appendix explains that engineering also introduces students to a type of science that directly enhances their lives. Whereas a student may have trouble understanding how balancing chemical equations affects them, engineering education equips students with knowledge and tools to improve their world (Achieve and Lead States).

As focus and attention grows on STEM education, researchers and educators are becoming more curious about how to best implement STEM practices and what results come from such implementation. This study looks specifically at how young students respond to formal engineering education, particularly in terms of their understandings about engineering and technology.
Chapter 3

Methods

In order to contextualize my data and resulting findings, in the following sections I outline the setting of my student teaching experience where data collection occurred. I outline the demographics of the school district, the makeup and procedures of my specific classroom, and the two curriculum units where the bulk of the data collection occurred. I also describe the various methods by which data were collected. Data were collected to support the large research question of How does participating in a formal engineering unit affect the way students perceive engineering? as well as the following four sub-questions:

1. How does participating in a formal engineering unit affect the way students understand technology?

2. How does participating in a formal engineering unit affect the way students understand engineering?

3. Do students recognize that engineering connects to other subjects?

4. Do students enjoy learning about engineering?
Teaching Context

The research for this study was done in Truffula Elementary School in a 5th grade classroom during the fall semester of the 2015-2016 school year. The school is situated just a few miles from the main campus of a major university, Lorax University, which creates a unique environment that often feels like a small town and large town all rolled up in one place. The Thneedville Area School District is made up of eight elementary schools, including Truffula Elementary School. According to data obtained by the Office of Civil Rights, the school itself has a total of 491 students, the majority of whom are white (82.1%). The school includes Kindergarten through 5th grade, and is a school that has a Title 1 classification. The building is relatively new, having been opened in 2005, but the previous building was in the same location with the same name for many years prior. Some things that are quite unique and notable about this elementary school are the community and the environmental initiatives it takes.

The emphasis on community is evident throughout the school based on both what is physically present and the way that the school operates. When a person walks into the building, they are immediately greeted by big yellow signs that read “Are You Sure?” These signs are a reminder to all students that they are responsible for their actions and that what they do affects the other people that are in the building. Classrooms are filled with small signs and posters that remind students about positivity, helping others, being kind, trying your best, being truthful and trustworthy, and working together. A sign hangs outside the bathrooms in the upper intermediate hallway that reads, “Have positive energy Truffula Elementary” with a hand drawn smiley face.

The school also holds monthly All School Gatherings and Small School Gatherings. At these 1

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4 Thneedville Area School District is a pseudonym for the district where this study took place. It will be used for the duration of this paper.
hour sessions, students share mini-presentations on citizenship focuses such as respect and gratefulness, and students also acknowledge one another for excellent work and citizenship throughout the month.

In addition to these community efforts, the school clearly shows their emphasis on environmental citizenship. Aside from the big yellow signs above major hallways, visitors and attendees of the school are greeted every morning with a tree in a pot that lives in the center of the opening hallway. As someone ascends the stairs, they are also greeted with murals depicting plants and animals. The school heavily focuses on recycling, with two major recycling areas around the staircase and multiple bins for recycling in every classroom. The school is participating in a zero waste initiative that began back in 2012. As a result, the school now not only follows traditional recycling plans for items like plastic bottles and paper, but now strives to repurpose or recycle as many different materials as possible. They even utilize the services of the TerraCycle program, which takes difficult-to-recycle items (e.g., chip bags, Capri Sun pouches, writing instruments, and Scotch Tape dispensers and cores) and repurposes them into new products.

The specific classroom within Truffula Elementary School being studied consisted of 24 students, two of whom received services from the special education department and had aids with them for the majority of the day. There were 12 boys and 12 girls in the class, and the vast majority of the students were white. One was African American, one was Indian, and another was Hispanic. The classroom environment was one that created a sense of comfort, community, and personal responsibility.

When a student first walked into the classroom, they were greeted by a futon covered in a bright orange sheet, a lime green satellite chair, and a blue exercise ball. These pieces of
furniture were exemplary of the fact that my mentor teacher, Julie Swomee\textsuperscript{5}, wanted her students to be comfortable in her room. Students had the option to sit wherever they felt comfortable, as long as they could still complete their work. This system changed a little bit during the school year, as the students in the room were unable to handle the freedom of seat choice with appropriate behaviors, so assigned seats were created for them. However, student names were chosen out of a jar every morning to determine who would get to sit on the futon, the satellite chair, and the exercise ball (three of the most coveted seating locations). The classroom was also equipped with several rolling desk chairs, a few of which students were allowed to sit on at their assigned seats. The students were most frequently seated at one of four colored horseshoe shaped tables. These tables were angled so that all students could see the board easily at the front of the classroom, and they allowed for discussion and collaboration among peers. This was especially important, as the students frequently engaged in group projects and conversations.

The class’s daily schedule was relatively consistent throughout the week, with minor changes across the days. Each morning started with students entering the room and taking responsibility to complete tasks written on a “To Do” list. This was something that Julie gradually worked the students towards, having started the year giving them specific tasks to do each morning, in an effort to help students be accountable for their own work. They could work on items in any order at any pace, so long as the work was completed by the due date. Students would often work in pairs or small groups when appropriate, such as on their Daily Geography workbook. The morning then moved into either science or social studies. The year began primarily with social studies, where students discussed rights, responsibilities, and the origins of America. However, since the introduction of \textit{Engineering is Elementary!} (EiE), that morning slot

\textsuperscript{5} Julie Swomee is a pseudonym for my mentor teacher. It will be used for the duration of this paper.
was primarily dedicated to science. Science lessons typically consisted of some type of investigation or activity centered on the theme of water quality and environmental science. Activities were completed in consistent groups, which students had been in since the beginning of EiE.

After science, students shuffled around in the three 5th grade classrooms for math. Each class was decided primarily on a student’s working pace (not their ability), and were determined through use of a pre-survey at the beginning of every unit. Occasionally students would shift to different classes for different units. In Julie’s classroom, math was primarily independent work in their student work books, though many classes began with a whole group mini-lesson. This structure was in place to allow students to work at their own pace. The math class consisted of a wide range of ability that made it difficult to differentiate whole group instruction for each student. Students worked independently, then checked their answers with a partner. If students found discrepancies in their work they were each to redo the problem entirely, and only then if they still were having trouble were they to ask a teacher. This was also meant to foster responsibility and accountability. However, Jen always made herself available for students who needed assistance with their workbooks.

Students then went to specials (e.g., music, art, P.E., or library), came back to watch Student CNN News, had lunch, and went to recess. The afternoon was almost always filled with another block of science, usually completing activities from the morning. Julie focused very heavily on science and social studies, so the two substantial blocks a day of science and/or social studies was somewhat different from the other two 5th grade classrooms. The day then either ended there with science, or included a block of language arts (reading and writing). The majority of the day was filled with group and collaborative work, though students sometimes
would work independently. Subject blocks also tended to include a great deal of classroom
discussion around various topics.

<table>
<thead>
<tr>
<th>Time</th>
<th>Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:30-8:45</td>
<td>Morning Work</td>
</tr>
<tr>
<td>8:50-9:30</td>
<td>Science/Social Studies</td>
</tr>
<tr>
<td>9:30-10:30</td>
<td>Math</td>
</tr>
<tr>
<td>10:35-11:15</td>
<td>Special</td>
</tr>
<tr>
<td>11:20-11:35</td>
<td>Student CNN News</td>
</tr>
<tr>
<td>11:40-12:10</td>
<td>Lunch</td>
</tr>
<tr>
<td>12:15-12:45</td>
<td>Recess</td>
</tr>
<tr>
<td>12:45-1:00</td>
<td>Word Study</td>
</tr>
<tr>
<td>1:00-1:50</td>
<td>Science/Social Studies</td>
</tr>
</tbody>
</table>

Finally, it is important to note that this thesis was being completed and written under the
umbrella of a larger research project being run by Lorax University Assistant Professor of
Science Education, Dr. Mary Barbaloot. Her larger project was centered around five 5th grade
teachers in the district who are implementing the EiE curriculum and how they work
with/view/integrate engineering into their science teaching. Julie was one of the five teachers in
her study. This research project is titled “Investigating Elementary Science & Engineering
Curriculum Materials – Does Sequence of Instruction Make a Difference?” and specifically
examines the question of whether or not there is an effect due to the sequence in which the
engineering unit is taught in relation to the larger environmental sciences unit which will be
outlined in the following paragraphs. This project received IRB approval (STUDY00003428). The informed consent form is included in this paper as Appendix A.

This research study took place while the students in Julie Swomee’s 5th grade classroom explored two specific units, the first being a unit from the program *Engineering is Elementary!* (EiE) called *Water, Water Everywhere: Designing Water Filters* and another being a somewhat modified unit of the *Project-Based Inquiry Science* (PBIS) program called *Living Together*. The classroom frequently discusses and works in science, which is closely integrated into social studies, but these two programs framed the inquiries and discussions for the overarching unit on environmental education.

*Engineering is Elementary!*

The first curriculum used was from *Engineering is Elementary!* (EiE), more specifically a sub-unit titled *Water, Water Everywhere: Designing Water Filters*. This unit consisted of a pre-lesson devoted to helping students uncover the actual meanings behind “technology” and “engineering,” and four lessons that introduced students to the engineering design process and walked them through it in a scaffolded fashion.

The pre-lesson tries to debunk the misconception that technology is only defined by wires and electricity. Instead, students discovered that technology is simply any invention that makes life easier for people and solves a problem, ranging from iPhones to toothbrushes. Students also learn that engineers are the people behind the designs of these inventions.

The remaining four lessons of the EiE unit are based around a short book included in the unit titled *Saving Salila’s Turtle*. The story centers around a young girl living in India who one
day finds a small turtle among the oily, polluted water of the Ganges River. Alarmed by the conditions which the turtle was living in, she brought the turtle home, and with extensive research and testing, created a water filter so that she could take polluted water from the Ganges, clean it, and have the turtle live in a tank with the filtered water. The four main lessons took place over four days.

The first lesson involved reading *Saving Salila’s Turtle* out loud. While reading, students were prompted to fill out a chart with types of pollution mentioned in the story, what the source of that pollution might be, and an imagined solution to that pollution. After reading the story, students then worked in their assigned groups for the unit (5 groups of 4-5 students), and track how Salila completed each of the steps of the engineering design process (ask, imagine, plan, create, and improve).

The second lesson focused on contaminants and their sources. Special emphasis was placed on the fact that containments can be man-made, as many of the students thought initially by supplying things like gasoline and soap as examples of contaminants, but that they can also be natural. I explained to the students that things like soil, animal waste, and bacteria can also contaminate water, as they are still things that we as people would not want in our water sources. The students were then given panels of a drawn mural from the unit and asked to circle different sources of contamination. Many groups easily recognized cars and factories as sources, but had to be pushed to recognize some of the natural sources of contamination. Students then put on their engineering hats and brainstormed potential solutions for one of the contamination sources in their picture.

The third lesson prompted students to turn from thinking like engineers to begin acting like engineers. The culminating lesson (Lesson 4) would ask students to design, create, and test
their own water filters, but first students needed to go through the part of the planning process, which is to test filter materials. Each group was given a 2-litre bottle filled with one type of contaminated water (one group received a bottle with water and cornstarch, two were given water and soil, and two were given water and loose tea). Each group then constructed a filter holder from half of a clear, plastic 1-liter bottle (Figure 1) and proceeded to individually test wire screens, paper coffee filters, and a sand/gravel mixture to filter their contaminated water. Groups timed how long it took for ¼ cup of water to filter through, and used this plus observation to describe their filtered water based on three criteria: time to filter, color, and number of particles.

The last lesson requires students to synthesize all of the knowledge and experience they gained in the previous four lessons. Based on their data from the previous lesson on how materials served as filters, students designed their own water filters. Students first designed independently, then with their group decided on a final design. These filters were tested on the same three criteria from lesson three (color, time, particle removal), but students were also
introduced to the criterion of cost. Each filter material was assigned a cost value and students were challenged to keep their design under $10. Each group built, tested, and collected data on their filters, then moved to improve them in an effort to improve at least one of the criteria. Most groups ended up trying at least three different versions of their filters.

*Project-Based Inquiry Science and Ferguson Township*

Throughout the EiE unit, students were given a few small introductions into the next unit, which began officially and in full force after the completion of engineering. The next unit came from the *Project-Based Inquiry Science* curriculum and was titled *Living Together*. This unit was easily one of the most unique learning experiences that occurred in Julie Swomee’s classroom. This was only the second year it had been used in the 5th grade classrooms of the Thneedville Area School District, and this year it was enacted with a few alterations to the written curriculum materials.

The unit, as it is straight from the book, focuses on questions of water quality, ecology, and the effects of such things on communities. To help students engage in the material, a fictional, struggling farming town called Wamego is introduced, and the town is facing a decision of whether or not they should allow a company (FabCo) to move in and build a factory. The concerns and benefits for the stakeholders involved are numerous and compelling. Throughout the unit, students engage in different investigations that help them understand water quality, movement of water, water filtration, and how all of these factors can affect a community. Their ultimate goal is to provide a recommendation to the town of Wamego about whether or not
the town should allow FabCo to move in, and these recommendations are to be based on evidence from the investigations.

The thing that is especially interesting about this unit being taught in the studied classroom (and a few others throughout the Thneedville Area School District) is that the story of Wamego has been left out to instead include an actual situation occurring locally in Onceler Township\textsuperscript{6}. This township is very close to Truffula Elementary School, and some of the students actually live there. Within the last year, proposals have been made by the major development company, the Toll Brothers, to take a piece of land in Onceler Township and develop it by building brand new apartment complexes (intended to be student housing for Lorax University). Major concerns surround this development proposal, including the proximity of the land to well heads and potential for polluting the water table. Just as it is straight from the printed materials, students were asked at the end of the unit to create a recommendation to present to the Ferguson Township board. Students were scaffolded into this recommendation making by Jen emphasizing students writing claims with strong, objective evidence and reasoning based on investigations. This change was made in a hope to integrate science and social studies together, and present them in a way that is real and meaningful to the students.

\textbf{Data Collection Methods}

Data for this research was collected in a various ways and takes various forms. The following section outlines the methods used.

\textsuperscript{6} Onceler Township is a pseudonym. It will be used for the duration of this paper.
Before the start of the engineering unit, the students in the classroom were given a survey on technology and engineering. This survey was created by the *Engineering is Elementary!* team at the Museum of Science in Boston (Cunningham, Lachapelle, & Lindgren-Streicher, 2005, 2006). Students were asked to complete the survey for their morning work on the day that the unit started, which is roughly 20 minutes of work time. Copies of each page of the survey are included at the end of this paper as Appendix B.

The survey posed 82 questions of various answer formats. The first question asked students which of 10 phrases they thought described technology, and they were instructed to pick as many as they saw fit. The options were such phrases as “Must be a computer,” “Must solve a problem,” and “Must be invented by people.” The next question asked students whether or not they believed lightning to be a kind of technology, which either “Yes” or “No” as responses. Questions 3-39 listed a series of tasks which students were to decide whether or not were things that an engineer would do for his or her job. The students had to pick either “Yes” or “No” for the tasks, and the tasks varied from “Install cable television,” to “Invent warmer kinds of clothes,” to “Think about ways to clean the air.” The next section of questions, 40-60, listed a series of activities. Students had the options of “Not important,” “Sort of important,” and “Very important,” with two extra options spaced between the three, to describe how important each activity is to the work of an engineer. Listed activities included “Understanding science,” and “Telling other people what they find.” Questions 61-80 showed images of items and asked students to answer either “Yes” or “No” to whether or not the item is an example of technology. Examples of items given are sandals, a broom, a laptop, a bonnet, and an oak tree. The last two questions were open-ended and asked “What is technology?” and “What is an engineer?”
The day after the engineering unit ended, students were given a very brief survey where they had two free response questions to answer: “What is an engineer?” and “who is an engineer? How do you know this?” This survey was posed to see the immediate differences between their original answers relating to what exactly an engineer does to what they thought after completing a formal engineering unit.

Finally, near the conclusion of the PBIS unit, students were asked to complete the original 82 question survey for a second time. This was done so that a direct comparison could be drawn from the students’ original answers to their answers at the end of their major science units. The survey was given at the end of the PBIS unit instead of the end of the engineering unit to see how much information students retained, and also to see if students pulled any information from the PBIS unit to add to their definitions and ideas of engineering and technology.

Observations and Notes

While in school, I kept a notebook filled with anecdotal observations about my students and their interactions with engineering. During the unit itself I was unable to write notes, as I was teaching the majority of the time, but video footage was collected and notes were taken off of that footage. The notes take place during a variety of subjects on a variety of days. Ultimately, any time a student would mention engineering or allude to it, I would take note of the date, time, subject, brief context, and what was said.
Throughout the engineering unit and the proceeding PBIS unit, students worked frequently in their science journals. For engineering, this meant worksheets coming from the EiE curriculum pertaining to engineering design and *Saving Salila’s Turtle*, which were completed by students and then glued into their journals. For PBIS, this meant frequent note taking and claim writing. I randomly selected six student science journals to look through extensively and took photos of the EiE and PBIS work with my iPhone.

I also took a few examples from the students’ Family Journals. These are notebooks that on every Friday students must take home and write a multi-paragraph letter to their families about what they did in school that week, and their families write responses back in the same journal. I went through each student’s journals and read their entries from the week where we completed the EiE unit. I took photos of any entries where students mentioned the engineering work they had done in class. During analysis of student work, names were removed and replaced with a generic label (JC1, JC2, JC3, etc.) so that analysis could be done without bias, considering my personal relationships with the students.

Finally, I also took pictures of student work that was being done in class, such as model building for the filter activity, creating stream tables, or other experiments done in class.

**Interviews**

The final method of data collection was through brief interview. Several weeks after the conclusion of the engineering unit, and as we approached the end of the PBIS unit, I pulled a few students over to my desk. Students were selected by drawing their names randomly. The class
has a jar of popsicle sticks that are used to decide who sits on the futon, exercise ball, and satellite chair on any given day, so each stick has a student’s name written on it. I used these sticks to randomly draw names, and during morning work I called these students over to my desk. Each student that was called over was asked the same three questions: “Do you think our engineering unit relates to what we’re doing in [the PBIS unit]?,” “Have you thought about or used the things you learned in our engineering unit since we finished it?” and “What do you remember from our engineering unit?” Students then received one or two individual questions to follow up on what they had said.

Analysis Process

Data from the surveys was compiled into an Excel spreadsheet and any handwritten notes were typed into a Word Document. Data was analyzed in two different fashions. The first was to examine the data as a whole and find trends among the entire class. The second was to look at individual students (whose names had been removed from their work and were instead identified with a neutral tag such as JC1, JC2, JC3, etc.) to see if any trends existed laterally through time. The trends that were recognized amongst the entire class were then turned into the claims that will be described in detail in the Findings chapter. Observations of trends across time with individual students were used to support wider class findings.

Data from the surveys was specifically inputted into an Excel spreadsheet and analyzed numerically. Each question was recorded with the raw scores given in both the pre- and post-survey. Data was then transformed into percentages of answer per multiple choice options. For example, if a question had 5 different responses that could be bubbled in, the percentage for each
individual response was calculated. These scaled percentages were then compared between the pre- and post-survey to discover where the largest changes occurred.

Data from the two short answer questions on the survey (“What is technology?” and “What is an engineer?”) as well as observations and data from qualitative sources (such as interviews and family journal responses) were analyzed for specific ideas centering around student perceptions of what engineers are and do. Trends of change amongst specific students from pre- to post-survey were especially considered.

The mixture of quantitative survey data and qualitative observational/anecdotal/student work data allowed for a complete picture of the students and their perceptions. Numerical data showed distinct and concrete changes, while the qualitative data allowed for conclusions to be drawn about engagement level and where specific perception shifts existed in particular students.
Chapter 4

Findings

In this chapter, claims will be drawn about each of the four specific sub-questions introduced at the beginning of this paper:

1. **How does participating in a formal engineering unit affect the way students understand technology?**

2. **How does participating in a formal engineering unit affect the way students understand engineering?**

3. **Do students recognize that engineering connects to other subjects?**

4. **Do students enjoy learning about engineering?**

Each claim is supported by specific evidence from the study and explained through reasoning.

**Claim 1**

**Claim:**

Formal engineering education shifts student understanding of technology to a broader, more encompassing definition.
Evidence:

Figure 2 "Is This Item an Example of Technology?"

Table 2 Written Responses to "What is Technology?"

<table>
<thead>
<tr>
<th>Student</th>
<th>Pre-survey</th>
<th>Post-survey</th>
</tr>
</thead>
<tbody>
<tr>
<td>JC1</td>
<td>“Something that is advanced and no normal person can make.”</td>
<td>“Something that a person makes that helps other people.”</td>
</tr>
<tr>
<td>JC9</td>
<td>“Electronics or other things that involve technology.”</td>
<td>“Technology is anything that has moving parts. Technology is also supposed to make life easier or better.”</td>
</tr>
<tr>
<td>JC13</td>
<td>“Electric toys/devices.”</td>
<td>“Something that has moving parts or helps in everyday life.”</td>
</tr>
<tr>
<td>JC16</td>
<td>“A source of power used to do things by itself.”</td>
<td>“Something that makes life easier.”</td>
</tr>
</tbody>
</table>
Reasoning:

Before beginning any lessons in the EiE unit, students took the survey described in the Methods section of this paper. The start of the engineering unit began with a lesson on what defines technology. Student responses to questioning at the beginning of this lesson very much reflected the things that were shown through their survey data. Items with batteries and screens, such as MP3 players, laptops, cell phones, and even game controllers were almost unanimously identified as being examples of technology, as students displayed a tendency to make technology synonymous with electronic. This was also evident in the short answer question of “What is Technology?” Many students wrote answers that suggested wires, electronics, and machinery, such as “technology is something that has batteries like phones or something like an engine” and “technology is some sort of power source or something that uses power with cables or wires.”

After completing the lesson on technology (which focused on asking students to and the rest of the unit, students demonstrated an understanding that technology is anything that solves a problem, whether or not it runs on electricity. This is displayed in the post-survey data, where items such as bicycle, windmill, broom, and hand-held fan showed a notable jump from students saying it is not an example of technology to saying it is one. None of these items use electricity, but each of them was created to solve a distinct problem, such as transportation or being hot. In the short answer question about technology, students also often wrote about items that made life easier or solved problems. Some students however still focused on electronics and moving parts - though this second aspect is likely influenced by the multiple choice question at the beginning of the survey where “has moving parts” is listed as a potential requirement for describing technology. Despite this, there was a notable shift in perception of technology and this shift
shows that students gained a better understanding of what technology is and retained it even over a month after their formal engineering unit was completed.

Claim 2

Claim:

Formal engineering education shifts student understanding of engineering in that they recognize the role of an engineer is more to create and design as opposed to technical jobs such as building or fixing

Evidence:

![Figure 3 "Would an Engineer Do This For Their Job?"](image-url)
Table 3 Written Responses to "What is an Engineer?"

<table>
<thead>
<tr>
<th>Student</th>
<th>Pre-survey</th>
<th>Post-survey</th>
</tr>
</thead>
<tbody>
<tr>
<td>JC2</td>
<td>“An engineer is very many things. It can be a spaceman, a construction worker, or a car guy.”</td>
<td>“Someone who creates and improves things to help the public.”</td>
</tr>
<tr>
<td>JC3</td>
<td>“An engineer is someone who fixes things or kind of makes something better. Like a iPhone 4 going into an iPhone 6. Because it’s making it more modern.”</td>
<td>“A engineer invents things like a iPhone or just running shoes to solve a problem. Also a hand held fan to cool you down.”</td>
</tr>
<tr>
<td>JC9</td>
<td>“Someone who works, builds, or fixes thing.”</td>
<td>“Anyone could be a engineer at any time. You don’t need a job that says your and engineer. You just have to be using materials and you have to be fixing something. I think.”</td>
</tr>
<tr>
<td>JC10</td>
<td>“A person who does all kinds of work.”</td>
<td>“An important job for people that want to improve the world.”</td>
</tr>
<tr>
<td>JC18</td>
<td>“A person who makes technology.”</td>
<td>“A person who invents things.”</td>
</tr>
</tbody>
</table>

**Reasoning:**

In the survey given at the very beginning of the engineering unit, students often selected very technical activities as being ones that engineers would do for their jobs. These included activities such as installing cable television (82% said yes, this is something an engineer would do), fixing headlights on cars (again, 82% said yes), and running machines for doctors (77%). These activities are electronic based and do not represent the creativity and designing process that the students later learned is the key component of being an engineer. This early understanding of an engineer’s role was also displayed in discussions that occurred during the lesson defining technology. Students responded to questions about what an engineer is with responses that focused on them building or physically creating something (often something
related to electronics). These same sentiments are evident in student responses to the survey question “What is an Engineer?” In the pre-survey, responses focused heavily on physical acts such as fixing or building.

After the conclusion of the engineering unit, however, post-survey data showed a shift in understanding that engineers focus more on designing technology to improve life and solve problems. On the post-survey on the question of “Would an Engineer do this for their Job?,” less students said yes to physical labor jobs like installing cable television and fixing headlights on cars. At the same time, there was an increase in students who said yes for activities such as “develop better bubble gum” and “figure out how to package bottles so they don’t break.” The changes in percent for yes responses did not change dramatically, staying around a difference of 10-15%. There is a change, however, and the formal engineering unit only lasted for five days. A more extensive unit would likely increase the amount of change in student perception.

Claim 3

Claim

Students do not consciously recognize the connections between engineering to other subjects.
Evidence:

Figure 4 "Do You Think Our Engineering Unit Relates to What We're Doing Right Now in Science?"

Figure 5 "Have You Thought About or Used The Things You Learned in Our Engineering Unit Since We Finished It?"
**Reasoning:**

When interviewed, students were asked whether or not they thought the engineering unit related to what they were doing in science at the time (which was learning about water quality and working to understand the effects that a proposed development could have on the local water quality) and whether or not they thought about or used the things they learned in the engineering unit after finishing it. The majority of students (50% for the first question and 50% for the second) answered that they did not see a connection. The data for the yes responses is also a bit deceiving. For the first question, four of the five yes responses saw relation between the units because they were both about water. For the second question, all of the yes responses said they thought about the unit in that sometimes they reminisced about the unit, thinking about the filter activity.

These responses are partially tied to the unclear wording of the questions. The intention of the questions was to see if students found the engineering design process relevant to the work they were doing in other units or subjects. Students may not have realized it, but they were often doing work that involved the engineering design process. One example of an activity was the students having to design and build a land use model. Groups were assigned a specific land use (such as agriculture or commercial), and students then designed, built, and ran models to represent those land uses and observe how water acts in such settings.

It is important to note, however, that even if students did not consciously recognize the effect of their knowledge of the engineering process on their school work, they were faced with work in other units and subjects that asked them to call on those experiences.
Claim 4

Claim:

Students enjoy actively participating in engineering education in school.

Evidence:

Table 4 Family Journal Entries

<table>
<thead>
<tr>
<th>Student</th>
<th>Journal Entry</th>
</tr>
</thead>
<tbody>
<tr>
<td>JC3</td>
<td>“This week has been really interesting. We did things we have never done this week.”</td>
</tr>
<tr>
<td></td>
<td>“We have been having science a lot lately and it has been really fun. This week has been really fun and I can’t wait to go back to school.”</td>
</tr>
<tr>
<td>JC14</td>
<td>“This week we learned about engineering. We learned that anyone can be an engineer.”</td>
</tr>
<tr>
<td></td>
<td>“I had a lot of fun in science.”</td>
</tr>
<tr>
<td>JC17</td>
<td>“We are learning about engineering and we made filters to clean water. Cause we read about filters and coffee filters worked the best and you guys know I did another one at home.”</td>
</tr>
<tr>
<td>JC5</td>
<td>“My week was wonderful.”</td>
</tr>
<tr>
<td></td>
<td>“We did the same* in science, how cool!!!!!!”</td>
</tr>
<tr>
<td></td>
<td>*referring to how in the book <em>Saving Salila’s Turtle</em>, the main character made a filter and then the students made filters as well.</td>
</tr>
<tr>
<td>JC6</td>
<td>“This week we did an awesome engineering unit!”</td>
</tr>
<tr>
<td></td>
<td>“I hope we can do it again.”</td>
</tr>
<tr>
<td>JC12</td>
<td>“We are doing engineering and I love it so much!”</td>
</tr>
</tbody>
</table>
Reasoning:

Overwhelmingly, students displayed positive reactions to the engineering unit. The quotes from Figure 4.7 are taken from the students’ family journals. These are journal assignments that students were given every Friday where they were required to write an entry addressed to someone from their home where they tell them about the things they had done in school the previous week. As displayed in the figure above, many students spoke with excitement to their family members about the engineering unit they had done in school. One student, Taylor, even mentioned in her writing that she had gone home and performed an engineering experiment on her own. This sentiment was also observed during the unit itself. Especially in the last two days when students were designing and building their filters, students were actively engaged in their work (i.e., doing what they were asked to do, not being distracted) and some even expressed that they did not want the unit to end.

One thing to note, however, is that this enjoyment is primarily tied to those two days of designing and building. In student interviews, when asked what they remember from the engineering unit, all students responded that they remembered testing the materials and building their filters. There were three other days in the unit that were focused on what technology is, understanding the engineering design process, and discussing pollution/pollutants. When interviewed, no students referred back to these lessons.
Chapter 5
Conclusion

Discussion

The results of this study imply that overall, the students in the discussed classroom experienced a change in their perceptions of engineering at least partially in part because of the formal engineering unit that they experienced. Their understandings of engineering became broader and more encompassing of the actual work that an engineer in the real world might be expected to do - of which the tasks are numerous and diverse. There are of course, however, several things to keep in mind when considering the results of this study. The first is that the research was done with only one class of students. Results could potentially be a result not necessarily of the unit itself, but of the composition of those particular students, their experiences, and the specific style and experience of their teacher. Additionally, the unit in question was fairly brief, consisting of only five lessons which occurred over five days. Some noted quantitative changes did not appear to be very drastic, however it is reasonable to believe that more substantial changes would have been noted had the unit been longer and more in-depth.

Claim 1 addresses the question of How does participating in a formal engineering unit affect the way students understand technology. Data shows that students entered into the unit with an understanding the technology was directly related to electronics, while at the end of the
unit the exhibited a more comprehensive understanding of technology being something created to solve a problem.

Claim 2 addresses the question of *How does participating in a formal engineering unit affect the way students understand engineering?* Similar to the claim about technology, data shows that student understanding shifted from considering engineers to primarily build and fix things. However, at the end of the unit, students displayed an understanding that engineers work to solve problems.

Claim 3 addresses the question of *Do students recognize that engineering connects to other subjects?* Data from this claim is less conclusive than the first two. It appears that after a one week unit, students do not necessarily draw connections between the engineering unit and their work in other subjects. Literature suggests that engineering is a natural tendency of young students and that skills in engineering can assist students with critical thinking and problem solving in other areas. According to this study alone, students do not seem to draw these connections on their own. Perhaps with a longer unit or by having a teacher draw connections more explicitly, students may be able to recognize the multiple uses of the skills they gained in the engineering unit.

Finally, Claim 4 addresses the question of *Do students enjoy learning about engineering?* Anecdotal data from student interviews and student family journals as well as observations throughout the unit suggest that students do in fact enjoy learning about engineering. This is a very worthwhile finding, as students tend to learn more when they are actively engaged in an activity, and enjoyment is often an integral piece of engagement.

Together, these four claims suggest that students experience a shift in understanding when they are formally instructed in engineering and answer the larger research question of *How*
does participating in a formal engineering education unit affect the way students perceive engineering? Not only do they gain skills and learn concepts directly tied to engineering, they are able to understand the subject itself more comprehensively and more accurately. These understandings may help students to view engineering as a highly beneficial and approachable subject. At the very least, misconceptions about technology and engineering were dispelled.

Implications

It has become evident through this research that engineering is not a subject that is limited to the abilities of only college students and professionals. While some people exhibited slight shock in hearing that I was teaching engineering to my 5th grade students, the students themselves handled the material with enthusiasm and competency. I have found that by learning about engineering formally in school, young students are able to gain mature understandings of the subject. They may start off believing that engineering is simply about working with electronics or working on large scale, complex projects, but the evidence from my students shows that they were able to shift their thinking and understand that engineering is simply methodical problem solving and creation of solutions.

These findings have several implications for the future of STEM education in elementary schools. Firstly, there is ample evidence to support the idea that elementary school students are able to appropriately handle the material. While this is just one short study, it seems that concerns educators or others may have in terms of a young student’s ability to handle engineering material may be unfounded. Of course, every class of students is different, but an
educator should not immediately write off engineering for being too difficult for their students based solely on their age.

Second, the evidence of this study shows that learning about engineering formally in school guides young students to a more comprehensive understanding of the subject. The results of this are not directly known, but it reasonable to believe that such lessons in school could prompt a student to pursue engineering later in their life. It is also reasonable to believe that formal engineering education can help encourage students to pursue sciences in general. Science can be a daunting subject for many students, and learning about a type of science that relates so directly to their lives can serve as a doorway into other fields. Creating these sparks of interest in the sciences is especially important in the elementary years, where children tend to have a heightened curiosity towards the natural world. Capitalizing on this inherent interest can turn curiosity into a lifelong passion (Lachapelle, 2014).

Ultimately, this study has provided a small piece of encouragement to the idea of introducing engineering formally to elementary learners. It serves to dispel misconceptions young students may have about exactly what engineering and technology are. At the same time, it teaches them that it is a highly approachable subject that they can be successful at. Engineering is found all over the world and throughout everyone’s lives, and to show this to children in a formal school setting can help them to grow into adults who care about and are interested in science.
Appendix A

IRB Informed Consent Form

The following page contains the Informed Consent Form completed by Dr. Barbaloot and submitted to Lorax University for IRB approval.
INFORMED CONSENT TO TAKE PART IN RESEARCH

Signature of Person Obtaining Informed Consent

Your signature below means that you have explained the research to the subject or subject representative and have answered any questions he/she has about the research.

__________________________  Date  __________________________
Signature of person who explained this research          Printed Name
(Only approved investigators for this research may explain the research and obtain informed consent.)

Signature of Person Giving Informed Consent

Before making the decision about being in this research you should have:
- Discussed this research study with an investigator,
- Read the information in this form, and
- Had the opportunity to ask any questions you may have.

Your signature below means that you have received this information, have asked the questions you currently have about the research and those questions have been answered. You will receive a copy of the signed and dated form to keep for future reference.

Signature of Subject

By signing this consent form, you indicate that you voluntarily choose to be in this research and agree to allow your information to be used and shared as described above.

__________________________  Date  __________________________
Signature of Subject          Printed Name
Appendix B

Pre- and Post-Survey

The following pages contain scanned images of the survey given at the beginning and end of the unit.
What Is Engineering? What is Technology?

<table>
<thead>
<tr>
<th>Marking Instructions</th>
<th>CORRECT:</th>
<th>INCORRECT:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Use a No. 2 pencil or a blue or black ink pen only.</td>
<td>• Do not use pens with ink that soaks through the paper.</td>
<td>• Make solid marks that fill the response completely.</td>
</tr>
</tbody>
</table>

Name: ___________________________ Date: ________________________

Which of these describe Technology? Choose ALL that apply.

- Must be a computer
- Must solve a problem
- Must be new or modern
- Must be a kind of power
- Must have parts that move
- Must be invented by people
- Must use electricity or power
- Must have a computer inside
- Must have a screen to look at
- Must be a thing you can touch

Are these things that an engineer would do for his or her job? (YES or NO):

1. Develop better bubble gum | ☐ Yes | ☐ No |
2. Steer ships | ☐ Yes | ☐ No |
3. Install cable television | ☐ Yes | ☐ No |
4. Improve bandages | ☐ Yes | ☐ No |
5. Draw diagrams of new technologies | ☐ Yes | ☐ No |
6. Fix headlights on cars | ☐ Yes | ☐ No |
7. Fly airplanes | ☐ Yes | ☐ No |
8. Nail beams together for new houses | ☐ Yes | ☐ No |
9. Figure out how to package bottles so they don't break | ☐ Yes | ☐ No |
10. Drive trains | ☐ Yes | ☐ No |
11. Come up with ways to keep soup hot for a picnic | ☐ Yes | ☐ No |
12. Develop smaller cell phones | ☐ Yes | ☐ No |
13. Invent warmer kinds of cloth | ☐ Yes | ☐ No |
14. Drive motor boats | ☐ Yes | ☐ No |
15. Operate cranes | ☐ Yes | ☐ No |

Is Lightning a kind of technology?

- Yes
- No

[SERIAL]
How important are each of the following activities to the work of an engineer?

<table>
<thead>
<tr>
<th></th>
<th>Not Important</th>
<th>Sort of Important</th>
<th>Very Important</th>
</tr>
</thead>
<tbody>
<tr>
<td>38. Using math</td>
<td>☐  ☐  ☐  ☐  ☐</td>
<td>☐  ☐  ☐  ☐  ☐</td>
<td>☐  ☐  ☐  ☐  ☐</td>
</tr>
<tr>
<td>39. Driving machines</td>
<td>☐  ☐  ☐  ☐  ☐</td>
<td>☐  ☐  ☐  ☐  ☐</td>
<td>☐  ☐  ☐  ☐  ☐</td>
</tr>
<tr>
<td>40. Using models</td>
<td>☐  ☐  ☐  ☐  ☐</td>
<td>☐  ☐  ☐  ☐  ☐</td>
<td>☐  ☐  ☐  ☐  ☐</td>
</tr>
<tr>
<td>41. Testing ideas</td>
<td>☐  ☐  ☐  ☐  ☐</td>
<td>☐  ☐  ☐  ☐  ☐</td>
<td>☐  ☐  ☐  ☐  ☐</td>
</tr>
<tr>
<td>42. Building houses</td>
<td>☐  ☐  ☐  ☐  ☐</td>
<td>☐  ☐  ☐  ☐  ☐</td>
<td>☐  ☐  ☐  ☐  ☐</td>
</tr>
<tr>
<td>43. Working as a team</td>
<td>☐  ☐  ☐  ☐  ☐</td>
<td>☐  ☐  ☐  ☐  ☐</td>
<td>☐  ☐  ☐  ☐  ☐</td>
</tr>
<tr>
<td>44. Doing experiments</td>
<td>☐  ☐  ☐  ☐  ☐</td>
<td>☐  ☐  ☐  ☐  ☐</td>
<td>☐  ☐  ☐  ☐  ☐</td>
</tr>
<tr>
<td>45. Solving problems</td>
<td>☐  ☐  ☐  ☐  ☐</td>
<td>☐  ☐  ☐  ☐  ☐</td>
<td>☐  ☐  ☐  ☐  ☐</td>
</tr>
<tr>
<td>46. Sketching ideas</td>
<td>☐  ☐  ☐  ☐  ☐</td>
<td>☐  ☐  ☐  ☐  ☐</td>
<td>☐  ☐  ☐  ☐  ☐</td>
</tr>
<tr>
<td>47. Repairing engines</td>
<td>☐  ☐  ☐  ☐  ☐</td>
<td>☐  ☐  ☐  ☐  ☐</td>
<td>☐  ☐  ☐  ☐  ☐</td>
</tr>
<tr>
<td>48. Using their creativity</td>
<td>☐  ☐  ☐  ☐  ☐</td>
<td>☐  ☐  ☐  ☐  ☐</td>
<td>☐  ☐  ☐  ☐  ☐</td>
</tr>
<tr>
<td>49. Understanding science</td>
<td>☐  ☐  ☐  ☐  ☐</td>
<td>☐  ☐  ☐  ☐  ☐</td>
<td>☐  ☐  ☐  ☐  ☐</td>
</tr>
<tr>
<td>50. Reading about inventions</td>
<td>☐  ☐  ☐  ☐  ☐</td>
<td>☐  ☐  ☐  ☐  ☐</td>
<td>☐  ☐  ☐  ☐  ☐</td>
</tr>
<tr>
<td>51. Using power tools to fix things</td>
<td>☐  ☐  ☐  ☐  ☐</td>
<td>☐  ☐  ☐  ☐  ☐</td>
<td>☐  ☐  ☐  ☐  ☐</td>
</tr>
<tr>
<td>52. Using power tools to build things</td>
<td>☐  ☐  ☐  ☐  ☐</td>
<td>☐  ☐  ☐  ☐  ☐</td>
<td>☐  ☐  ☐  ☐  ☐</td>
</tr>
<tr>
<td>53. Writing down their ideas</td>
<td>☐  ☐  ☐  ☐  ☐</td>
<td>☐  ☐  ☐  ☐  ☐</td>
<td>☐  ☐  ☐  ☐  ☐</td>
</tr>
<tr>
<td>54. Fixing broken things for other people</td>
<td>☐  ☐  ☐  ☐  ☐</td>
<td>☐  ☐  ☐  ☐  ☐</td>
<td>☐  ☐  ☐  ☐  ☐</td>
</tr>
<tr>
<td>55. Writing reports for other engineers</td>
<td>☐  ☐  ☐  ☐  ☐</td>
<td>☐  ☐  ☐  ☐  ☐</td>
<td>☐  ☐  ☐  ☐  ☐</td>
</tr>
<tr>
<td>56. Brainstorming different ideas</td>
<td>☐  ☐  ☐  ☐  ☐</td>
<td>☐  ☐  ☐  ☐  ☐</td>
<td>☐  ☐  ☐  ☐  ☐</td>
</tr>
<tr>
<td>57. Driving people from place to place</td>
<td>☐  ☐  ☐  ☐  ☐</td>
<td>☐  ☐  ☐  ☐  ☐</td>
<td>☐  ☐  ☐  ☐  ☐</td>
</tr>
<tr>
<td>58. Telling other people what they find out</td>
<td>☐  ☐  ☐  ☐  ☐</td>
<td>☐  ☐  ☐  ☐  ☐</td>
<td>☐  ☐  ☐  ☐  ☐</td>
</tr>
<tr>
<td>Number</td>
<td>Activity</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>--------</td>
<td>----------------------------------------------</td>
<td>-----</td>
<td>-----</td>
</tr>
<tr>
<td>16</td>
<td>Improve camera lenses</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Invent waterproof materials</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Design tools for surgery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Improve a truck by putting new wheels on it</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>Build chimneys out of bricks</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>Design ways to clean polluted air</td>
<td></td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>Drive garbage trucks</td>
<td></td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>Figure out ways to explore the ocean</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>Run machine for doctors and scientists</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>Install wiring</td>
<td></td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>Fix computers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>Think about ways to clean the air</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>Figure out what materials to use to make bridges</td>
<td></td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>Put shelves together in a store</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>Design smaller kinds of computers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>31</td>
<td>Drive racecars on a race track</td>
<td></td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>Pour cement for new roads</td>
<td></td>
<td></td>
</tr>
<tr>
<td>33</td>
<td>Measure how much weight materials can hold before they break</td>
<td></td>
<td></td>
</tr>
<tr>
<td>34</td>
<td>Figure out how tall you can safely build towers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>35</td>
<td>Cut glass to make windows in buildings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>36</td>
<td>Pack furniture into boxes in a factory</td>
<td></td>
<td></td>
</tr>
<tr>
<td>37</td>
<td>Repair cars</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Which of these are examples of technology? Choose all of the items that you think are technology.

<table>
<thead>
<tr>
<th>Item</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind-up Toy</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Running Shoes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Sandals</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Broom</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>MP3 Player</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Volcano</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Plano</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Laptop</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Bird</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Windmill</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Keyboard</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Bonnet</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Bicycle</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Hand-held Fan</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Roller Blades</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Basket</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Oak Tree</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Dandelion</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Game Controller</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Cell Phone</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>
1. What is technology?

2. What is an engineer?
REFERENCES


Education
THE PENNSYLVANIA STATE UNIVERSITY
The Schreyer Honors College
B.S., Childhood and Early Adolescent Education, Expected May 2016
Minor in Special Education
Honors in Childhood and Early Adolescent Education

Honors and Awards
Dean’s List, 8 semesters
The President’s Freshman Award

Thesis
Title: Effects of Formal Engineering Education on Elementary Students’ Perspectives
Supervisor: Mandy Biggers

Professional Experience
Park Forest Elementary School
September 2015 – April 2016
Student Teacher

Park Forest Middle School
January – April 2016
Student Teacher

Association Memberships/Activities
Member of the Pennsylvania State Education Association 2012-2016
Rules and Regulations Committee Member for Penn State Dance Marathon 2016
Member of the Student Sustainability Advisory Council 2014-2015
Member of the Student Pennsylvania State Education Association 2012-2015