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Statistical Analysis Of The Effectiveness Of The 'You're Hired!' Program At Changing Students' Attitudes Towards Engineering

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STATISTICAL ANALYSIS OF THE EFFECTIVENESS OF THE 'YOU'RE HIRED!' PROGRAM AT CHANGING STUDENTS' ATTITUDES TOWARDS ENGINEERING

By

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This thesis, submitted by Kristin Brevik in partial fulfillment of the requirements for the Degree of Master of Science in Chemical Engineering from the University of North Dakota, has been read by the Faculty Advisory Committee under whom the work has been done and is hereby approved.

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This thesis is being submitted by the appointed advisory committee as having met all of the requirements of the School of Graduate Studies at the University of North Dakota and is hereby approved

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Date

PERMISSION

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Kristin Michelle Brevik

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ABSTRACT

With the growing need for qualified employees in STEM-based careers, it is critical to develop activities for middle and high school students to increase their awareness of opportunities in these areas. With proper design, increasing awareness of STEM-based careers in conjunction with overcoming current stereotypes can lead to a change in attitudes towards these various careers. As part of this research project I have developed 'You're Hired!', a program providing middle and high school students a hands-on, authentic experience in various engineering roles while assessing the change in a student's attitude towards the engineering profession. Project design also incorporates an opportunity in which students can hone their 21st Century Skills such as collaboration, critical thinking and time management, also known as engineering mindset or workforce skills.

'You're Hired!' is a series of three STEM-based projects, given over the course of a school year, that requires students to work as a 'company' for an entire school day to find a solution to a relevant, present-day problem. At the end of each project, the students communicate their solution to a community-led boardroom, comprised of school board members, community stakeholders and local industry representatives. The 'You're Hired!' program is designed to immerse students in an authentic real-world experience that incorporates the engineering design process and 21st Century Skills. The program also tracks student progress in these areas throughout the year using peer- and self-assessments.

This research project used both quantitative and qualitative data collection methods to measure the impact of the ‘You’re Hired!’ program. The methodology includes comparing a control group to an experimental group to further understand the benefit of the program. Other factors, such as gender and school setting, were also analyzed to determine program impact. The results of the statistical analysis show there is a significant difference in the change in a student’s attitude toward engineering when participating in the program.

CHAPTER I

INTRODUCTION

For some students the closest thing to engineering they are introduced to in K-12 schools is physics class, and even that may not be offered until the student is a junior or senior. The lack of understanding of what engineering was, and association between the word engineering and extremely hard were the key factors in what made me decide to pursue a bachelor's degree in physics, not engineering. The goal of this research is to determine if the 'You're Hired!' program is effective at changing students' attitudes towards engineering. 'You're Hired!' is an engineering education outreach program for middle and high school students that was designed to change students attitudes about engineering so that students could better understand the type of work, the variation of possible jobs and the impact on the world that engineers have.

One key piece of information I believe to lacking from most schools in the immediate area of this research is not only that students can choose engineering as a career opportunity, but the diversity of engineering that can be chosen from.

William Wulf states that his favorite definition of engineering is "design under constraint." (Wulf, 2006) Wulf goes on to state that engineers design things to solve problems, but not just any design will work. The design must satisfy a long list of constraints such as cost, size, manufacturability, environmental impact, ect. (Wulf, 2006) Engineers must be creative in the way that they solve problems to provide the best possible solution. My goal for the 'You're Hired!' program is that it provides the opportunity for students to understand engineering as this definition; not that engineering is too hard. This project will measure the effectiveness of the 'You're Hired!' program doing just that.

For some schools the 'You're Hired!' program is a supplementary educational tool to an already STEM-focused curriculum. To other schools this program is its STEM-curriculum. For a number of schools that have been a part of the program, 'You're Hired!' may have provided the first opportunity in which students have talked about engineering at school.

In addition to providing exposure to engineering, other STEM careers such as technicians, web designers, etc. will also be highlighted. Not every student will want to be an engineer. The program is not designed to ensure all students decide to be engineers, it is designed to increase attitudes and understanding of a career that currently still has students thinking that engineers only drive trains or work on cars. If the program could provide understanding to more people, then when an individual is interested in pursuing a career option like engineering, their support system of friends/family would be able to understand and encourage.

One outcome I am aiming for within the scope of this project long term is to assist in creating more diversity in local engineering bachelor's degree programs. I want the program to reach students who enjoy math and science so that they see engineering as a combination of their interests in a fun, engaging way. This program isn't necessarily aimed at the students who already think they want to be engineers, instead it is focused on the ‘out-of-the-box’ thinkers that don’t know, because they haven’t been reached, that engineering is a great option for them.

1.1 Scope of this Research

This project consists of two main parts: 1) development of a program that is designed to change students’ attitudes and understanding of engineering, and 2) a research study to determine the effectiveness of the program based on data from participants. The ‘You’re Hired!’ program that was developed is designed achieve the following goals: 1) introduce a variety of engineering careers possible with an engineering degree, 2) increase students’ attitudes and understanding of engineering by incorporating features that have been previously researched and are proven to show impact, 3) introduce teachers to incorporating STEM and 21st Century Skills into their classrooms with minimal additions to their already busy workload, 4) hone students’ 21st Century Skills also known as engineering mindset skills or workforce skills, and 5) engage industry professionals to participate and provide feedback as well as being a positive role model for students.

For this project there are two items the research study assessed: 1) change in students’ attitudes and understanding of engineering, and 2) impact of the program on students’ self-assessment about their own abilities and ambitions. The study did not assess improvement of engineering design mindset or skills, influence on teachers, students changing career choices, or the amount of impact the industry professionals had on students. These items were beyond the scope of the current research and could be assessed in future studies. The research study used student survey data to assess program effectiveness. Data analysis considered two primary factors:, 1) comparing data based on school, and 2) comparing data based on gender. Information on these two factors, gender and school, is readily accessible from the pre- and post-surveys the students were given. Ethnicity was briefly looked into for analysis, however with the region that this project took place in, 85% of individuals participating in the activities classified themselves as 'White Americans'.

1.2 Thesis Overview

This thesis describes both the 'You're Hired!' program I helped develop and a research study into whether or not student attitudes and understanding of engineers shifted from pre- to post-survey as well as program impact.

Chapter 2 reviews the research based design of past/current K-college level STEM programs. An overview of a variety of programs as well as discussion of why these programs are beneficial to students can be found in this chapter. Chapter 3 describes the program design of 'You're Hired!'. Explanation of how 'You're Hired!' fits into the school-year calendar as well as what happens during a typical activity is discussed. Program features of 'You're Hired!' are explained and linked back to research based design programs from Chapter 2. Chapter 4 covers the research methodology behind the project. This chapter explains the methods used to gather information during the study and the analysis used to develop conclusions based on data. Chapter 5 explains the results of the program and the discussion of those results. In each section, statistical analysis is presented along with discussion of the results. Chapter 6 finalizes the document with concluding statements as well as proposed future work topics and considerations.

CHAPTER II

RESEARCH-BASED DESIGN OF K-COLLEGE STEM PROGRAMS

2.1 Why a Program is Needed

In the 21st Century workforce employers are looking for potential employees that can solve a range of intellectual and technical problems regardless of the position. (Marzano & Heflebower, 2012) Employers will be looking for employees that are willing to use an engineering mindset in which they problem solve, think critically, collaborate with others, and are able to solve elementary issues as well as more complex problems that may arise. In other terms, employers are looking for employees that have well developed 21st Century Skills. Today's workplace is very different than it was 10-20 years ago. Mastery of the basic skills in education such as reading, writing, and math is no longer enough. (Marzano & Heflebower, 2012) Schools need to place more emphasis on the 21st Century Skills such as critical thinking, problem solving, time management, etc. in addition to the basics.

While not always pictured this way, engineering is a very creative profession. It is important that engineers be able to design a solution while meeting constraints such as time, cost, manufacturability, size, etc. (Wulf, 2006) Without diversity within the profession, the same types of solutions will continue to be the only solutions. It takes a variety of people from various backgrounds to help solve the larger problems like renewable energy sources that work in all areas of the world, or a process that can inexpensively bring clean water to those countries that are less fortunate, or even an individualized identification system that would make identity theft nearly impossible. The engineering design team needs to be diverse and creative in order to continue to excel and meet the needs of the society they are impacting. Engineering touches almost every piece of the world we live in, from an online video chat to an artificial heart valve. It takes unique ideas and brainstorming to design and redesign products for the future.

While engineering careers are in high-demand within a wide array of industries, the general public has only a limited perspective of what these careers really are. (Kimrey, 2013) The images/stereotypes students have about engineering frequently identify engineers as car mechanics, construction workers or train operators. (Knight & Cunningham, 2004) Other stereotypes include: engineering is boring, engineers work alone or at a computer, and engineers help society. (Knight & Cunningham, 2004) (Fussell Policastro, 2009) Research has linked K-12 students' limited knowledge and/or negative image of engineering careers to the shortage in the number of college graduates receiving degrees in engineering. (Committee on Public Understanding of Engineering Messages and National Academy of Engineering, 2008) (Hill, Corbett, & St. Rose, 2010)

Not only is there a limited knowledge of what engineering is, there is limited knowledge in general in terms of students being prepared to take the classes needed to pursue a degree like engineering. In one study, roughly 300 2-year and 4-year college instructors were interviewed and stated that high school did not prepare their students to comprehend complex materials, think analytically, or apply what they learned to solve problems. (Marzano & Heflebower, 2012) It may not come as a shock to these instructors that 40% of all students that enter college need to take remedial courses in addition to their major requirements. (Marzano & Heflebower, 2012)

In order to properly prepare the students of the United States of America for a successful future, President Obama has launched an initiative called Educate to Innovate which calls out two things that need to happen in order to keep the United States as a leader of innovations. The first point is that students, including women and minorities, need to be *prepared* and proficient in STEM (Science, Technology, Engineering, and Math) subjects in order to be ready for the future workforce. The second point is that students need to be *inspired* and motivated in STEM activities so that they can be encouraged to pursue a STEM career. (The President's Council of Advisors on Science and Technology, 2010)

Whether students decide to pursue a STEM career or not, they should have the knowledge, conceptual understandings, and critical-thinking skills that come from studying STEM subjects. (The President's Council of Advisors on Science and Technology, 2010) While the 21st Century workforce cannot function without the appropriate advances made in science and technology, it also cannot function without advances in education, business practices etc. There are numerous careers that do not require the use of math and science specifically.

Research has been done regarding the importance of implementing more STEM as well as experiences in which students can hone their 21st Century Skills into K-12 classrooms.

STEM learning environments provide opportunities for students to focus on discovery and the ability to solidify educational concepts in their minds by being able to understand a concept in a variety of contexts. A STEM learning environment has been described as one in which there are no barriers between the various classes the students take. All subjects become pieces to a bigger picture in terms of student understanding. Students that are actively learning in a STEM environment would not ask why they need to know about citations because they would be using them not only in English, but also understanding the need to use them in science, math and history. Students in geography would not ask why they have to know about Africa, because in science they are creating water purification prototypes, in gym they are walking a mile carrying full jugs of water and in English they are reading 'A Long Walk to Water' by Linda Sue Park. A true STEM environment has student engaged in all aspects of a topic that include all core classes that are standard across the nation.

In most schools, the E in STEM is left out completely. All schools have science and math teachers and many have technology education teachers (tech ed.), however engineering tends not to make it into most schools consistently. This leads to students' images of engineering stemming from a variety of other outside sources such as: knowing engineers in their community, career expositions, friends or family members, class trips, guest speakers or media. (Yurtseven, 2002) (Young, 2007) Unfortunately, these current methods of educating K-12 students about engineering and engineering careers have shown little impact on improving the number of students pursuing an engineering related degree, with the percentage of U.S. bachelor's degrees awarded in engineering remaining constant around 4.5% over the past decade, down from an average of 7.1% during the 1980's. (Science and Engineering Degrees: 1966-2010, 2013) Of the students who took the ACT college readiness assessment in 2013, only 23% expressed an interest in STEM careers. (The Condition of STEM 2013 National, 2014) The ACT assessment categorized STEM as four key areas: science, computer science & mathematics, medical & health, and engineering & technology. (The Condition of STEM 2013 National, 2014) A series of questions about STEM related activities was also asked. The ACT defines *expressed interest* as students stating that they are interested in STEM. *Measured interest* was defined as interest shown regarding STEM ideas and activities, while when the student was asked specifically about STEM careers did not express interest. Of the 54% of students that took the ACTs, 9% answered the STEM related questions in such a way that it is possible that the student is interested in a potential STEM career, even though when asked specifically the student said no. (The Condition of STEM 2013 National, 2014)

Changing Attitudes with Authentic Experience

One of the goals of the 'You're Hired!' program is to introduce a variety of engineering careers possible with an engineering degree. Another goal is to increase students' attitudes and understanding of engineering. My theory is that while not every student will want to be an engineer, after participating in the 'You're Hired!' program more students will have a better understanding of the work engineers do. In order to meet the national engineering demand with more students choosing the engineering profession, students must first have a positive image of engineers and the engineering profession. 'If you want to change how people behave, you first have to change how they think.' (Patterson, Grenny, Maxfield, McMillan, & Switzler, 2007) Recognizing that the engineering profession has had the same image for numerous years, innovative approaches must be taken to change this persistent and resistant view by providing personal experiences in which participating students can see first-hand the variety of work that is engineering. (Bandura, 1977) As Benjamin Franklin stated, "Tell me and I forget, teach me and I may remember, involve me and I learn." (Franklin) By giving students the opportunity to learn about engineering through hands-on learning, the program is increasing the likelihood that a student will pursue a degree in engineering or related STEM field.

2.2 Engineering Education Program Design

Limitations of Current Engineering Education Programs

There are numerous programs aimed at educating K-12 students about what engineers do. Most traditional programs fit into the following categories: competitions, summer schools/camps, speaker programs, site visits/tours, career advisers and teacher resources. (Dawes & Rasmussen, 2006) While these traditional programs have high impact rates with the participating students, there are some major limitations that need to be considered. One of the largest limitations with current methods of educating students about engineering has to do with the students that are impacted. Sometimes the students that could greatly learn and benefit from an activity or experience are students that are not exposed. One major limitation in the current programs to educate students is that every student is not personally invested in the program.

While it may appear beneficial to bring an engineer into the classroom to spend time with the students and talk about their profession, many students are often left with only a slight understanding of the guest engineer's career and fail to see themselves in the same role as that engineer. (Eniola-Adefeso, Fall 2010) Another current method of introducing students to engineering is field trips to see the kind of environment an engineer works in. Similar to the classroom visit, this type of exposure gives students a look into only one of the many types of jobs engineers have. Students could leave an industry tour thinking that all engineering is dirty or they could leave thinking that engineers only work on roads and bridges. It is also possible that engineering is not mentioned in their classroom after that one visit or field trip.

Summer camp is another current tool to get students interested in engineering. Summer camps tend to have a higher impact on students' understanding of engineers and engineering careers which would suggest that they are effective, however given the number of students camps reach, this type of approach, while greatly beneficial, only confirms that an interested student is indeed wanting to become an engineer. The summer camp method of outreach completely misses the students that don't understand what engineering is, meaning that it can potentially miss the students that could benefit most.

More effective methods of generating student interest in and understanding of engineering are needed as well as a tool that will assist students in the ability to hone their 21st Century Skills which are closely aligned with engineering attributes – qualities of an engineer.

Learning from Effective Programs

Research into K-college engineering programs has identified a variety of elements that contribute to effective programs. For example, a review by researchers from Old Dominion University and Colorado State University found that effective pre-engineering activities, such as robotics club and engineering camp, include what they term 'key attributes' that positively influence students to successfully pursue and complete an engineering degree: self-motivation, use of problem-solving strategies, use of computer applications, and immediate feedback on success of efforts. (Fantz, Siller, & DeMiranda, 2011) Other researchers have highlighted 'key design features' that offer engagement with engineering: the ‘wow’ factor, simple yet effective ideas, social responsibility, potential for world-wide impact, and personal relevance. (Marshall, McClymont, & Joyce, 2007) For programs that impact all students, not just a select group that joins a club or camp, additional common ‘themes’ regarding engineering education arise including: active learning/inquiry-based learning through hands on activities, interdisciplinary approaches which add a technological component, teacher engagement, curriculum supplements that connect to standards, and creating mentorships and partnerships that make engineers “cool”. (Dawes & Rasmussen, 2006) (Jeffers, Safferman, & Safferman, 2004) Work done by one successful program, Engineering is Elementary, has led to a list of inclusive ‘principles’ as a starting point for resource design. The Engineering is Elementary principles include many of the attributes listed above for other programs. (Cunningham & Lachapelle, 2012)

Including these key attributes, factors, themes, and principles should theoretically increase the likelihood of positively impacting a broad range of students, as different individual students will respond best to different program elements. It is thought that changing attitudes towards engineering on a large scale will require that multiple influence strategies and project attributes be incorporated.

More recently, a greater emphasis has been put on program designs that offer a tool for schools to use in which the program is integrated into current curriculum and every student participates. (Dawes & Rasmussen, 2006) (Cunningham & Lachapelle, 2012) (Clarke & Dede, 2009) (Mooney & Laubach, 2002)

One innovative approach directly involves students in a personal, authentic experience where they take the role of an engineer. Such an experience will change a student's attitude and behavior towards engineering if the student can answer 'yes' to two questions: 1) can I do it? and 2) what is in it for me? (Patterson, Grenny, Maxfield, McMillan, & Switzler, 2007) (Bandura, 1977) (Fantz, Siller, & DeMiranda, 2011)

Some programs are designed to be implemented locally, while others are designed for scaling and sustaining across broader regions to impact a greater number of students. Regardless of how the program is implemented there are attributes or common approaches that have been adopted by a majority of these programs, at least in some combination. The adoption of these approaches is supported by the statistically significant effect the previous programs have had regarding the attitudes, understanding and behaviors of students towards engineering.

In applying effective research design from the literature review to the design of the 'You're Hired!' program, the many proven attributes, factors, themes and principles were first summarized as a set of common program attributes and common individual activity attributes. Common program attributes describe the key features that are incorporated into the overall program, which is comprised of a variety of individual activities. Common activity attributes are the key features that assist in getting participants engaged in the individual activities and allow for the best learning environment. Common activity attributes do not look past the individual activity in terms of projected impact. However in the design, building upon the skills acquired during the individual activities plays into the overall program attributes.

Common Attributes of Effective Engineering Education Programs

The common attributes of effective K-12 engineering education programs can be broken down into 5 categories: active learning/inquiry-based learning, curriculum standards aligned, engaged teachers/role models, appropriate range of student ages, and partnerships/community involvement. (Jeffers, Safferman, & Safferman, 2004) (Davis, Yeary, & Sluss, 2012) (Cunningham & Lachapelle, 2012) (Dawes & Rasmussen, 2006)

Active Learning/Inquiry-Based Learning

Engineering is a hands-on field, so in order to teach students what engineering is, students must do some sort of engineering - and do so in a hands-on, inspiring, active learning environment. (Jeffers, Safferman, & Safferman, 2004) (The President's Council of Advisors on Science and Technology, 2010) It is not enough to be lectured about engineering. Most outreach programs recognize this and have incorporated active learning into their programs. These active learning/inquiry-based learning environments allow students to explore a problem using previously learned principles. These types of learning environments focus less on theory and more on context-based materials that students can relate to on a personal level. (Dawes & Rasmussen, 2006) Activities that focus on and emphasize observation as well as an exploration through experimentation can facilitate the inquiry that is necessary for students to be able to focus their thinking in addition to the ability to form new ideas and pose new questions. (Jeffers, Safferman, & Safferman, 2004)

There are a number of students that will thrive in a hands-on, active learning environment; some of these students may be individuals that do not perform well in a traditional classroom setting. It is important to understand and recognize that students as a whole do not conform to one type of learning style. Recent research has highlighted that in order to reach the greatest number of students, multiple learning environments need to be incorporated in a classroom to accommodate the various learning styles students within that classroom have. (Dawes & Rasmussen, 2006) While some students thrive in a traditional classroom in which the teacher lectures and students complete in class worksheets, homework and tests where the students reiterate information in a similar context to what was taught. Other students thrive in situations where they can try out principles they have learned and see first-hand the laws of gravity or the accuracy of probability calculations. While the best method of teaching relies heavily on the students within that classroom, in order to facilitate the most learning possible, it is important for teachers to incorporate these various learning styles within their teaching.

Numerous schools across the United States have incorporated active learning/inquiry-based learning into their classrooms as an additional style of learning/teaching. More emphasis still needs to be placed on this type of instruction if students want to be ready for the 21st Century workforce. As explained by Wagner et al, in the 21st Century, it will not be enough for students to master skills in reading, writing and math. Almost any job that pays more than minimum wage – blue or white color – will require employees that can solve a range of problems and think intellectually to do so. (Wagner, 2008) (Marzano & Heflebower, 2012)

Curriculum Standards Aligned

It is important for engineering education programs to provide curriculum supplements so that teachers can integrate fun and exciting examples of engineering while tying back to curriculum standards. (Jeffers, Safferman, & Safferman, 2004)

(Dawes & Rasmussen, 2006) The goal of engineering education programs is not only to supplement current math and science curricula, but to also include other curricula subjects such as history, geography, writing, and reading - to provide a true integrated STEM learning experience for both the teachers and the students. (Jeffers, Safferman, & Safferman, 2004)

Including teachers in the development process of new engineering education programs and allowing them to help with curriculum alignment can be very beneficial. Teachers can quickly see that they can be engaged and incorporate these engineering lessons while still meeting other curriculum standards from the basic courses such as math and science. (Dawes & Rasmussen, 2006) Because engineering generally blends math and science together, teachers quickly realize that one engineering lesson can meet the criteria of multiple curriculum requirements from a variety of subjects.

Engaged Teachers/Role Models

One way that teachers are included and engaged in engineering education is the partnership with engaged role models such as engineering professors from local universities. Due to time constraints, it is often difficult for professors to be present in multiple classrooms. Engineering students have been used as professor replacements in which engineering students work with a classroom including the teacher on activities and get the students excited about engineering. (Jeffers, Safferman, & Safferman, 2004)

Engineering students make great role models for children in schools because it is often a way for them to see a diverse group of people with different backgrounds all passionate about the same thing – engineering. In one successful engineering education program, Engineering is Elementary, researchers found that it is best to have a diverse group of role models for students to relate to. A variety of role models – of both genders from a variety of races and ethnicities, with different strengths and disabilities, and that engage in a variety of hobbies and extracurricular activities create a broad picture of the types of people that make great engineers. (Cunningham & Lachapelle, 2012)

Appropriate Range of Student Ages

Most engineering education programs understand that it is important to get engineering exposure to students as soon as possible. One researcher goes as far to state, 'young children are inherently active with strong impulses to investigate, share with others what they have discovered, to construct things, and to create. In other words, young children are natural engineers.' (Genalo, Bruning, & Adams, 2000) (Jeffers, Safferman, & Safferman, 2004) It is not until children reach school where they split into specific classes such as English, math, science, and history that students start to lose interest in math and science because it becomes difficult to see how the 'facts' relate to their everyday life.

While many original engineering education programs were designed to work with high school students in hopes to increase enrollment numbers at engineering universities, the current focus is on younger students. Some programs choose to focus on elementary level students; others focus on middle school to early high school aged students. Exposing younger students to engineering will give the students an early opportunity to try out engineering concepts. If the young students enjoy the experience they will have a reason and motivation for taking more difficult and intimidating math and science classes in high school and in college. (Price, 2000) (Jeffers, Safferman, & Safferman, 2004)

Partnerships/Community Involvement

In addition to local universities supplying support to teachers in the form of engineering professors and engineering students, Dawes expresses in his research that partnerships in which the community is involved in the students' education are important. (Dawes & Rasmussen, 2006)

In some situations, partnerships can create a valuable incentive for businesses within a community to take interest in educational content. If teachers could build an educational project that revolves around a specific business such as a power company or a water purification plant, it provides an opportunity for teacher, students, and families to understand more about the businesses within their community. The students will also benefit greatly by the ability to make the connection between what they are learning in school and how it applies not only to a real world application, but one that specifically impacts their immediate community.

Common Attributes of Activities that Lead to a Change in Student Attitude and Understanding

The attributes of individual engineering education activities affect how well students perceive and accept the information presented. This can vary from program to program. There are a variety of primary attributes that appear to enhance program effectiveness. Those primary attributes are real-world problems, hands-on active learning, application of problem solving skills, computer/technology applications, and feedback on student efforts. (Dawes & Rasmussen, 2006) (Jeffers, Safferman, & Safferman, 2004) (Cunningham & Lachapelle, 2012) (Fantz, Siller, & DeMiranda, 2011)

Real-World Problems

In order to increase the number of students that choose to pursue engineering as a future career opportunity, students must first see the connection between engineering and the world around them. “Many students who are academically competent in the school subject matter ultimately view school’s knowledge and skills as irrelevant for their future career and/or everyday lives.” (Cunningham & Lachapelle, 2012) Therefore to increase the number of students pursuing engineering and the appreciation for engineering by all students, not only must students see the relevance of what they are learning in context to the real-world, but they need to be given the opportunity to explore and to discover the possibility of them personally filling such roles in the future.

Research indicates that students learn concepts and skills through experience. (Cunningham & Lachapelle, 2012) “Children’s learning is more profound when they engage in realistic disciplinary practices.” (Cunningham & Lachapelle, 2012) As an adult applying for a job position, previous experience can be the deciding factor of whether or not the job is offered. Employers are looking for prospective employees that can utilize knowledge from past experiences in order to learn new information quickly in addition to being able to problem solve when needed. When students learn new information, rarely do they have the proper past experiences to connect the information to a real-life application which makes it more difficult to understand and remember. If students are given opportunities in school to learn through real-world applications, all of a sudden the concept of volume calculations they are using to relate the amount of oil that was spilt in the Gulf Oil Spill to the volume of the classroom they are in, or the swimming pool in the park become more understandable and provide a better foundation of information for future problems. The open-ended structure to a real-world problem provides students the ability to make connections with their interests and prior experiences. (Cunningham & Lachapelle, 2012) In the real world, the engineering career is filled with open-ended problems.

Hands-on, Active Learning

Engineering is a hands-on field. (Jeffers, Safferman, & Safferman, 2004) It is difficult to teach fundamental concepts such as the law of gravity or calculating volume of non-uniform objects by water displacement without actually doing hands-on learning. Students focus their effort on being engaged in the hands-on learning that is taking place and don't even realize the valuable information that they are gaining in the process.

Not all hands-on experiences have an impact on student achievement. Active-learning that emphasizes student engagement in analyzing and making sense of the presented information is clearly superior to traditional student learning in terms of increasing student conceptual understanding. (Cunningham & Lachapelle, 2012)

Application of Problem Solving Skills

The use of problem solving skills proved to be important in one study that was based on pre-engineering attributes that not only had short term effects on the interest of students, but long term effects of the pre-engineering experience on a student's self-efficacy when compared to students that did not have the same experience. (Fantz, Siller, & DeMiranda, 2011) Problem solving skills are the skills that students must use to solve an open-ended problem. Sometimes students will need to hone their problem solving skills when working on a project by themselves, other times the students will be given a larger problem to solve and will need to do so in a group environment.

More often than not, when students are placed into a problem solving environment they are grouped with other students. Part of the learning process then becomes a small group of students working together and trying to explain their different ideas and viewpoints to each other – students must collaborate to solve the problems in a team environment.

Computer/Technology Applications

Technology has become a resource that most careers cannot do without. While basic technology skills such as Microsoft Word, Excel, Power Point, etc. are not only used by teachers, but are taught in computer classes across the United States, few students have the opportunity to take a technology class that would gear them up for the 21st Century workforce.

Technology education should include more than learning basic skills at this point in the 21st Century. Technology education should include: basic skills (at an earlier level), various applications and examples of how and when to use the different types of technology (What is the probability of your basketball team making it to the finals? How to determine randomly within your group of friends who gives a Christmas gift to whom?), and last but most importantly how to trouble shoot that technology.

Research has shown that when schools effectively integrate technology within an educational setting in addition to traditional instructor-led teaching strategies, it improves effective knowledge access and transfer, encourages students to critically think, enhances students' academic achievement, and overall improves the quantity and quality of teaching and learning within a classroom. (Safar & AlKhezzi, 2013) (Ololube, 2009) This integration of technology could include both teachers using technology to explain new material as well as teachers assign projects for students to complete that requires the use of technology.

Access to educational technology tools has greatly improved in numerous schools across the United States as a result of millions of dollars spent through political and institutional support. (Keengwe & Onchwari, 2008) While the technology per student ratio has increased, the technology has not been utilized or integrated to its full intended potential. (Keengwe & Onchwari, 2008) One study found that fewer than 20% of teachers utilized technology in their classrooms several times a week, and up to 50% of teachers did not use technology at all. (Keengwe & Onchwari, 2008) Some teachers become very hesitant to incorporate technology into their classes due to the amount of change required. Overall teachers are not only asked to change the way they teach their students, but to also change the role they play within their classroom and the way the classroom time is arranged. Teachers need to hone their technology and troubleshooting skills, however teachers will be most successful in utilizing technology within their classroom when they do not act as the experts, but as instead as guides to facilitate the students learning. (Keengwe & Onchwari, 2008)

Feedback on Student Efforts

Feedback is a very beneficial teaching and learning strategy. Feedback comes in many forms, indirect and direct, immediate and delayed, as well as a number of types of feedback that can be delivered (correct response, try again, elaborated, error flagging, etc.) (Shute, 2008) In addition to student feedback influencing achievement, it is also shown to be a significant factor in motivating learning. (Shute, 2008)

Studies have been done around the topic of feedback, and have found that good feedback contains the following: (Ertmer, 2007)

1. Clarifies what good performance is (goals, criteria, standards).
2. Facilitates the development of self-assessment and reflection.
3. Delivers high quality information to the students about their learning.
4. Encourages teacher and peer dialogue around learning.
5. Encourages positive motivational beliefs and self-esteem.
6. Provides opportunities to close the gap between current and desired performance.
7. Provides information to teachers that can help shape teaching.

Feedback from both teachers as well as peers is very beneficial to the student's learning. Peer feedback allows students to take a different role and participate in each other's learning. This type of learning environment creates on in which students have understanding and appreciation for their peers. (Ertmer, 2007) Work has been done to propose that when students give peer feedback, the amount of learning is greater because the student must step out of the mindset of completing a task and move into one that allows them to read, compare or questions a peers efforts. (Ertmer, 2007)

There is an abundance of articles that have been written about the role that feedback has in student learning. (Shute, 2008) While most articles convey that the feedback is an important piece to the learning process, there are quite a few articles that have reported either no effect or debilitating effects on learning. (Shute, 2008) Feedback can have a negative effect on learning if it is students see the teacher feedback as being critical or controlling or if the students are interrupted by feedback from an external source. (Shute, 2008) There are also a couple of challenges to be aware of when students provide peer feedback. One challenge is students overcoming the anxiety about giving feedback to their peers, especially negative feedback. Another challenge is ensuring that students are giving accurate feedback.

Local Programs versus Scaled Programs

Learning is a complicated phenomenon with numerous, often contradictory, approaches that try to explain when and where learning happens. (Clarke & Dede, 2009) Too many times programs are designed in a particular location and expected to be able to scale, or expand, to impact a greater number of students, but in very different settings. (Clarke & Dede, 2009) One-size-fits-all models for teaching and learning that are abundant in policies and accountability measures are not always realistic in every situation. One-size-fits-all educational programs do not work because they ignore factors that determine a program's efficacy in a particular local situation. (Clarke & Dede, 2009)

A properly scaled project could be used in a variety of locations and situations. In the design of a project that is intended to scale is a 'ruggedness' that needs to be attained so that the project can succeed at multiple locations. (Clarke & Dede, 2009) Clarke and Dede explain that while there are key design features for scaling a project, the robust-design that is created in order to scale is not expected to outperform a program that is designed to work locally for a specific group of students. (Clarke & Dede, 2009) The design of a project that can scale versus a project that is meant to stay local is different. It is important that program designers decide if it is more important to have a tool reach a variety of people from various backgrounds, or if it is intended to greatly and specifically impact a select group of people. It was decided for the 'You're Hired!' program that the goal is a program that can reach a variety of individuals, including both urban and rural schools.

Coburn defined scale as four interrelated dimensions: depth, sustainability, spread, and shift. Clarke and Dede took Corburn's work one step further by adding evolution to the end of the list of dimensions to bring the total to five. (Clarke & Dede, 2009)

Depth

Depth can be related to the deep and substantial change in a classroom practice, changing teacher's beliefs, norms within the classroom and classroom interactions, and pedagogical principles as enacted in the curriculum. (Clarke & Dede, 2009) (Coburn, 2003) Coburn defines teacher's beliefs as the underlying assumptions that teachers have about the way that students learn, the nature of the subject material, expectations they have for their students, and what constitutes effective instruction. (Coburn, 2003) Uprooting a teacher's beliefs can prove to be very difficult given that teachers tend to 'gravitate' or stay close to approaches of teaching and learning that are similar to that of their previous classroom situations. (Coburn, 2003)

Because depth is a critical element of scale, it is important that the degree of depth is able to be assessed correctly. It is probable that depth cannot be assessed by survey alone. Instead, capturing depth correctly could possibly require in-depth interviewing, classroom observation, instructional support, etc. (Coburn, 2003)

Sustainability

Sustainability relates to the ability of a classroom practice to continue over a substantial period of time given the practice's depth. It is possible and common that reforms can be adopted without being implemented and can be implemented superficially only to fail shortly after they start. (Coburn, 2003) In order to reach a level of long term sustainability, researchers must use a robust design that is not only optimal for many different locations, but also for a variety of different types of learners. (Clarke & Dede, 2009)

When researchers are preparing a program that has the necessary attributes to be able to scale and sustain, that enough of the original requirements remain in order to make the program still valuable. (Clarke & Dede, 2009) One way to do this is by developing a list of attributes that define a program during design. Then ensure that while the project is implemented and slightly altered (adapted) to meet the need of a variety of locations, that the main attributes remain assuring that the project is still carrying the same significance as the original design.

Spread

Spread involves the diffusion of the innovation to a large number of locations. In order to achieve spread, the design of the project needs to be modified and altered to reduce the amount of resources and expertise needed for success. (Clarke & Dede, 2009) If a project can run off of minimal expertise from researchers, it is more likely to spread seamlessly. However, if the researchers continue to play a large role in the project as in providing a feedback loop, customizing data and projects for each location, etc. It is less likely that the project will successfully be able to spread.

Websites are a great tool to encourage spread more efficiently. Websites provide information needed by each location, and in the design leaves it up to the individual locations to utilize that resource with minimal help from the research team. In the case of some schools, all information to successfully run the project could be available online with specific teacher sections being password protected. This type of a design tool allows teachers and students to share the same resource which makes it very clear where the important resources can be found.

Shift

Shift is the exciting point in the project's design where the ownership is passed from researchers/designers to the individual sites that are implementing the project. During shift, teachers and schools take ownership in the sense that instead of following a strict curriculum, it is encouraged that the focus be on adapting to meet the needs of their specific location. (Clarke & Dede, 2009) (Coburn, 2003)

In the case of an educational project, teachers become co-evaluators, and co-designers at every stage of implementation. (Clarke & Dede, 2009) Teachers provide researchers with a very important perspective in regards to the overall design of an educational project. Integrating teacher feedback into redesign is critical in creating a project that can truly scale up and sustain.

Evolution

Evolution is the process of adopters taking a project and revising it in such a way that project designers have reshaped their thinking in terms of the innovation of the project. (Clarke & Dede, 2009) Evolution goes further than shift in terms of users taking ownership of a project. With evolution, users not only take ownership, but they incorporate their ideas into the evolution of the project.(Clarke & Dede, 2009) Having a continuous feedback loop between designers and teachers will help to ensure appropriate evolution of the project.

CHAPTER III

YOU'RE HIRED! PROGRAM DESIGN

I am proposing that a successful engineering education outreach program can be designed that includes many of the attributes described in Chapter 2 that have been proven to be effective in changing K-12 students' attitudes and understanding of engineering. The program design not only includes the attributes for successful programs, but it also has been specifically designed to scale and sustain across a broader region. This ability to scale will ensure that schools over a greater area will have access to positive engineering experiences for their students. The program is named 'You're Hired!' to symbolize that this program can help students hone the skills necessary for being successful in their future workplace, not only in an engineering career, but in a broad range of non-engineering careers that also require these important skills.

The 'You're Hired!' program is designed to engage students in an intense, coherent set of STEM-focused experiences, which requires the use of the engineering design process and infuses 21st Century Skills to solve real-world problems. The program was designed to be an innovative way to meet school's needs of (1) implementing interdisciplinary STEM experiences for all their students and teachers without burdening existing resources and (2) providing a method to assess and hone all students' 21st Century Skills. The program also is designed to addresses industry's need for more students to enter STEM-related careers by providing the students with a positive, authentic experience of engineering. Ultimately, 'You're Hired!' is intended to be a proven piloted program which can be replicated, adapted to other contexts, and nationally scaled using Dede's dimensions of scale that were covered in Chapter 2.

3.1 You're Hired! Program Design

The 'You're Hired!' program design has small groups of students, ideally 5-8, work together as a 'company' for an entire school day to research a real-world problem, experiment, determine a reasonable solution given the problem constraints, and then communicate, advertise, and market their discoveries/solution in front of a boardroom that is deciding which company has done the best job of meeting the constraints of the problem. In each activity the students participate in, there are five possible careers to choose from. Having 5-8 students in each group allows there to be at least one student per job, but there isn't too many students in which an individual feels unneeded/left out.

This program provides an experience that incorporates many of the key attributes for successful pre-engineering activities. Students must be *self-motivated* to complete their tasks in a timely manner. Students also have to *problem-solve* in an *active learning* environment to come up with a solution to the given *real-world problem*. Students use *computer applications* to make graphs and presentations for communicating their discovery/solution to a community-led boardroom, comprised of school administrators, school board members and local industry representatives including professional engineers. The boardroom gives students immediate *feedback on students' efforts* after each activity.

The 'You're Hired!' program is not just a onetime event; it is a series of three day-long activities that occur over the course of a school year to provide multiple authentic experiences of possible engineering careers. Individual 'You're Hired!' activities set learning in a real-world context by posing different problems with world-wide impact that require the expertise of different engineering disciplines. For example, one project has students in the role of chemical/environmental engineers that are helping to clean up an oil spill using a nano-based coating on sand. Another project has students diving into electrical engineering in which they have the opportunity to build a nightlight circuit and determine through a series of calculations the amount of power that can be saved by switching from incandescent to LED lighting in a home. Problems are developed that will be of personal relevance to students (e.g., determining the effect texting has on reaction times and relating the experimental results to the dangers of texting while driving) and that can be described with simple engineering ideas. Introducing various engineering careers within the construct of solving socially relevant problems helps convey the diversity within the engineering profession. The variety of problems is also intended to increase the likelihood of individual students experiencing the 'wow' factor at least once during the year.

The age of students participating in 'You're Hired!' range from 6th grade to 12th grade. While engineering outreach programs are being implemented throughout the entire K-12 range nationwide, many of these programs focus on middle to high school students because this is the age when students begin thinking about and planning their own paths in education. (Dawes & Rasmussen, 2006) (Cunningham & Lachapelle, 2012) (Cunningham & Lachapelle, The Impact of Engineering is Elementary (EiE) on Students' Attitudes Towards Engineering and Science, 2010) (Lachapelle, Phadnis, Hertel, & Cunningham, 2012) (Habash & Suurtamm, 2010) (Mooney & Laubach, 2002) (Davis, Yeary, & Sluss, 2012) Students can do this by choosing classes to take in high school and thinking about options to pursue math or science related fields in college. (Dawes & Rasmussen, 2006) (Mooney & Laubach, 2002) (Habash & Suurtamm, 2010) (Davis, Yeary, & Sluss, 2012)

'You're Hired!' Over the Course of a School Year

The 'You're Hired!' program begins at a participating school prior to the first day-long activity with teachers organizing companies that consist of 5-8 students. Depending on the size of the school, if multiple grades are participating teachers can choose to mix students from the various grades in a company. It is important that teachers divide up the groups because they have spent the most time with the students in their regular classrooms and know which students should not be in the same group.

The 'You're Hired!' team also works with a school contact to coordinate scheduling days, students, teachers, boardroom participants and other necessary approvals well in advance to ensure smooth project execution. In the future, in order to scale, the organizational information will be available online. The school then completes a total of three separate 'You're Hired!' activities throughout the school year. During and after these activities, students receive multiple forms of feedback on their success and efforts.

Breakdown of a 'You're Hired!' Activity

The basic framework of a day-long 'You're Hired!' activity ensures that schools are able to easily conduct the activity with minimal resources required, a key aspect when designing for scalability. The following breakdown is offered as a template, with flexibility to modify as needed.

Each activity starts with an introduction of the problem statement given by either a teacher, an online video from the 'You're Hired!' website or myself personally. The problem statements are designed to be simple, yet open-ended so that students can dive into a creative solution. In the future, all introductions will be available on the 'You're Hired!' website so that the school/classroom can start the day without any additional support.

For the pilot year, 2012-2013, the three problem statements used with the schools were:

1. Using nano-technology coated sand to clean up an oil spill
2. Experimenting with reaction times and creating a prototype to end texting while driving
3. Creating a school lunch menu that follows all new nutrition standards.

For the 2013-2014 school year the problem statements were:

1. Using Glo-Germ powder to show how quickly viruses can spread in a school
2. Building a nightlight circuit to determine the amount of energy that can be saved by switching every home from incandescent to LED lighting
3. Experimenting with non-Newtonian fluids to try to find a mixture to replace the synovial fluid in the human knee that can meet both viscosity and force requirements.

During the introduction to the activity student groups are given a packet of paper information along with an experiment kit. The paper packet includes: A written version of the introduction, a company information sheet that students will need to turn in a guide/list of objectives and questions to answer in the form of the engineering design process, a copy of the rubric that the boardroom members will use to score the presentations, and access to three separate 5-minute question sessions with teachers. For projects that involve more difficult experimentation, an additional experimental procedure document is given to students as well as online videos are available on the 'You're Hired!' website to assist in student discovery.

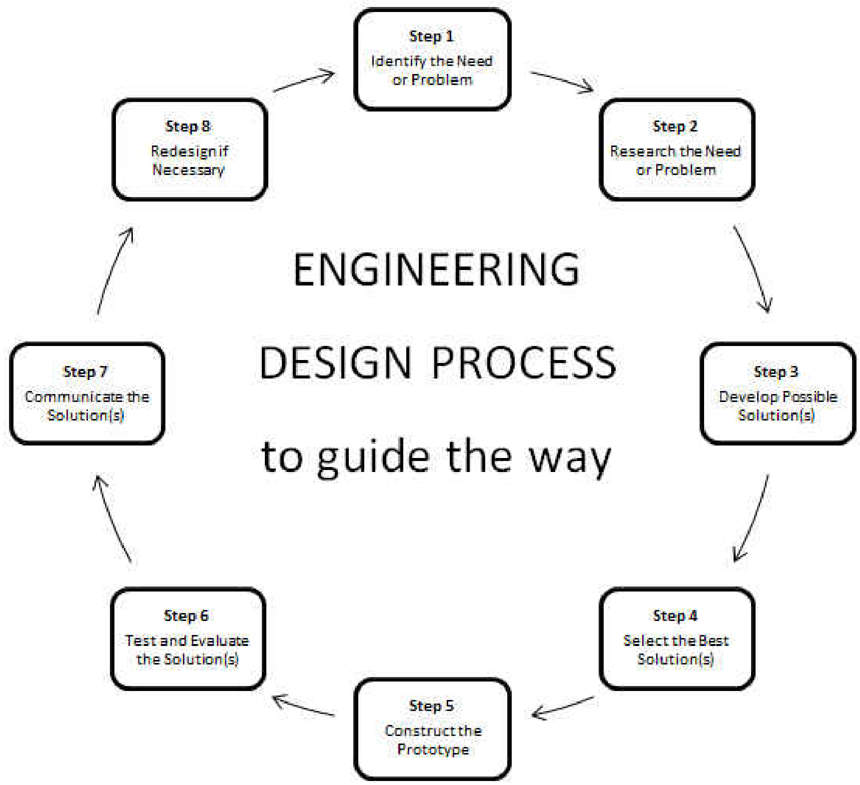
For the oil spill design challenge, students were given a written introduction as shown in Figure 4.1. The experiment kit included an oil dropper, vegetable oil, a plastic cup, a spoon, and Magic Sand.

> An environmentalist group known as **Greener Ways** has decided to undertake the large task of safely cleaning up oil spills. It's estimated that millions of gallons of oil enter the oceans each year, from ship motors, natural leaking, and oil spills. The oil waste then reaches the coastal shoreline and contaminates beach vegetation, wildlife, and swimming environments.
>
> **Greener Ways** has developed a break-through product that is predicted to clean oil spills easily and effectively. They have developed a product known as Magic Sand that they would like to use to clean up such incidences.
>
> Your company is a state of the art company that is very good at cutting edge technology. Your company has been chosen to be one of the finalists in our search for a company that will be able to use the Magic Sand to clean up an oil spill.
>
> Your company's tasks will be to:
> - Research
> - Experiment
> - Advertise
> - Market the product
> - Come up with a presentation to convince us to use your company over other leading companies.

Figure 4.1. Oil Spill Problem Statement.

Once the introduction is completed and the students break into their pre-determined companies the students must define their company including a name, mission statement, logo and organizational roles. A company profile sheet within the student information packets calls out specific roles, requiring the students to take on specific tasks during the day. In the design of the individual activities, groups of students should preferably not be larger than 8 students in order keep students feeling necessary and engaged in the activity. With this design there are enough students in the group so that more than one student can take on a given role for the day, however if one student is not participating or has to leave school for some reason, the group can still manage and be successful. Typical roles include manager, advertising specialist, website designer, engineer, and technician. Each 'You're Hired!' activity tailors the engineering and technology-related roles to the specific careers that would actually be working on the problem. This level of explicit detail provides the practical application of role responsibility in a STEM career and draws a strong connection between their one-day experience and a possible future career.

After the company is defined, the students work on developing their solution in a problem-based/active learning environment for a majority of the school day (4-5 hours). Students are guided in what they should be doing in the form of an engineering design process sheet which is included in their paper packets. This engineering design process document as shown in Figure 4.2 guides the student companies through an engineering mindset of: identify the problem, research the problem, develop possible solutions, select best solution, construct a prototype, test and evaluate the solution, redesign if necessary, and communicate the solution. As students go through the engineering design process there are a series of 'questions to consider' that are asked in order to get students to think about and find a solution that meets the objectives of the given activity.



1. Identify the need or problem
- Problem statement given at the beginning of the day
  - Employees understand project objective, roles, and responsibilities
  - Company Information Sheets due at 9:30 AM

2. Research the need or problem
- Examine current solutions
- Explore other options via internet, library, interviews, videos, etc.
  - How much oil was spilt? (Use information on the Gulf Oil Spill)
    - Make me care! – How many swimming pools is that? What about classrooms?
  - How does Magic Sand really work?
  - What impact did the oil spill have on a community, wildlife?

3. Develop possible solutions(s)
- Brainstorm possible solutions
- Use your knowledge from all of your classes
- Present the solutions using little sketches/drawings

4. Select the best possible solution(s)

5. Construct a prototype (model)
- How does it work?

6. Test and evaluate the solution(s)
- Does it work?
- Does it meet the requirements?

7. Redesign (if necessary)
- Based on your tests

8. Communicate the solution(s)
- Make a presentation that includes a discussion of how the solution(s) meets the needs of the original problem or need.

Figure 4.2. The Engineering Design Process.

Identify the Problem

The students were initially made aware of the problem during the introduction. The company also has a written form of the introduction/problem statement available to them in their company packet and should utilize that document in order to clearly identify the objectives for the project. For the example of the oil spill project the objectives are stated that the students should first determine if the nano-based coated sand, Magic Sand, works to clean up oil spills, and second the companies should come up with a prototype for using the sand to clean up the 2010 Gulf Oil Spill.

Research the Problem

Once students have turned in their company profile sheets, it means that students know what their role in the activity will be and can start working on the next step of the engineering design process. In researching the problem, the engineer and technician will generally start by looking over the experimental supplies given. The engineers and technicians should research and learn the basics of the nano-based coating on the sand. The sand coating is hydrophobic which means it repels water. The sand and oil do not repel one another, in fact the combination of the nano-based coated sand and the oil creates a somewhat viscous mixture which potentially could make it easier to clean. The advertising marketer along with the web designer should research facts about past oil spill clean ups, methods that are utilized versus not utilized, how using this sand would give the company a leading edge over other methods, etc. Advertising marketers along with web designers will also use this step to find images and facts about the 2010 Gulf Oil Spill.

Develop Possible Solutions

The companies may look into other methods of cleaning up oil spills for guidance. For example, when researching oil spills, a group may find that booms are used to contain the oil to a specific area. Students might choose to use a design similar to this to contain the oil spill before using the sand. When developing possible solutions, students are encouraged as part of the engineering design process document to create sketches or construct make-shift prototypes out of materials found in the classroom to better explain their ideas. Students work through the details of their proposed solutions in order to determine the feasibility of them.

One of the tasks students have to complete is to prepare a cost estimate for the clean-up. This cost estimate keeps students from finding solutions that involve major equipment and excess resources. Students have to think about how many helicopters or ships they would use. What is the cost of the sand and how much do you need for your design? It is important that students think through their solutions and are able to justify their decisions in the boardroom.

Select the Best Solution

Once the students have thought through a couple possible solutions, the company will select its best solution. This solution should be explained in detail including rough cost estimations and drawings.

Sometimes the solution the company presents in the boardroom is the only solution they thought of, the students did not consider a redesign. When this happens, generally the presentations are weak in detail and explanation. Teachers are encouraged to take advantage of this situation and talk to the students about the importance of the engineering design process and making sure brainstorm and redesign are part of that process. The teacher input generally takes place during the 'Teacher Feedback' portion of the boardroom hour or the next school day.

Construct a Prototype

Constructing a prototype is the part of the project where students can be creative. At this point, students know the experiment and what their solution is and can create a visual for the boardroom. For the oil spill project this could include using a paper towel as an example of the fine-holed net that is suggested to keep the oil/sand combination from sinking to the bottom of the ocean after distribution of the sand, or the bucket and fish tank pump that is designed to circulate the ocean water and capture the oil/sand mixture in a filter before releasing clean water back into the ocean.

In some 'You're Hired!' projects, a prototype isn't as straight forward. For example the Energy activity doesn't have a prototype the students can build necessarily, so instead students must present their final solution in the form of a mathematical model. In regards to saving energy, does switching light bulbs really increase savings, or would it be more beneficial to unplug unused appliances? Students must do the math and then determine what they think the best solution is, and how much energy their company can save if their solution is implemented.

Test and Evaluate Solution

Students should test their prototype before presenting in front of the boardroom. This point of the activity might be the first time other group members have seen the solution the engineers and technicians have come up with first hand. The engineers and technicians should have been communicating their ideas to the advertising specialist, the web designer and the marketing team so that those individuals could tailor their work, but this may be the first time everyone has seen an actual prototype/product. Pictures and/or videos are usually taken at this point in order to best convey the solution to the boardroom.

Redesign if Necessary

If a small fix cannot solve the design issues with the prototype, then students should try out other options as part of the redesign process. It is important to both the students and the boardroom members that the presentations include something that is tested and that works.

Out of all the engineering design process steps the students go through during the 'You're Hired!' activity, this is the step that is overlooked the most. There is an abundance of time and effort that goes into getting to a solution for these projects. When a solution does not work the way the students think it should, the students may decide to keep it due to a timing issue, or because they still think it is a good idea.

Communicate the Solution

Once students have prepared a solution, they must present that solution to the boardroom. Students must put together a presentation including key elements stated in the problem statement, the engineering design process worksheet, and the boardroom scoring rubric. Students should understand their presenting time limit and have practiced to ensure they could meet that time limit.

Most importantly, students need to make sure they are prepared to answer questions based on what they worked on throughout the day. They are the experts in their role, and the boardroom members may ask them questions based on what they did during the activity.

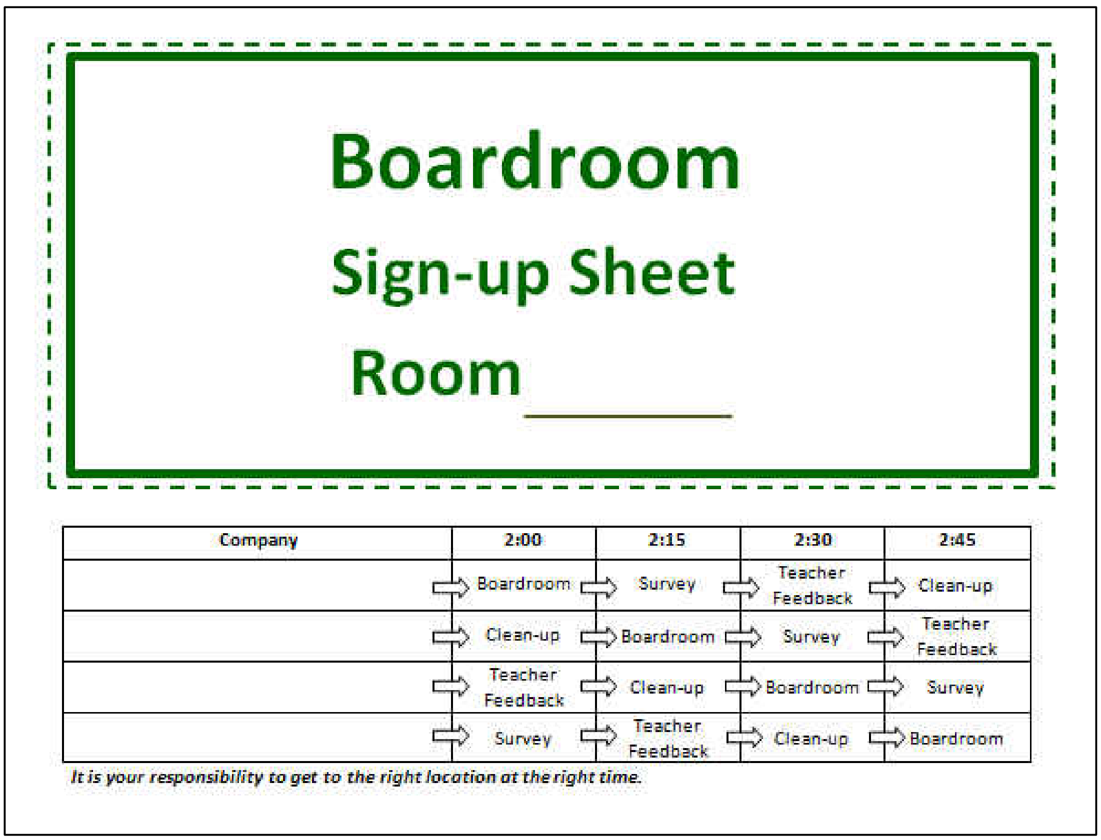
The program is designed so that during the 4-5 hours the students are working to develop a solution, the amount of interaction and collaboration between students is ample, whereas the amount of interaction with the teachers is minimal.

While teachers do not interact with the students as much as they would on an average school day, the teachers play a key role during the day by providing content knowledge on a just-in-time basis through a system of question vouchers. For the day-long activity each student group is given three vouchers that can be used for 5-minute question sessions with a teacher. These question sessions provide direct teacher instruction on the specific topics of immediate interest to students. Because these mini-lessons are student-instigated at a time of need, rather than force-fed by teachers at the beginning of the day before their importance is clear, students are in a much better position to understand the necessity of the information provided and its relevance to their problem-solving and investigating practices. Additionally, 'such just-in-time instruction promotes knowledge construction in a way that makes knowledge more available for future use in relevant contexts.' (Hmelo-Silver, Golan Duncan, & Chinn, 2007) (Edelson, 2001) The number of vouchers is limited to encourage students to problem solve and collaborate together instead of immediately looking to a teacher for the "correct" answer.

Because the 'You're Hired!' activities build on knowledge students already have, all students are able to participate and they can do so independently from teachers. For example, with the oil spill activity, students are told that millions of gallons of oil are introduced to the oceans each year. The students are then told they need to be able to convey this information to the boardroom to make them care about not only the issue, but the clean-up efforts. To do that, students need to first understand for themselves the volume of oil that was spilt. Students are guided on the engineering design process sheet to convert the huge unimaginable number of 'millions of gallons' to a more approachable value such as 'x' number of classrooms full of oil is spilt. Students determine for themselves what they would like to compare the volume of oil spilt to (classrooms, swimming pools, bathtubs, etc.), and then use their knowledge of volume calculations and unit conversions to solve. The Common Core Standards Initiative states that by the 5th grade, students are to have been introduced to volume calculations and unit conversions. (Grade 5 Measurement & Data, 2014)

Due to the problem based nature of this program, students are encouraged to utilize technology and other resources such as the library to guide them to useful information that can assist them in finding a solution. Students will quickly see that 'You're Hired!' is a project that merges all their different classes together in a real-world application. If students cannot find the answer they are looking for, they have the chance to use one of their three 5-minute questions sessions to ask a teacher for guidance.

Students are not told when they are supposed to present to the boardroom, instead students take responsibility and sign themselves up for an appropriate time on the Boardroom Sign-Up Sheet as shown in Figure 4.3, which also includes times for students to take the post-activity survey, clean-up, and talk with the teacher from their classroom to receive immediate feedback on their efforts and success. Students are also not instructed on what type of a presentation they should give. Some students will choose to present via PowerPoint, others through a Prezi. Some students might decide to present through the website they designed throughout the day. The boardroom presentation is broke into two parts, a six minute presentation followed by four minutes of questions to total ten minutes in the boardroom. Students should know what the boardroom is expecting because they were given a copy of the boardroom scoring rubric as one of the documents in the paper packet. The boardroom rubric states that companies will be scored on different aspects including the engineering design process, teamwork, and creativity of the solution, etc. Whether the students chose to read through every document in that packet is up to each individual company.


Boardroom

Sign-up Sheet

Room ______

Company	2:00	2:15	2:30	2:45
	⇨ Boardroom	⇨ Survey	⇨ Teacher Feedback	⇨ Clean-up
	⇨ Clean-up	⇨ Boardroom	⇨ Survey	⇨ Teacher Feedback
	⇨ Teacher Feedback	⇨ Clean-up	⇨ Boardroom	⇨ Survey
	⇨ Survey	⇨ Teacher Feedback	⇨ Clean-up	⇨ Boardroom

It is your responsibility to get to the right location at the right time.

Figure 4.3. The Boardroom Sign-Up Sheet.

The companies present their solution to the challenge in front of a boardroom comprised of school board members, school administrators, and local industry representatives including local engineers. Generally a boardroom is made up of 2-4 volunteers and can see 4 companies per hour. In the design, 2-4 volunteers consistently can generate quality questions and still have time to properly assess the student presentations. Company presentations involve all students that participated throughout the day. Understanding that one or two students might lead the presentation, all students must be available and ready for any questions the boardroom members may have.

The boardroom not only provides immediate feedback on the company's solution, marketing and presentation, but also includes recommendations for improvements, both of which enhance overall student learning by affirming that students' contributions and ideas have value. For students, this feedback from the boardroom is different than teacher feedback. Students see teachers every day and become accustomed to how teachers asses their work. The boardroom provides a fresh perspective to both the student efforts as well as the teacher efforts which is beneficial.

The boardroom is not the only time students get feedback. During the post-activity survey students are asked questions about the specific activity they just completed. The survey questions provide a chance for the individual students to reflect on how they thought they did throughout the activity in terms of 21st Century Skills. This survey also provides students the opportunity to assess how well their group members did regarding the same 21st Century Skills. There is an area on the survey for individuals to reflect on the things they can improve as well as an area in which students can set goals for the next activity. Peer/Self feedback is returned to the individuals shortly after the activity is completed, within a school day or two. Students receive a hand-out similar to the one shown in Figure 4.4. This feedback provides an anonymous average of how a group rates an individual compared to how that individual rates themselves. The ability for students to give honest feedback to their peers comes with knowing that their assessment of their teammates is anonymous. This reduces the challenges that are associated with peer feedback.

'You're Hired!' Student Data

Student Information

Name
Company Name

21st Century Skills Assessment (*5-Excellent Job, 1-Not Acceptable*)

Skills Assessed	Self-Assessment	Company Members (N=8)
Leadership	5	4.8
Participation and cooperation	5	4.9
Contributions to the project	5	4.9
Attitude	4	4.6
Commitment to the group's success	5	4.9
Ability to put themselves in another person's shoes	4	4.5
Ability to identify and move onto the next task without being told to do so	5	4.8

Personal Reflection

Where on the scale below would you place your group's presentation and WHY? Be sure to cite as evidence the board room's reaction as well as your "gut feeling".

Ok on the day: We didn't have a product ready to show

Overall, for next time...What are three things you would do differently? Why?

1. Make a product to sell first
2. Different teams
3. Have fun doing it so we have better attitudes

Please describe what you did today? How did you contribute to the project?

I wrote scripts for everyone and helps with poster and go things straight when managers were gone.

How can you use your reflection and peer evaluation to be more of a team player in solving conflict or keeping yourself and others on task?

Letting others help me

Figure 4.4. Peer/Self-Assessment Feedback.

Some of the ‘You’re Hired!’ activities can get messy. Clean-up is simply that, a time for students to straighten up the room, hallways, area they had occupied throughout the day and ensure that the school is cleaner after the activity than it was before.

‘You’re Hired!’ is designed to be a series of short term interventions that give students authentic experiences that can later be built on in the classroom. During the activity teachers are available for student support, but also have the opportunity to stand back and observe student learning. This allows teachers to see gaps within students’ ability to utilize educational material and take notes. During the boardroom hour, teachers have the opportunity to sit down with each individual company for 15 minutes to give immediate feedback on what they observed throughout the activity.

The boardroom hour generally ends shortly before the end of the school day. After the final boardroom session, depending on how much time there is before the day ends, some schools choose to compile boardroom winners quickly and announce the winners of each boardroom before the students leave. It is suggested that each boardroom has its own winner due to the differences between boardroom members scoring. By keeping the boardrooms separate in terms of scoring, if a judge tends to give high scores, than that judge will give all the companies high scores which will average out as opposed to one boardroom scoring average presentations highly and another boardroom scoring presentations low.

In the following days in the classroom, teachers now have a personal experience for students to reflect on while revisiting key material. For example, an English teacher at one school realized that while students had learned about citations, many of the presentations did not use them correctly. That teacher was then able to revisit the topic in the classroom, using the ‘You’re Hired!’ activity as an example. During the next activity, the students did much better at understanding the importance of citing the information they found. As I continue to develop the ‘You’re Hired!’ program, the addition of professional development for teachers will be a key component, including training on how to take ‘You’re Hired!’ teacher observations to the next level and allowing teachers to be able to reflect with the students on their experiences in the regular classroom.

After the school year is over and data has been compiled and analyzed, a report is put together for the schools. Late summer/early fall the report is distributed to the school contacts with the intent that the report will provide motivation for the school to participate again the following year. In the report the specific school’s student pre-survey and post-survey results are presented. Those results are then compared to an anonymous grouping of all the other participating schools. This allows schools administrators to see not only the progress that their students made, but also where their students stand in comparison to other schools doing the same project. A large motivator for the schools comes from the data about program impact on students. If a high percentage of students agree that the ‘You’re Hired!’ program ‘helped them understand problem solving better’, that would provide a very positive result for the school officials to see, and ultimately would be a motivator for the schools to participate again.

CHAPTER IV

RESEARCH METHODOLOGY

The purpose of this research was to determine the success of the ‘You’re Hired!’ engineering education program at changing students’ attitudes and understating of engineering.

In order to research the effectiveness of the “You’re Hired!’ program at promoting positive attitudes towards engineering, pre- and post-surveys were used for summative evaluation of students’ awareness and perceptions towards different aspects of engineering. The pre- and post-survey responses were studied using statistical analysis, considering factors such as program participation, gender and school. The influence of these factors are thought to be able to provide insight when designing a program that can work not only in one specific area, but that can be scaled and able to sustain to benefit a larger region. Data from these surveys has been used to address the following research question: Does the ‘You’re Hired!’ program lead to a change in student attitudes towards engineering? The other key metrics for project effectiveness, increased engineering design skills and enhanced 21st Century skills, are not directly assessed in the student surveys. Separate assessment rubrics for measuring student growth in these areas are under development. Evaluation for this research, therefore, focuses on student attitudes toward and understanding of engineering careers.

This research study provides a solid platform that can be used as motivation for more in depth future research work. This research is the first step of many in determining an effective engineering education experience for not only students, but for teachers, administrators, and the community.

4.1 Institutional Review Board (IRB)

My research on the 'You're Hired!' program involves humans as research subjects and thus the study had to be approved by an Institutional Review Board, IRB. The job of the IRB is to ensure the safety of all human subjects that are involved in research. This research project on the 'You're Hired!' program was approved through the University of North Dakota's IRB. In order to meet IRB requirements, every school participating in the research study needed to complete the following two items.

First, a school administrator had to write and sign a letter of willingness to participate in the project. The letter stated that the administrator would like the 'You're Hired!' program in their school for the upcoming year and included a list of deliverables the administrator agreed to provide. That list included deliverables such as: students would take a pre-survey, the school would complete 3 separate 'You're Hired!' activities, students would take a post-survey, and that teachers would provide feedback to the program design team.

Second, students had to provide assent to participate in the project. Because the IRB declared that the program was similar to what a normal classroom could potentially do, parental consent was not required for students under the age of 18 to participate. The program is part of a research project however, so assent from every student stating willingness to participate was necessary. The assent form was presented to the participants as the first page of the pre-survey that every student took. If a student chose not to give assent, the student still participated in the program, however their data was not included in the research statistics.

Along with the two required pieces of documentation, the IRB also required that all documents that were used for the activities be accepted through the IRB approval process. That means that every document for each activity needed to be approved in order for it to be used as part of the research project.

4.2 2012-2013 You're Hired! Program

Prior to the 2012-2013 school year, there were only two schools that had experienced 'You're Hired!' as a proof of concept for an all-day engineering education activity. Both of the schools showed great interest and as a result work was done to pursue the program. The 2012-2013 school year was the pilot year for 'You're Hired! and included 17 schools. Of those 17 schools, three were included in the research study. Each of the three schools is considered suburban, however at varying degrees. Two schools were middle school grades (7-8) in which there was roughly 80 students per grade, and one school consisted of a cohort of high school students (grade 10) in which there was 18 participants.

Data Collection

Shortly after the start of the 2012-2013 academic year, schools administered a paper copy of the letter of assent to each student to read, sign and return. Only 10 of 17 of schools completed student assent forms. Without these forms, the individual student responses cannot be used as research data.

Schools then had students take either a paper or electronic pre-survey adopted from the Assessing Women and Men in Engineering (AWE) Core Middle School Immediate Pre-Participation Survey. (AWE instrument user guide - pre-college surveys, Accessed 2011) This survey established the baseline data of their initial exposure and knowledge about engineering and how this exposure and/or knowledge influences their decisions about future career paths. The survey also includes background questions such as age, gender, previous classes taken, etc. Because the survey tool was designed by AWE, there were questions asked that did not pertain directly to what I wanted to research, the change in attitudes towards engineering. From the survey, four main categories of questions were analyzed; Engineer, Future Work, Interests, and Attitude and Skills. The pre-survey provided an evaluation of these four question categories when compared to the end-of-the-year post-survey. Another category involving Impact of the program was also included in the post-survey analysis. In total 14 of the 17 of schools in the pilot year did not complete required documentation such as pre/ post-surveys or letters of willingness to participate from an administrator which were needed to be included in the research.

Both pre- and post-survey questions with the allowed categorical responses are listed in Table 4.1. Attitudes towards Engineer questions (E1-E8) relate to direct attitude and perception about the field of engineering and the interest in becoming an engineer. Future Work (F1-F9) and Interest (In1-In11) questions provided a background of the type of students that were participating in the program. Self-Efficacy, or Attitude and Skills questions (A1-A8) were chosen to measure the student’s attitude in regards to his/her understanding of the concept of the engineering design process and ability to successfully work with or lead a team to an effective solution. Project Impact questions (Im1-Im9) were used to gain insight into the students' perspective on the overall project. A full list of all questions asked on the pre-/post-surveys, including demographic questions, can be found in Appendix A.

Table 4.1. Electronic Pre-Survey and Post-Survey Questions by Category with Response Options.

IMPACT: How much did participating in the activity impact each of the following: (Not at All, Slightly, Moderately, A Great Deal)	
Im1	Helped me to understand problem solving better
Im2	Led me to a better understanding of my own career goals
Im3	Increased my interests in studying engineering in college
Im4	Increased my interests in studying a technical degree in college
Im5	Made me think more about what I will do after graduating from high school
Im6	Made me decide to work harder in school
Im7	Made me decide to take different classes in school (including college) than I had planned to
Im8	Made me more confident in my ability to succeed in engineering or a technical field
Im9	Increased my confidence in my ability to participate in engineering projects or activities
ENGINEERS: Read the following statements about what engineers might do and indicate your agreement or disagreement with each statement: (Agree, Disagree, Don't Know)	
E1	Mainly work on machines and computers
E2	Mainly work with other people to solve problems
E3	Work on things that help the world
E4	Can choose to do many different kinds of jobs
E5	Mainly work on things that have nothing to do with me
E6	I don't know what engineers do
E7	Pursue a career in an engineering-related field?
E8	Do you think you want to be an engineer?
FUTURE WORK: How important is it to you to do: (Not Important, Somewhat Important, Very Important)	
F1	Work that makes me think
F2	Work that allows me to make lots of money
F3	Work that allows me to use math, computer, engineering, or science skills
F4	Work that allows me to tell other people what to do
F5	Work that allows me to help solve problems and create solutions
F6	Work that is fun to do
F7	Work that allows me to have time with family
F8	Work that allows me to help my community and/or society

Table 4.1. cont.

FUTURE WORK: How important is it to you to do: (Not Important, Somewhat Important, Very Important)	
F9	Work that makes people think highly of me
F10	Work that is satisfying to me
INTERESTS: Here is a list of statements. Tell us what you think about them. Select a response that indicates your level of agreement: (Strongly Disagree, Somewhat Disagree, Somewhat Agree, Strongly Agree)	
In1	I look forward to science class in school
In2	I look forward to math class in school
In3	I would rather solve a problem by doing an experiment than be told the answer
In4	More time should be spent on projects in science or technology activities at school
In5	I would like to (or already do) belong to a science or technology activities club
In6	I get bored when I watch programs on channels like Discovery Channel, Animal Planet, Nova, Mythbusters, etc.
In7 In8	I like to get science books or science experiment kits as presents I like learning how things work
In9	Science is too hard when it involves math
In10 In11	Science is a difficult subject Doing experiments in science class is frustrating
In12	I feel comfortable with using a computer to make graphs and tables
In13	I am interested in learning more about how things work
In14	I like to learn to use new technology
ATTITUDES AND SKILLS: The table lists things you can do when you are working on school activities or assignments. Check the appropriate box to tell us how often you do each of these things: (Never, Sometimes, Very Often, Always)	
A1	When I see a new math problem, I can use what I have learned to solve the problem
A2	I can use what I know to design and build something mechanical that works
A3	In lab activities, I can use what I have learned to design a solution to a problem
A4	I can effectively lead a team to design and build a hands-on project
A5	I know where I can find the information that I need to solve difficult problems
A6	I can explain math or science to my friends to help them understand
A7	I can get good grades in math
A8	I can get good grades in science

After students took the electronic pre-survey, the school completed three separate 'You're Hired!' activities throughout the school year. For the 2012-2013 school year the activities included: 1) using nano-technology coated sand to clean up an oil spill, 2) experimenting with reaction times and creating a prototype to end texting while driving, and 3) creating a school lunch menu that follows all new nutrition standards.

At the end of the academic year, roughly 2-4 weeks after the school had completed the third and final 'You're Hired!' activity, students completed the paper or electronic post-survey. Each participating school received a year-end report anonymously summarizing their students' responses. This report also included a school by school comparison with all student and school names and identifiers removed. An example copy of this year-end report can be found in Appendix B.

The pilot year went well, however there were gaps in the program design that made it difficult to gain all of the necessary information from the schools. To address these shortcomings, several elements of the program were redesigned for the 2013-2014 school year.

4.3 2013-2014 You're Hired Program

For the 2013-2014 school year, there were three schools that participated in the research study: School A, School B and School C. School A and School B had 7th grade participants whereas School C had both 7th and 8th grade participants. School A and School B have much larger class sizes than School C.

The class size in School A is large enough that students are broken down into pods, or sub-sections of students within a grade. The pods of students stay together and have their own set of primary teachers including: math, science, geography and English.

School A allowed the project to have an experimental versus control comparison by having one pod complete the surveys as well as the three separate ‘You’re Hired!’ activities whereas the control group only completed the surveys. School B and School C provided experimental groups only.

Redesign

As part of redesign for the 2013-2014 school year, the student assent was included on the electronic pre-survey as the first question the students read. Students could choose to participate or to not participate in the research before continuing with the rest of the pre-survey. Redesign also included an improved system to make sure that all schools complete the necessary documentation in a timely manner, while improved, this system will need to continue to be redesigned.

Electronic pre- and post-surveys were also part of the pilot year redesign. In order to analyze the data, responses to the survey questions needed to be entered into the data analysis software. To do that, every paper version of the pre- or post-survey needed to be hand entered. This method of manually entering data was not only time consuming, but can lead to errors when typing the data in. In designing a program that could eventually scale across a broader region, it was important to move away from paper surveys towards electronic versions. In the 2013-2014 school year and future years to come, only electronic versions of the surveys will be available. The electronic documentation used for the 2013-2014 program allowed me the ability to quickly see and address schools that had outstanding deliverables needed for research.

Increased discussion about engineering and possible engineering careers throughout the activities was another point for redesign. Students could remember the activities they had previously done, but had a hard time remembering the role which they played during that activity. Company profile sheets were changed as part of redesign to include more specific roles for everyone. Originally engineering and technician roles were called out with great detail, while the other roles were more general, such as manager, researcher, and marketer. It is believed that the generalization of roles lead the whole group to not remember their job for the activity. Redesign for the 2013-2014 school year included the same specific engineering and technician roles aimed at the current project as well as manager, website designer, and advertising specialist, all careers that students could look into and find not only career information, but college information as well. Overall, more emphasis on roles and responsibilities throughout the day, including the boardroom was used during the 2013-2014 school year.

With the goal of increasing student engagement, the process of providing feedback was redesigned to ensure that after each activity, students received all forms of feedback within one to two days of school. This feedback included boardroom presentation results, peer/self - assessment results, and teacher feedback. This immediate feedback is something that was missing from the 2012-2013 school year, but that is one of the key attributes in the program design.

Although the survey questions were another item identified as needing redesign, in the process of scientific research, it was decided that for the 2013-2014 redesign only the structure of the project activity would be changed, while the survey questions would remain unchanged to provide a consistent basis for measuring if the changes could alter student responses. In future redesign, the survey will be looked at closely and changed to better fit the needs of the program.

4.4 Data Analysis

Removing Identifiers

In accordance to IRB requirements, all data analysis and data handling needed to be done without calling out individual student names. To do that, I created student identification numbers for all students and then paired their responses to their number. The student identification numbers can be traced back to original names by only a select group of approved researchers that have access to the research analysis storage folders.

Prior to the redesign that was done for the 2013-2014 school year in which all assent and pre-surveys were done electronically, all students signed a paper version of the assent and some schools had their students take a paper version of the pre-survey. All of these documents with student names need to be kept in a safe place. The documents are organized by school and are locked in a cabinet at North Dakota State College of Science's Fargo campus.

Data Analysis

The data from the pre- and post-surveys for the three 2012-2013 and three 2013-2014 schools was downloaded from the online survey site called Surveymonkey, formatted in excel and analyzed using the statistical software JMP 7. Over the two years, five different schools participated in 'You're Hired!' There was one school, School C that participated during both years.The 2012-2014 data was analyzed in four sets; results from School A's experimental and control groups, results from all students that participated in the project, results based on school and results based on gender in order to understand the project impact more clearly. Descriptive statistics including means, 95% confidence intervals and standard error were calculated as well as significance testing using p-value and chi^2.

The chi-square test along with its associated p-value was used to determine the significance of categorical data. Because the pre-and post-survey responses were categorical, this test is an appropriate tool for determining significance. The chi-square test measures the statistical difference between two or more independent sets of categorical data. The p-value calculated from the chi^2 result is the probability that the data sets are not different.

The categorical data was also converted into numerical data using a Likert Scale. Once numerical data was available, descriptive statistics such as means and 95% confidence intervals were calculated.

I used the categorical data to determine the p-values. The survey questions students answered were presented as categorical, and I believe that p-values based off of this analysis are the most accurate. When the data was converted to a Likert Scale there is deviation that may arise because the Likert Scale is not how the students perceived the response options. However, the Likert Scale allowed for an additional opportunity to see changes in responses based on the difference in means and confidence intervals between pre- and post-surveys. The converted numerical data was not used to determine significance.

The first set of data analysis consisted of primary significance tests to determine the program impact by comparing pre- to post-survey responses for the control vs. experimental group. For this comparison, only School A that had both a control and experimental group was included. All other schools that did not have a control group associated with the experimental group were left out of the analysis in order to understand the project impact more clearly.

The second analysis set included experimental data from all schools to see if the same significance was present between pre- and post-survey responses from the full "All-School" experimental group for those same questions that showed significant differences between responses for the experimental and control groups at School A. This analysis also provided responses that were significant for the All School experimental only group that was not present in the School A experimental group versus control group analysis.

When analyzing the results for this research study, it is important to note that School A has been working over the last couple years to integrate STEM, especially the engineering design process into the various grades within the school. The experimental group at School A was part of the STEM track whereas the control group was part of the non-STEM, more traditional track. While overall the STEM track is still new, and the number of actual activities is still limited, it is possible that the increased exposure to STEM activities resulted in a difference for these students.

CHAPTER V

RESULTS & DISCUSSION

This chapter summarizes the statistically significant changes that were observed when completing a statistical analysis on every question that was asked of the students during the ‘You’re Hired!’ pre- and post-surveys. In each section, the results are objectively stated, followed by a brief discussion of the results.

Section 5.1 looks at data from the school with separate experimental and control groups, School A. In this section, responses from an experimental group made up of students that completed both pre- and post-surveys as well as three separate ‘You’re Hired!’ activities is compared to a control group made up of students that completed pre- and post-surveys, but no ‘You’re Hired!’ activities. Section 5.2 looks at the experimental group responses from all 5 schools, also referred to as the all-school experimental group. The responses in this section are a representation of every student in every school that participated in the ‘You’re Hired!’ program. Section 5.3 looks into differences that were seen between the all-school experimental group responses when comparing each of the five schools to each other. Section 5.4 presents an analysis of the questions by gender for every student and every school participating in the activities. Finally in Section 5.5 results on the impact of the ‘You’re Hired!’ program are presented. Students that participated in the three ‘You’re Hired!’ activities were given a post-survey that had extra ‘Impact’ questions on it. The results of what the students thought about the program specifically can be found in this section.

The analysis in this chapter supports the hypothesis that 'You're Hired!' positively influences students' ideas and attitudes of engineering.

5.1 School A - Analysis of Experimental and Control Group Responses

Table 5.1 contains questions from the pre- and post-survey in which there was a statistically significant difference between experimental and control group responses for either survey or between pre and post responses for either group for School A. The questions listed in this table were present on both the pre-survey as well as the post-survey. If a significant difference was determined for any of the comparisons, then the question was included for analysis. The significance differences were determined by the values of the analysis having p-values less than or equal to 0.05.For each category of question, Engineer, Future Work, Interest and Attitudes and Skills there are two tables of data. One table is for the pre- and post-survey comparisons, the other table is for the comparisons between experimental group and control group. It is possible that for the comparisons in one table, the question is not significant, but for the comparisons in the other table the question is significant. Out of the four categories of questions; Engineers, Future Work, Interests, and Attitude and Skills, three categories contained questions that showed significant differences in the survey responses. The three categories that contained significant shifts were; Engineer, Interest, and Attitude and Skills. Statistical analysis of the different questions can be found in Figures

5.1-5.3 and Tables 5.2 –5.7. Statistical analysis of every question, including questions that were not significantly different, can be found in Appendix C.

Table 5.1. Statements Showing Statistically Significant Differences in Responses between either Experimental and Control Groups for either Survey or between Pre- and Post-Responses for either Group for School A.

Engineer Questions	
E1	Mainly work on machines and computers
E2	Mainly work with other people to solve problems
E4	Can choose to do many different kinds of jobs
Interest Questions	
In1	I look forward to science class in school
In4	More time should be spent on hands-on projects in science or technology activities at school
In5	I would like to (or already do) belong to a science or technology activities club
In8	I like learning how things work
In9	Science is too hard when it involves math
Attitude and Skills Questions	
A4	I can effectively lead a team to design and build a hands-on project
A8	I can get good grades in science

5.1.1 Engineer Question

Figure 5.1 and corresponding tables, Table 5.2 and Table 5.3, show a statistical comparison of responses for the Engineer statements that displayed statistically significant differences. The statement from the surveys for this category read, 'Read the following statements about what engineers might do and indicate your level of agreement or disagreement with each statement.' Response choices for these statements were converted to a Likert scale in order to further compare the responses, with 'Agree'=3, 'Don't Know'=2, and 'Disagree'=1. It was decided to put 'Don't Know' as an intermediate value on the Likert scale because it was more of a neutral response between the 'Yes' and 'No' responses.

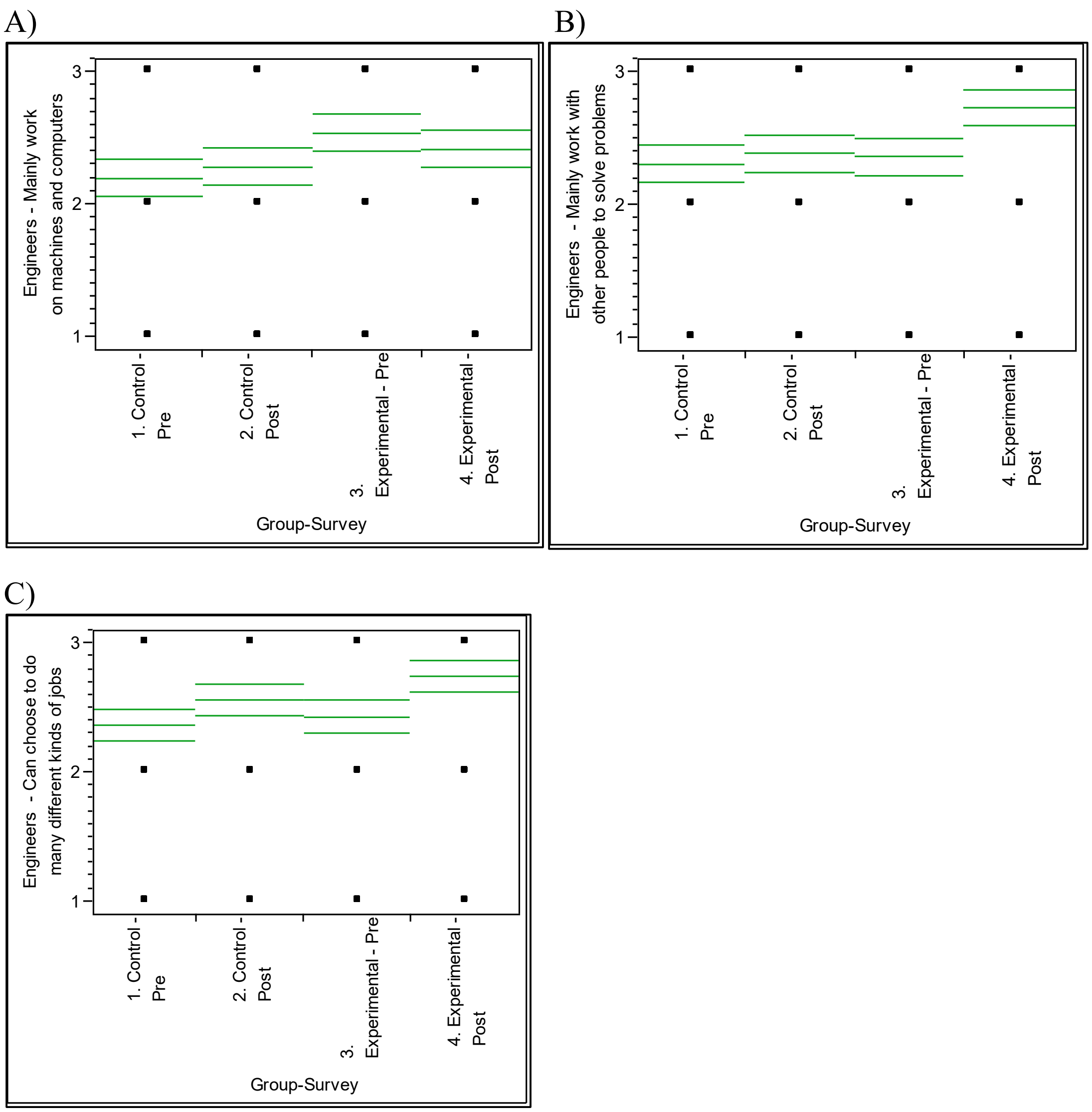


Figure 5.1. Comparison of Mean Values for School A's Experimental and Control Group Responses for Engineer Statements on Pre- and Post-Surveys. A) Statement E1 – Mainly work on machines and computers, B) Statement E2 – Mainly work with other people to solve problems, C) Statement E4 – Can choose to do many different kinds of jobs.

Table 5.2. Statistical Comparison of Pre- and Post-Survey Responses to Engineer Questions for Control and Experimental Groups at School A.

Engineers	Group	N	P-Value	X^2	Pre-Survey Mean	Post-Survey Mean
E1 - Mainly work on machines and computers	C	270	0.74	0.60	2.20	2.29
	E	271	0.30	2.42	2.54	2.42
E2 - Mainly work with other people to solve problems	C	267	0.30	2.40	2.31	2.39
	*E	269	<0.01	17.52	2.36	2.74
E4 - Can choose to do many different kinds of jobs	*C	266	0.05	6.21	2.37	2.57
	*E	270	<0.01	13.18	2.43	2.74

*Significance: p-value less than or equal to 0.05
C: 'Control Group' and E: 'Experimental Group'
Degrees of Freedom (DF) =6

Figure 5.1 summarizes the data in numerical form in which the dots represent the possible answer choices. For example with this set of Engineer statements, there were three answers the students could choose from: 'Agree' (3), 'Don't Know' (2), and 'Disagree' (1). The middle line for each group is the mean for that particular group's responses. The green, horizontal outer lines for each set of responses represent the upper and lower 95% confidence intervals around the mean response. The x-axis contains the pre- and post-responses of each of the two groups, control and experimental. The y-axis displays the answer options in Likert scale format. The categorical data was converted to numerical data using the Likert Scale to provide another analytical method, comparison of means.

Tables 5.2 and Table 5.3 provide a statistical comparison of the categorical responses to the Engineer questions. P-values less than or equal to 0.05 are considered significant. The pre- and post-survey mean values are also included and represent the same value that is shown in the figures as the middle line for each group. Table 5.2 displays the analysis based on each group with p-value and chi^2 statistics representing the difference between pre- and post-survey responses, for example comparing control pre-survey versus control post-survey for statement E4, the statistical analysis results in a p-value of 0.05. Table 5.3 displays the analysis based on survey, with statistics representing the difference between control and experimental group responses for the pre- or post-survey.

As shown in Table 5.2 for statement E1, 'Engineers mainly work on machines and computers', the p-value indicates that there was no significant shift in either group from pre- to post-survey responses. For statement E2, 'Engineers mainly work with other people to solve problems' there was a significant shift between the pre-survey response mean of 2.36 to the post-survey response mean of 2.74 for the experimental group, but not for the control group. The shift to higher values for the experimental group indicates that, on average the students in that group agreed more with the statement 'Engineers mainly work with other people to solve problems' when taking the post-survey than when they took the pre-survey. For statement E4, 'Engineers can choose to do many different kinds of jobs' there was a significant shift for both groups between survey responses. The control group's responses had a shift in the mean numerical value of 0.20 and the experimental group's responses shifted by 0.31.

Table 5.3. Statistical Comparison of Control and Experimental Responses to Engineer Questions for Pre- and Post-Surveys at School A.

Engineers	**Survey**	**N**	**P-Value**	**X^2**	**Control Mean**	**Experimental Mean**
E1 - Mainly work on machines and computers	*Pre	269	<0.01	12.93	2.20	2.54
	Post	272	0.38	1.93	2.29	2.42
E2 - Mainly work with other people to solve problems	Pre	265	0.89	0.24	2.31	2.36
	*Post	271	<0.01	14.27	2.39	2.74
E4 - Can choose to do many different kinds of jobs	Pre	264	0.68	0.76	2.37	2.43
	Post	272	0.08	5.10	2.57	2.74

*Significance: p-value less than or equal to 0.05
DF = 6

Table 5.3 presents the same statements as shown in Figure 5.1 and Table 5.2, but analysis statistics look at the difference between control and experimental group responses. For statement E1, ‘Engineers mainly work on machines and computers’, the p-values indicate that there was a significant difference in the way that the experimental group and the control group responded to the pre-survey question. For all responses, the mean values were between the response options of ‘Don’t Know’=2 and ‘Agree’=3. The experimental group agreed with a mean response of 2.54 for the question whereas the control group’s mean response was 2.20. The statistical difference in the two group’s responses was not observed in the post-survey question. For E2, ‘Engineers mainly work on with other people to solve problems’, there was not a significant difference between the two groups for the pre-survey, but there was a statistical difference for the post-survey responses. The experimental group’s mean response increased from the pre-survey by 0.38 to result in a post-survey mean of 2.74. The control group’s mean response for this question increased by only 0.08 resulting in a post-survey mean of 2.39.For statement E4, ‘Engineers can choose to do many different kinds of jobs’ there was neither a significant difference between groups for the pre-survey nor for the post-survey responses. This statement was significant when looking at the data by group and not by survey.

Engineer Question Discussion

E1 - ‘Engineers mainly work on machines and computers’ did not have a significant shift for either group from pre- to post-survey, but there was a significant difference in how the two groups responded to the statement for the pre-survey. The experimental group responded statistically higher than the control group. There is a common misconception that while engineers do in fact spend time working on machines and computers, it is not the only type of work environment that is available to them. The post-survey responses for the two groups resulted in less of a difference as the two groups' attitudes and understanding shifted slightly.

The statement E2 - 'Engineers mainly work with other people to solve problems' had only the experimental group showing a statistically significant shift from pre- to post-survey responses. When looking at the statement by survey, there was no statistical difference between the experimental and control groups when looking at pre-survey responses, but there was a statistically significant difference in how the two groups responded in the post-survey. This change in understanding and attitude is thought to be a result of the 'You're Hired!' program because throughout the program students are encouraged by program designers (if present), teachers, and boardroom members to collaborate and work with their teammates no matter what career choice the students choose for the day. This suggests that the 'You're Hired!' program made a positive impact on the participating students' perceptions of engineers and engineering careers.

E4 - 'Engineers can choose to do many different kinds of jobs' showed a statistically significant shift for both the experimental and the control groups from pre- to post-survey responses. When comparing the surveys based on group, there was no significant difference for either survey. The results for this statement would indicate that while students did have a better understanding of the variety of possible engineering careers at the end of the program, that increase cannot be linked to the 'You're Hired!' program due to both the control and the experimental groups' levels of agreement increasing from pre- to post-survey.

5.1.2 Interest Question

Figure 5.2 and corresponding tables, Table 5.4 and 5.5 show the statistical comparison of pre-and post-survey responses for the Interest questions. The statement for this category of questions read, 'Here is a list of statements. Tell us what you think about them. Select a response that indicates your level of agreement.' Responses for these statements were converted to a Likert scale in order to further compare the responses, with 'Strongly Agree'=4, 'Somewhat Agree'=3, 'Somewhat Disagree'=2, and 'Disagree'=1.

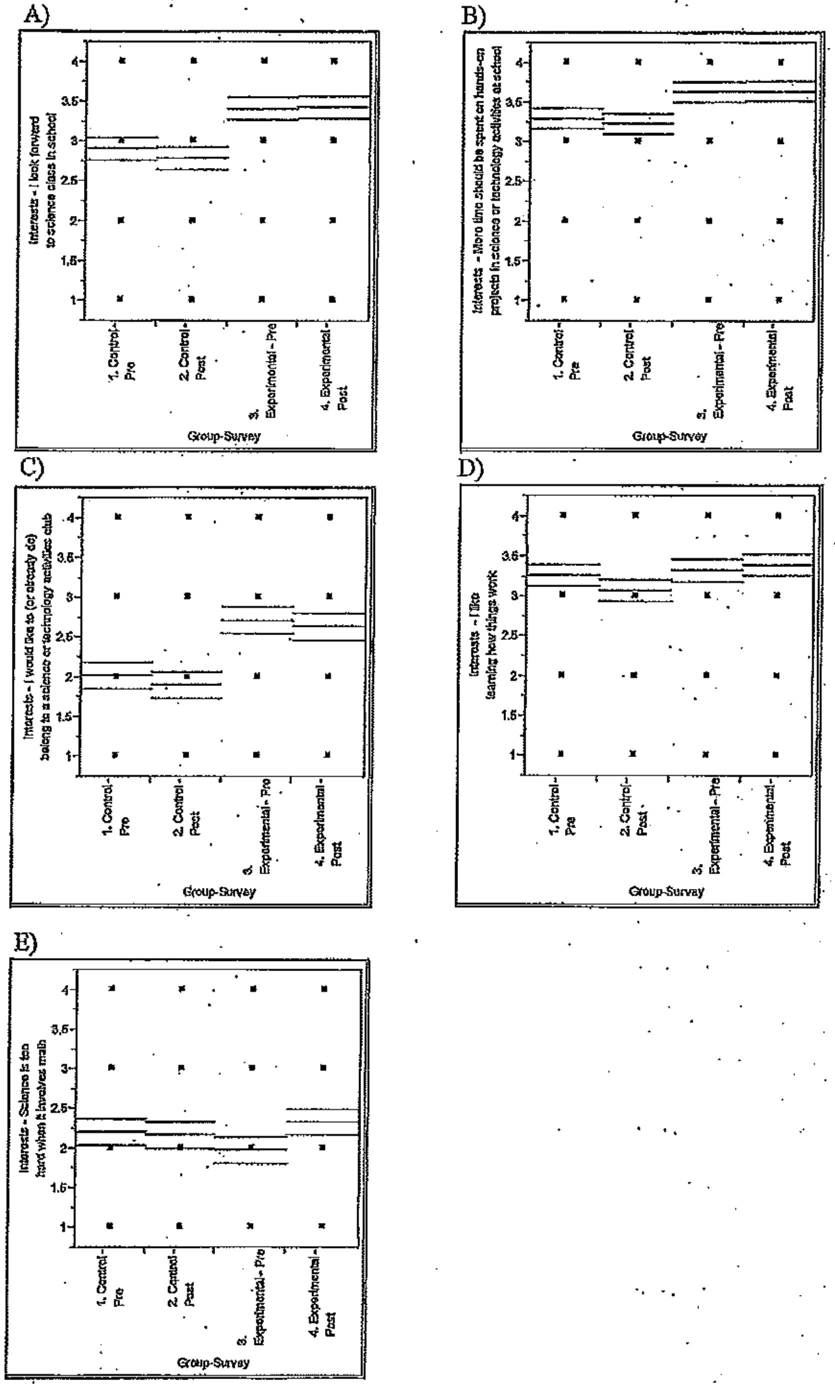


Figure 5.2. Comparing Control vs. Experimental responses for Interest Questions. A) In1 – I look forward to science class in school, B) In4 – More time should be spent on hands-on projects in science or technology activities at school, C) In5 – I would like to (or already do) belong to a science or technology activities club, D) In8 – I like learning how things work, E) In9 – Science is too hard when it involves math.

Table 5.4. Statistical Comparison of Pre- and Post-Survey Responses to Interest Questions for Control and Experimental Groups at School A.

Interests	Group	N	P-Value	X^2	Pre-Survey Mean	Post-Survey Mean
In1 - I look forward to science class in school	C E	269 269	0.46 0.54	2.56 2.16	2.90 3.41	2.78 3.43
In4 - More time should be spent on hands-on projects in science or technology activities at school	C *E	268 268	0.84 [a]	0.83 [a]	3.29 3.63	3.23 3.64
In5 - I would like to (or already do) belong to a science or technology activities club	C E	266 268	0.69 0.82	1.45 0.93	2.02 2.71	1.90 2.64
In8 - I like learning how things work	C E	267 265	0.22 0.32	4.39 3.54	3.26 3.32	3.07 3.39
In9 - Science is too hard when it involves math	C *E	264 270	0.88 0.01	0.69 11.52	2.21 1.98	2.17 2.33

*Significance: p-value less than or equal to 0.05
C: 'Control Group' and E: 'Experimental Group'
DF = 9

[a] - A reliable chi^2 and p-value could not be calculated for In4 – 'More time should be spent on hands-on projects in science or technology activities at school' because one of the answer options received less than five responses.

For the statements In1, In5 and In8, 'I look forward to science class in school', 'I would like to (or already do) belong to a science or technology activities club' and 'I like to learn how things work' the p-value indicates that there was no difference for either group from pre- to post-survey responses. The significance for these questions will be observed in Table 5.5.

For statement In9, ‘Science is too hard when it involves math’, there was a significant difference between survey responses for the experimental group, but not for the control group. When looking at the experimental group’s survey responses, the pre-survey mean was 1.98 and over the course of the school year, that mean responses increased by 0.35 resulting in a post-survey mean of 2.33. A statistically significant difference was not observed between the experimental and control group’s pre- to post-survey responses but there was a significant difference in the pre-survey between how the two groups responded.

Table 5.5. Statistical Comparison of Control and Experimental Responses to Interest Questions for Pre- and Post-Surveys at School A.

Interests	Survey	N	P-Value	X^2	Control Mean	Experimental Mean
In1 - I look forward to science class in school	*Pre *Post	270 268	<0.01 <0.01	30.88 44.15	2.90 2.78	3.41 3.43
In4 - More time should be spent on hands-on projects in science or technology activities at school	*Pre *Post	271 265	<0.01 <0.01	22.34 21.16	3.29 3.23	3.63 3.64
In5 - I would like to (or already do) belong to a science or technology activities club	*Pre *Post	267 267	<0.01 <0.01	30.71 35.04	2.02 1.90	2.71 2.64
In8 - I like learning how things work	Pre *Post	267 265	0.10 0.02	6.20 10.41	3.26 3.07	3.32 3.39
In9 - Science is too hard when it involves math	*Pre Post	268 266	0.03 0.24	8.66 4.20	2.21 2.17	1.98 2.33

*Significance: p-value less than or equal to 0.05
DF = 9

For the statements In1, In4, and In5, ‘I look forward to science class in school’, ‘More time should be spent on hands-on projects in science or technology activities at school', and 'I would like to (or already do) belong to a science or technology activities club' there was a significant difference between the control group and the experimental group for both pre-survey and post-survey responses. For statement In8, 'I like learning how things work', there was not a significant difference between groups when looking at the pre-survey responses, but there was a significant difference between the control group's mean of 3.07 and the experimental group's mean of 3.39 for the post-survey responses. When looking at the statement In9, 'Science is too hard when it involves math', there was a significant difference between groups when looking at the pre-survey responses, but not the post-survey responses. For the In9 statement, the difference between the two group's mean values for the pre-survey was 0.23 and for the post-survey the difference had decreased to 0.16 which resulted in the group's mean responses no longer being significantly different.

When looking at the changes in responses between pre-survey and post-survey by group, 1n4- 'More time should be spent on hands-on projects in science or technology activities at school' and 1n9- 'Science is too hard when it involves math' were significant for the experimental group, but not for the control group.

Interest Question Discussion

Out of the five statements that showed a statistically significant difference either between 1) the experimental and control group responses from pre- to post-survey or 2) the pre- and post-survey responses when comparing the groups, four of the five statements had pre-survey responses that were statistically different. This differentiation from the pre-survey responses was not present for all categories of questions/statements asked of the students, but for this set of Interest statements it was noted that the two groups did not have similar responses at the beginning of the study indicating that in terms of interests, these two groups of students were originally statistically different. It is possible that the difference in the students' responses may be due to the pod/house the students are in throughout the school year. School A is working to develop a STEM track within their middle school. The students that participated in the program were part of that STEM track. While the track is still fairly new, it is possible that the type of students attracted by this particular way of learning may have caused the statistical differences between group responses.

For the statement, In9 - 'Science is too hard when it involves math', there was a significant increase in the numerical mean from pre- to post-survey for the experimental group. This increase would suggest a negative shift in attitude towards science that involves math, however it is possible that this shift is related more to the everyday classes the students take as opposed to the supplementary program of 'You're Hired!'. This statement talks about science specifically indicating that it might have been influenced by experiences in a formal science class.

For the statement, In8 - 'I like learning how things work', the pre-survey showed no significant difference between the two groups, however after the course of the year and the implementation of the 'You're Hired!' program, the post-survey response shows a significantly higher level of agreement for the experimental group. This shift may be a result of the 'You're Hired!' program providing the participating students with the opportunity to problem solve real-world examples that affect everyday life.

5.1.3 Attitude and Skills Question

Figure 5.3 and corresponding tables, Table 5.6 and 5.7 show the statistical comparison of pre-and post-survey responses for the Attitude and Skills questions. The statement for this category of questions read, ‘The table lists things you can do when you are working on school activities or assignments. Check the appropriate box to tell us how often you do each of these things.’ Responses for these statements were converted to a Likert scale in order to further compare the responses, with ‘Always’=4, ‘Very Often’=3, ‘Sometimes’=2, and ‘Never’=1.

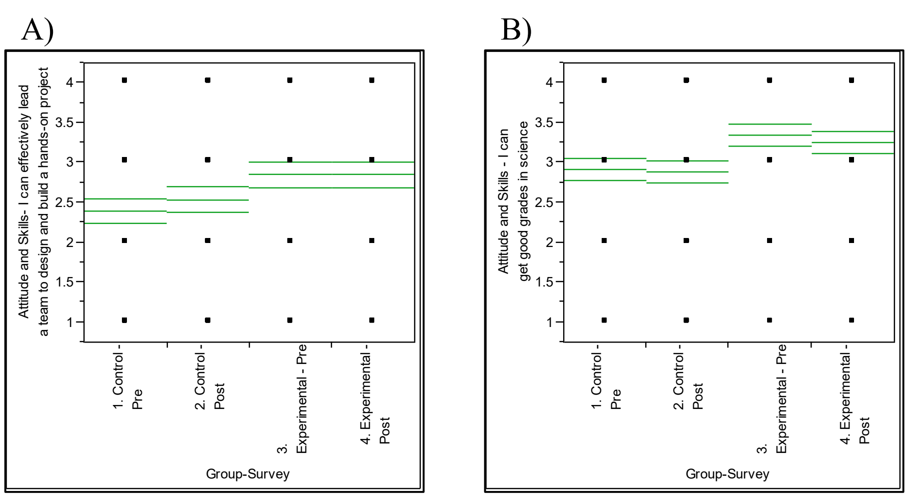


Figure 5.3. Comparing Control vs. Experimental Responses for Attitude and Skills Questions. A) A4 – I can effectively lead a team to design and build a hands-on project, B) A8 – I can get good grades in science.

Table 5.6. Statistical Comparison of Pre- and Post-Survey Responses to Attitude and Skills Questions for Control and Experimental Groups at School A.

Attitude and Skills	Group	N	P-Value	X^2	Pre-Survey Mean	Post-Survey Mean
A4 - I can effectively lead a team to design and build a hands-on project	C E	268 267	0.45 0.15	2.66 5.35	2.39 2.85	2.53 2.85
A8 - I can get good grades in science	C E	265 266	0.71 0.73	1.36 1.30	2.92 3.35	2.89 3.25

*Significance: p-value less than or equal to 0.05
C: 'Control Group' and E: 'Experimental Group'
DF = 9

As shown in Table 5.6, for the statements A4 and A8, 'I can effectively lead a team to design and build a hands-on project' and 'I can get good grades in science', there was not a significant shift between pre- and post-survey responses for either control or experimental group responses.

Table 5.7. Statistical Comparison of Control and Experimental Responses to Attitude and Skills Questions for Pre- and Post-Surveys at School A.

Attitude and Skills	Survey	N	P-Value	X^2	Control Mean	Experimental Mean
A4 - I can effectively lead a team to design and build a hands-on project	*Pre *Post	269 266	0.00 0.03	14.23 8.71	2.39 2.53	2.85 2.85
A8 - I can get good grades in science	*Pre *Post	267 264	0.00 0.00	19.10 13.59	2.92 2.89	3.35 3.25

*Significance: p-value less than or equal to 0.05
DF = 9

When comparing control and experimental groups by survey, there was a significant difference in responses to the statements A4 and A8. For each statement in each survey, the experimental group had a higher level of agreement when compared to the control group.

Attitude and Skills Question Discussion

When looking at the changes in responses between pre-survey and post-survey by groups, neither statement was significant. For changes in responses between groups by survey, both A4 - ‘I can effectively lead a team to design and build a hands-on project’ and A8 - ‘I can get good grades in science’ were significant for both pre- and post-survey responses. These results indicate that there was a statically significant difference between the two groups at the beginning of the program as well as at the end of the program. This analysis indicates that the ‘You’re Hired!’ program did not have an effect on students’ perceptions of their skills.

5.2 Experimental Group Results for the Five Participating Schools

The significant differences between an experimental group and a control group described in Section 5.1 only include one school’s responses, School A. There is a larger population of students that participated (School B – School E) in the program that did not have an associated control group. When looking at pre-survey data for all students participating in ‘You’re Hired!', there are significant differences between how the various schools respond. These significant differences between schools are not consistent with all questions. One question can have no significant difference between how the schools respond and the next question could result with some schools being statistically different from the others. A full list of the differences between pre-survey responses can be found in Appendix D.

This section describes statistically significant shifts in responses from pre- to post-survey when considering all participating schools, School A – School E, as a single experimental group, referred to as the “all-schools experimental group”. Table 5.8 contains questions that show a statistical difference between pre-and post-survey responses for the all-school experimental group. Of the four categories of questions, three had at least one question with responses that were significantly different between pre-and post-survey. The ‘Future Work’ category was the only category to not have a significant difference in responses to statement within the category. Analysis of the statistically different questions can be found in Figure 5.4 –5.6 and Table 5.9 –5.11. Further analysis of every question including questions that were not significantly different from pre-to post-survey responses can be found in Appendix E.

Table 5.8. Statements Showing Significantly Different Responses for the All-Schools Experimental Group between Pre-Survey and Post-Survey.

Engineers	
E1	Mainly work on machines and computers
E2	Mainly work with other people to solve problems
E4	Can choose to do many different kinds of jobs
Interest	
In10	Science is a difficult subject
Attitude and Skills	
A2	I can use what I know to design and build something mechanical that works

5.2.1 Engineer Question

Figure 5.4 and corresponding Table 5.9 show a statistical comparison of the all-school experimental group responses between pre-survey and post-survey for the significant Engineer statements.

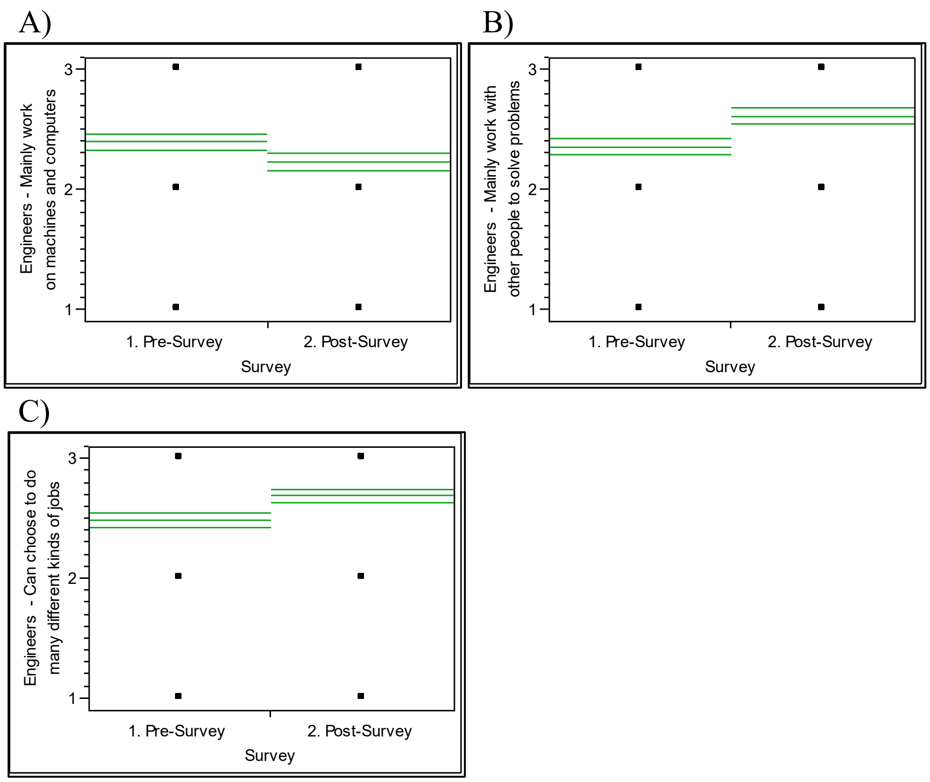


Figure 5.4. Comparing All-School Experimental Responses for Engineer Questions. A) E1 – Mainly work on machines and computers, B) E2 – Mainly work with other people to solve problems, C) E4 – Can choose to do many different kinds of jobs.

Table 5.9. Statistical Comparison of All-School Experimental Group's Responses to Engineer Questions for Pre- and Post-Surveys at all Participating Schools.

Engineers	N	P-Value	X^2	Pre-Survey Mean	Post-Survey Mean
*E1 - Mainly work on machines and computers	560	0.01	9.93	2.40	2.23
*E2 - Mainly work with other people to solve problems	554	<0.01	36.22	2.36	2.62
*E4 - Can choose to do many different kinds of jobs	554	<0.01	25.11	2.49	2.69

*Significance: p-value less than or equal to 0.05
DF = 2

For statement E1, 'Engineers mainly work on machines and computers', the shift was from a pre-survey numerical mean of 2.40 to a lower, less approving post-survey mean of 2.23. The statements E2 and E4, 'Engineers mainly work with other people to solve problems' and 'Engineers can choose to do many different kinds of jobs' both had positive shifts from the student's pre-survey mean to the post survey mean.

Engineer Question Discussion

The quantitative analysis of responses from all students indicates that statements E1 - 'Engineers mainly work on machines and computers', E2 - 'Engineers mainly work with other people to solve problems' and E4 - 'Engineers can choose to do many different kinds of jobs' show statistically significant pre- to post-survey changes. Responses to these three statements suggest that students had a more accurate understanding of engineering when they took the post-survey versus the pre-survey. The significance of E2 and E4 for the all-school experimental group correlates with the significant shifts of the experimental group from School A as described in Section 5.1.

In Section 5.1 the experimental group for School A had positive shifts for statements E2 and E4. In Section 5.2 the all-school experimental group also had positive shifts for statements E2 and E4.

Statement E1 resulted in a statistically significant shift from pre- to post-survey for the all-school experimental group, but not for the experimental group from School A. It is possible that due to the smaller sample size of students from School A, the change in students' response for this statement was not statistically different. The much larger sample size of the all-school experimental group suggests that these results could be an indication that 'You're Hired!' did in fact have an influence on students and that this impact was not seen in the analysis of only School A. A larger experimental/control sample size would help to clarify this difference and will be addressed in future work.

5.2.2 Interests Question

Figure 5.5 and corresponding Table 5.10 show the statistical comparison of the all-school experimental group responses between pre-survey and post-survey for the one Interest statement with a significant pre- to post-survey difference, 'Science is a difficult subject.'

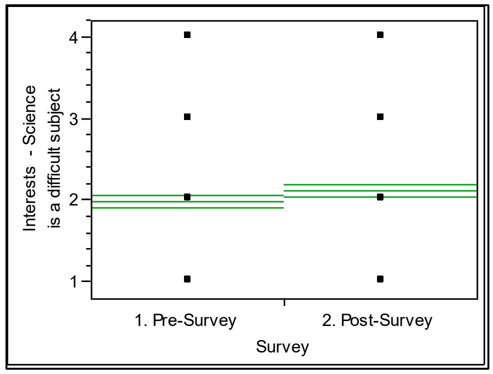


Figure 5.5. Comparing All-School Experimental Group's Responses for an Interest Statement, In10 – Science is a difficult Subject.

Table 5.10. Statistical Comparison of All-School Experimental Group's Responses to Interest Questions for Pre- and Post-Surveys at All Participating Schools.

Interests	**N**	**P-Value**	**X^2**	**Pre-Survey Mean**	**Post-Survey Mean**
*In10 - Science is a difficult subject	551	0.04	8.46	1.98	2.13

*Significance: p-value less than or equal to 0.05
DF = 3

Interest Question Discussion

The significant increase shifted from a pre-survey mean response between 'Disagree' and 'Somewhat Disagree' to a post-survey mean response between 'Somewhat Disagree' and 'Somewhat agree'. This shift appears to be in a direction that is unfavorable after the students had participated in the 'You're Hired!' program.

When reflecting on this result as well as the results of School A from Section 5.1, there are some similarities I noticed. The statement, 'Science is too hard when it involves math' from Section 5.1 showed a significant increase in the level of agreement from pre-survey to post-survey responses. The all-school experimental group analysis in this section resulted in a different significant statement, 'Science is a difficult subject'. Similar to the shift observed in Section 5.1, this statement from Section 5.2 also had an increase in the level of agreement from the pre-survey to the post-survey. Both statements appear to show negative attitudes towards science class. The 'You're Hired!' activities were specifically designed to remove the various walls that are currently dividing the essential core classes to blend together science, technology, engineering and math as well as English, computer, and geography/history in such a way that students understood that the core classes are important and can be related to real-world applications. Because this statement about science specifically had a shift in the unfavorable direction it is possible that the shift in responses may have had nothing to do with the 'You're Hired!' program and instead is related more to the classroom experiences the students had throughout the year. Future work involving a panel of students giving feedback on the survey tool may help to clarify this change.

5.2.3 Attitude and Skills Question

Figure 5.6 and corresponding Table 5.11 show the statistical comparison of experimental group responses from all five schools between pre-survey and post-survey for the significant Attitude and Skills statement.

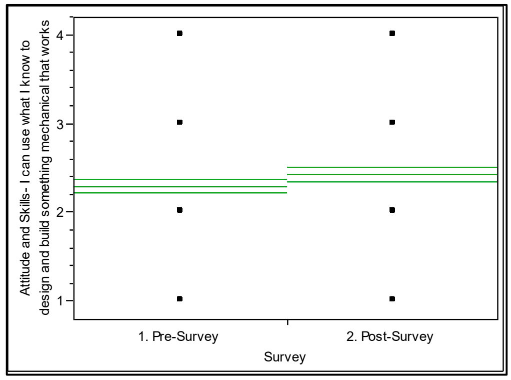


Figure 5.6. Comparing All-School Experimental Group's Responses for an Attitude and Skills Statement, A2 - I can use what I know to design and build something mechanical that works.

Table 5.11. Statistical Comparison of Experimental Group's Responses to Attitude and Skills Questions for Pre- and Post-Surveys at all Participating Schools.

Attitude and Skills	N	P-Value	X^2	Pre-Survey Mean	Post-Survey Mean
A2 - I can use what I know to design and build something mechanical that works	554	<0.01	17.24	2.30	2.43

*Significance: p-value less than or equal to 0.05
DF = 3

For the statements listed in Table 5.11 there was a statistically significant shift from pre-to post-survey responses for the group of students that completed the 'You're Hired!' program.

Attitude and Skills Question Discussion

Both pre- and post-survey mean responses were between 'Sometimes' and 'Very Often'. It is possible that this positive increase is a result of the 'You're Hired!' program because a majority of the schools that were part of the project do not have the opportunity to problem solve in a hands-on learning environment in their everyday classes. Because this program allowed students to problem solve to find a possible solution to a given problem, it is possible that the students' level of confidence increased.

5.3 Experimental Group Responses When Comparing Each of the Five Schools to Each Other

For the questions in which the all-school experimental group analysis in Section 5.2 did not result in similar observations to that of the control vs experimental analysis in Section 5.1, the statements were further broken down by school to indicate if one or two school's responses were greatly different than School A's experimental responses. Results of further analysis by school can be found in this section. A full list of the significant differences between pre-survey responses for the experimental group from all five schools can be found in Appendix D.

Table 5.12 contains the questions that were either significant for the experimental group in School A (Section 5.1) but not significant for the all-school group (Section 5.2) or questions that were significant for the all-school group but not for School A. The only category that had statements that were significant for both School A's experimental group as well as the all-school experimental group was the Engineer statements E2 and E4. Statistical analysis of the significantly different responses can be found in Figure 5.7 and Table 5.13. Further analysis of every question can be found in Appendix F.

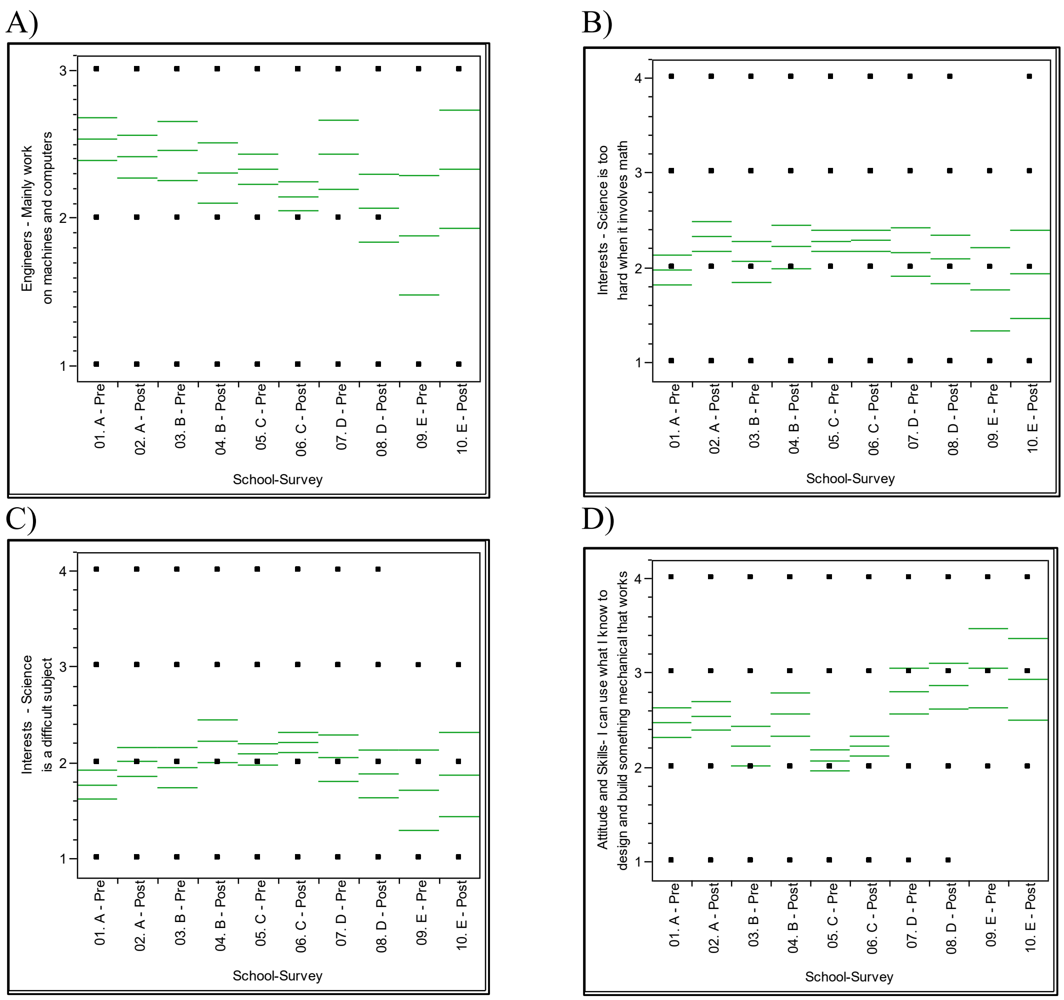


Figure 5.7. Comparing Experimental Responses for Questions that were not significant for both School A and School B – School E Experimental groups. A) E1 – 'Mainly work on machines and computers', B) In9 – 'Science is too hard when it involves math', C) In10 – 'Science is a difficult subject' and D) A2 – 'I can use what I know to design and build something mechanical that works'

Table 5.12. Statements Showing Significantly Different Responses between Pre-Survey and Post-Survey for Section 5.1 Experimental Group Compared and Section 5.2 Experimental Groups.

Engineers	
E1	Mainly work on machines and computers
Interest	
In9	Science is too hard when it involves math
In10	Science is a difficult subject
Attitude and Skills	
A2	I can use what I know to design and build something mechanical that works

Table 5.13. Statistical Comparison of Experimental Responses for Questions that were not significant for both School A and School B – School E Experimental groups.

Engineer	School	P-Value	X^2	Pre-Survey Mean	Post-Survey Mean
E1 - Mainly work on machines and computers	A	0.30	2.42	2.37	2.35
	B	0.56	1.15	2.46	2.31
	*C	0.04	6.33	2.34	2.15
	D	0.13	4.05	2.43	2.07
	E	0.18	1.80	1.89	2.33
Interests					
In9 - Science is too hard when it involves math	*A	0.01	11.52	1.98	2.33
	B	0.65	1.66	2.07	2.23
	C	0.11	6.08	2.29	2.29
	D	0.85	0.80	2.17	2.10
	E	0.39	3.04	1.78	1.94
In10 - Science is a difficult subject	A	0.13	5.59	1.78	2.01
	B	0.32	3.54	1.96	2.23
	C	0.15	5.34	2.10	2.21
	D	0.81	0.97	2.06	1.89
	E	0.62	0.97	1.72	1.88
Attitude and Skills					
A2 - I can use what I know to design and build something mechanical that works	*A	0.02	9.59	2.48	2.55
	B	0.06	7.35	2.24	2.57
	C	0.07	7.13	2.08	2.23
	D	0.60	1.89	2.81	2.87
	E	0.86	0.31	3.06	2.94

*Significance: p-value less than or equal to 0.05

Figure 5.7 displays information in the same format as the previous figures in this chapter, but with more groups. Figure 5.7 along with Table 5.13 contain the significant statements that were not consistent between the Section 5.1 analyses of the control School A compared to the Section 5.2 analysis of all participating schools, School A – School E.

For statement E1, School C contributed to the question being significant for the all-school experimental group. While most of the other schools exhibited similar changes in mean values, only School C's shift was significant. For this statement, all schools but one resulted in a decrease in the level of agreement from pre- to post-survey responses. School E responded with a mean that was 0.44 higher in the post-survey.

For statements In9 and A2, School A responded statistically different than the other participating schools. Statement In10 resulted in a significant shift from pre- to post-survey for the all-school experimental group from Section 5.2, however when breaking the responses down by individual school, there is not one school that consistently responds differently than the schools.

Section 5.3 Discussion

For three out of the five statements, there is a significant difference between School A's responses, but not any of the other schools' responses. This may be due to the fact that School A's experimental group is considered to be a STEM track. While overall the STEM track is still new, and the number of actual activities is still limited, it is possible that the increased exposure to STEM activities resulted in a difference for these students.

School B is also very similar to School A in the way that it has started a STEM track and that STEM group is the ones that participated in the project. School B was not statistically different than any other school for the five statements in this section. It is possible that School A spent more time and resources on developing their STEM track which resulted in their students having statistically different responses in three of the five statements as compared to the other participating schools.

5.4 Analysis Based on Gender

It is important to not only understand the different perceptions of engineering based on schools, but also on gender. This section looks into significant shifts in responses from pre- to post-survey for the all-school experimental group involving School A – School E by gender.

Table 5.14 contains questions from the pre- and post-survey where there was a statistically significant difference between female and male responses for either survey or between pre and post responses for either gender. If a significant difference was determined for any of the comparisons, then the question was included for analysis. For each category of question, Engineer, Future Work, Interest and Attitudes and Skills there are two tables of data. One table is for the pre- and post-survey comparisons, the other table is for the comparisons between female and male responses. It is possible that for the comparisons in one table, the question is not significant, but for the comparisons in the other table the question is significant. Out of the four categories of questions; Engineers, Future Work, Interests, and Attitude and Skills, all four contained questions that showed significant differences in the survey responses. Statistical analysis of the different questions can be found in Figures 5.8-5.11 and Tables 5.15 –5.22. Statistical analysis of every question, including questions that were not significantly different, can be found in Appendix G.

Table 5.14. Statements Showing Statistically Significant Different Responses between either Female and Male Responses for either Survey or between Pre- and Post- Responses for either Gender for the All-School Experimental Group.

Engineer Question	
E1	Mainly work on machines and computers
E2	Mainly work with other people to solve problems
E4	Can choose to do many different kinds of jobs
E5	Mainly work on things that have nothing to do with me
E6	I don't know what engineers do
E7	Pursue a career in an engineering-related field
E8	Do you think you want to be an engineer
Future Work Question	
F2	Work that allows me to make lots of money
F8	Work that allows me to help my community and/or society
Interests Question	
In5	I would like to (or already do) belong to a science or technology activities club
In6	I get bored when I watch programs on channels like Discovery Channel, Animal Planet, Nova, Mythbusters, etc.
In7	I like to get science books or science experiment kits as presents
In8	I like learning how things work
In13	I am interested in learning more about how things work
In14	I like to learn to use new technology
Attitude and Skills Question	
A2	I can use what I know to design and build something mechanical that works
A3	In lab activities, I can use what I have learned to design a solution
A5	I know where I can find the information that I need to solve difficult problems
A7	I can get good grades in math
Impact Question	
Im3	Increased my interest in studying engineering in college
Im4	Increased my interest in studying a technical degree in college
Im8	Made me confident in my ability to succeed in an engineering or technical field

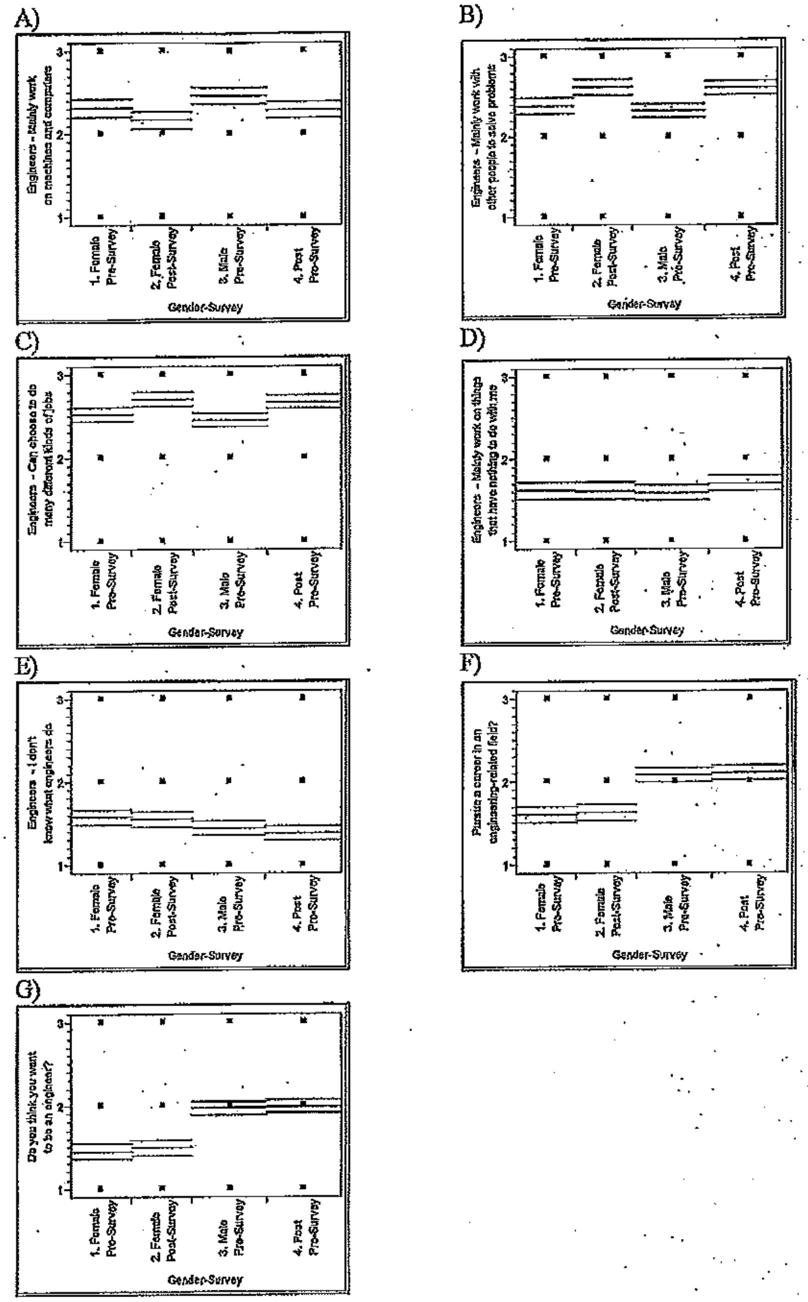


Figure 5.8. Comparing Female and vs. Male Responses for Engineer Statements. A) E1 – Mainly work on machines and computers, B) E2 – Mainly work with other people to solve problems, C) E4 – Can choose to do many different kinds of jobs, D) E5 – Mainly work on things that have nothing to do with me, E) E6 – I don't know what engineers do, F) E7 – Pursue a career in an engineering-related field, G) E8 – Do you want to be an engineer.

5.4.1 Engineer Question

Figure 5.8 and corresponding Table 5.15 and Table 5.16 show a statistical comparison of pre- and post-survey responses for the significant Engineer statements. The only statement that was not significant for the Engineer question was, 'Work on things that help the world'. Both female and male students responded highly for this statement in both the pre-survey and post-survey.

Table 5.15. Statistical Comparison of Female and Male Responses to Engineer Statements for All Participating Schools.

Engineers	Gender	N	P-Value	X^2	Pre-Survey Mean	Post-Survey Mean
E1-Mainly work on machines and computers	Female	251	0.06	0.12	2.32	2.17
	Male	309	0.03	1.22	2.46	2.29
E2-Mainly work with other people to solve problems	*Female	250	<0.01	18.23	2.39	2.62
	*Male	304	<0.01	19.59	2.33	2.61
E4-Can choose to do many different kinds of jobs	*Female	250	<0.01	15.49	2.52	2.71
	*Male	304	<0.01	14.30	2.45	2.68
E5-Mainly work on things that have nothing to do with me	Female	250	0.13	4.10	1.62	1.61
	*Male	302	0.02	7.97	1.59	1.70
E6-I don't know what engineers do	Female	242	0.94	5.56	1.58	1.55
	*Male	293	0.54	6.75	1.45	1.39
E7-Pursue a career in an engineering-related field?	Female	253	0.68	0.77	1.61	1.63
	Male	311	0.89	0.23	2.08	2.11
E8-Do you think you want to be an engineer?	Female	253	0.46	1.56	1.45	1.50
	Male	311	0.92	0.16	1.97	1.99

*Significance: p-value less than or equal to 0.05
DF = 6

For the statements, E2 – 'Engineers mainly work with other people to solve problems' and E4 – 'Engineers can choose to do many different kinds of jobs' there was a significant shift in both female and male responses from pre- to post-survey. For the statements, E6 – 'I don't know what engineers do' there was a significant decrease in the level of agreement for males that responded, for E5 –

‘Engineers mainly work on things that have nothing to do with me’ there was a significant increase in the male responses.

Table 5.16. Statistical Comparison of Pre- and Post-Survey Responses to Engineer Statements for Females and Males at All Participating Schools.

Engineers	Survey	N	P-Value	X^2	Female Mean	Male Mean
E1-Mainly work on machines and computers	*Pre	559	0.04	6.29	2.32	2.46
	Post	554	0.22	3.03	2.17	2.29
E2-Mainly work with other people to solve problems	Pre	535	0.27	2.62	2.39	2.33
	Post	560	0.86	0.30	2.62	2.61
E4-Can choose to do many different kinds of jobs	Pre	556	0.17	3.56	2.52	2.45
	Post	559	0.25	2.74	2.71	2.68
E5-Mainly work on things that have nothing to do with me	Pre	554	0.53	1.29	1.62	1.59
	Post	564	0.27	2.59	1.61	1.70
E6-I don't know what engineers do	Pre	553	0.15	3.80	1.58	1.45
	*Post	556	0.02	7.56	1.55	1.39
E7-Pursue a career in an engineering-related field?	*Pre	552	<0.01	48.16	1.61	2.08
	*Post	554	<0.01	48.09	1.63	2.11
E8-Do you think you want to be an engineer?	*Pre	551	<0.01	61.00	1.45	1.97
	*Post	558	<0.01	54.88	1.50	1.99

*Significance: p-value less than or equal to 0.05
DF = 6

Statements E7 and E8, ‘Pursue a career in an engineering-related field’ and ‘Do you think you want to be an engineer’ showed significant differences in how females responded versus males for both the pre- and post-surveys. Neither of these questions resulted in a significant shift between pre- and post-survey for a specific gender. The significant difference remained between how females answered compared to how males answered. Statement E6, ‘I don’t know what engineers do' there was not a significant difference between gender responses in the pre-survey, but there was for the post-survey. For the statement, E1 – 'Engineers mainly work on machines and computers' there was a significant difference between how males responded versus the females in the pre-survey but not the post-survey.

Engineer Question Discussion

Responses to statement E2 - ' Engineers mainly work with other people to solve problems' and E4 - 'Engineers can choose to do many different kinds of jobs' appear to be a result of the 'You're Hired!' program. The change from pre- to post-survey response is consistent with both the experimental versus control results for School A as stated in Section 5.1 as well as the all-school experimental results as stated in Section 5.2.

Male responses to statement E7 - 'Pursue a career in an engineering-related field' and E8 - 'Do you think you want to be an engineer' were statistically higher than female responses for both pre-survey and post-survey. Work still needs to be done to address current stereotypes that result in fewer women wanting to pursue a career in an engineering-related field. The 'You're Hired!' program is designed to address those stereotypes by providing real-world topics that interest both female and male students.

5.4.2 Future Work Question

Figure 5.9 and corresponding Table 5.17 and Table 5.18 show a statistical comparison of pre- and post-survey responses for the significant Future Work statements. Both F2 – 'Work that allows me to make lots of money' and F8 –

‘Work that allows me to help my community and/or society’ had a significant difference in responses when looking at changes by gender.

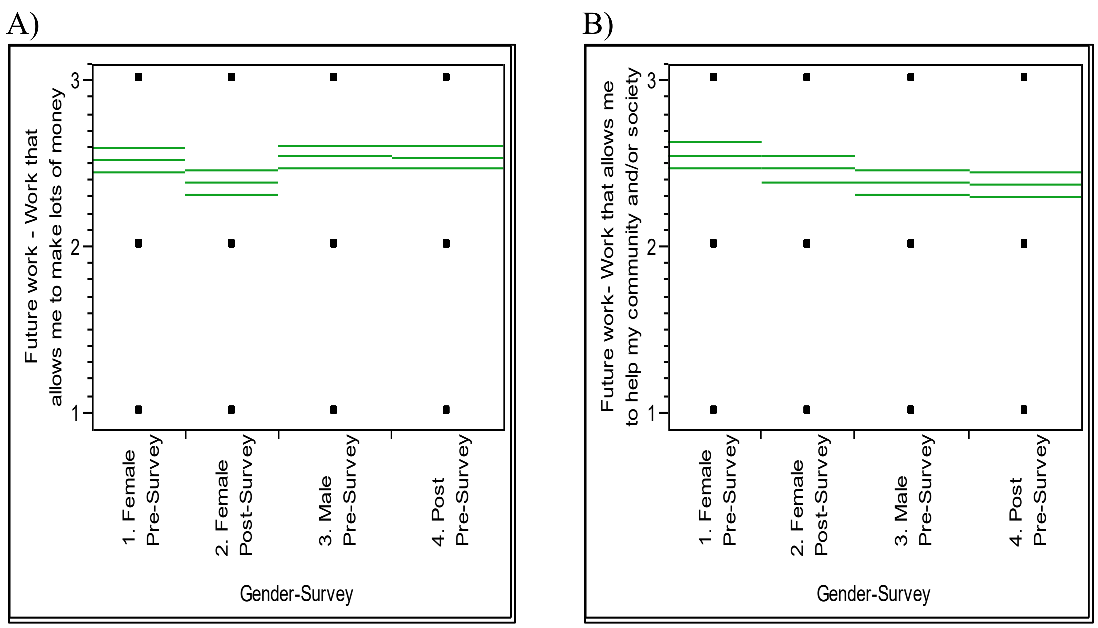


Figure 5.9. Comparing Female and vs. Male Responses for Future Work Statements. A) F2 – ‘Work that allows me to make lots of money’ and B) F8 – Work that allows me to help my community and/or society’.

Table 5.17. Statistical Comparison of Female and Male Responses to Future Work Statements for All Participating Schools.

Future Work	**Gender**	**N**	**P-Value**	**X^2**	**Pre-Survey Mean**	**Post-Survey Mean**
F2-Work that allows me to make lots of money	*Female	252	0.05	6.06	2.52	2.39
	Male	308	0.78	0.51	2.55	2.54
F8-Work that allows me to help my community and/or society	Female	250	0.30	2.39	2.56	2.48
	Male	306	0.64	0.88	2.39	2.38

*Significance: p-value less than or equal to 0.05
DF = 6

For the statement F2 – ‘Work that allows me to make lots of money’, the female responses dropped significantly from a pre-survey mean of 2.52 to a post-survey mean of 2.39. Indicating that females decided at the end of the school year money is less of a reason to choose a specific job.

Table 5.18. Statistical Comparison of Pre- and Post-Survey Responses to Future Work Statements for Females and Males at All Participating Schools.

Future Work	Survey	N	P-Value	X^2	Female Mean	Male Mean
F2-Work that allows me to make lots of money	Pre	560	0.14	3.93	2.52	2.55
	*Post	553	0.01	9.49	2.39	2.54
F8-Work that allows me to help my community and/or society	*Pre	556	0.01	9.53	2.56	2.39
	Post	551	0.18	3.46	2.48	2.38

*Significance: p-value less than or equal to 0.05
DF = 6

Statement F2 – ‘Work that allows me to make lots of money’ did not show a significant difference in how females versus males responded in the pre-survey, but did in the post-survey. Post-survey responses for this statement had the female level of agreement dropping from pre- to post by 0.13 and the male level of agreement only dropping by 0.01. Statement F8 – ‘Work that allows me to help my community and/or society’ showed a significant difference between how the genders responded for the pre-survey. The female level of agreement dropped by 0.08 from pre-to post-survey resulting in a mean of 2.48 which was closer to the male level of agreement of 2.38 which was only a 0.01 decrease from the pre-survey response.

Future Work Question Discussion

There was a significant change in how females looked at the importance of money from pre-to post-survey. This shift was not apparent in the male responses.

While there was not a significant shift in how the genders themselves responded to importance of helping the community and/or society from pre- to post-survey, the slight decrease in the female level of agreement lead to the change in significance from pre- to post-survey. In the pre-survey the females had a significantly higher level of agreement compared to males that was no longer apparent in the post-survey responses.

While it is not believed that these changes in responses are a result of the 'You're Hired!' program, it is important to keep the category of Future Work with all of its subsequent statements to provide a clearer understanding of the type of students that are participating in the program.

5.4.3 Interest Question

Figure 5.10 and corresponding Table 5.19 and Table 5.20 show a statistical comparison of pre- and post-survey responses for the significant Interest statements.

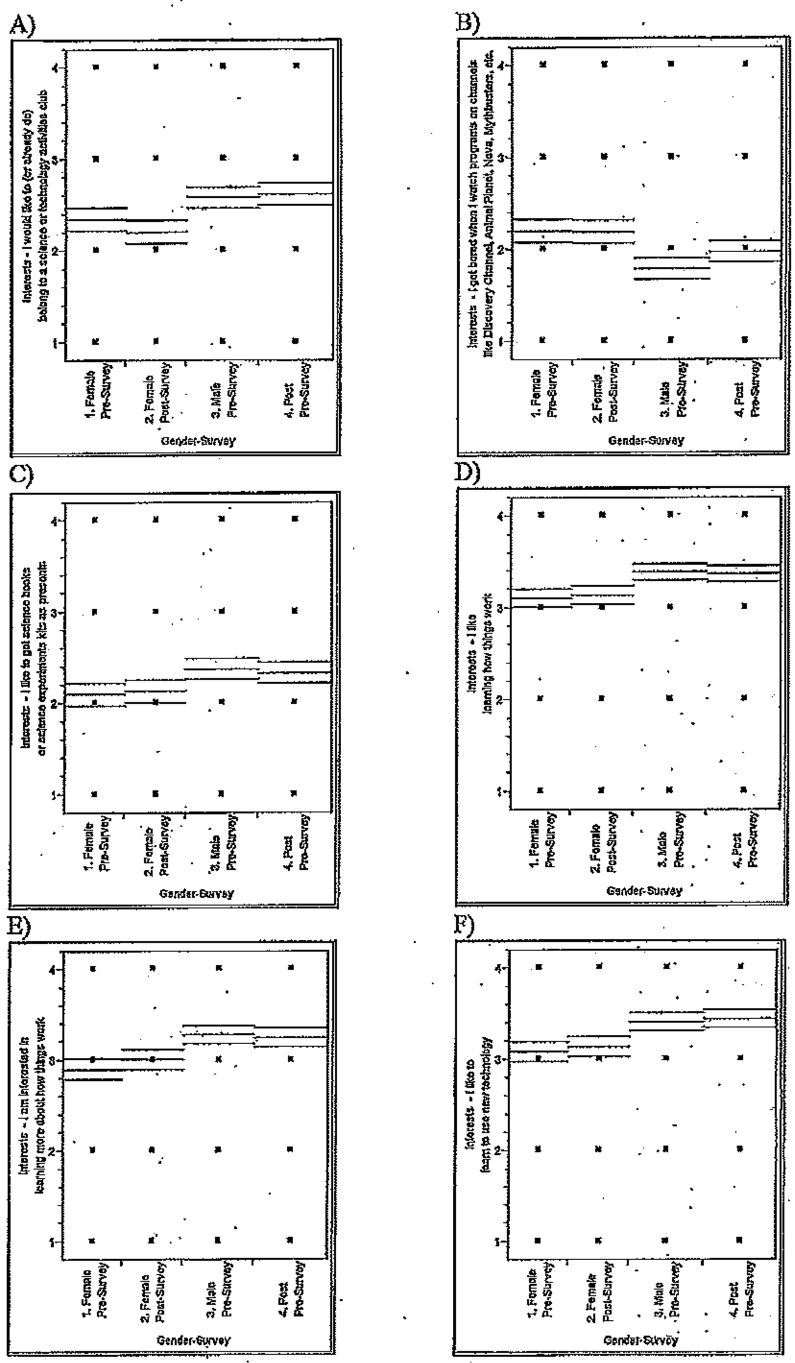


Figure 5.10. Comparing Female and vs. Male Responses for Interest Statements. A) In5 – 'I would like to (or already do) belong to a science or technology activities club', B) In6 – 'I get bored when I watch programs on channels like Discovery Channel, Animal Planet, Nova, Mythbusters, etc.', C) In7 – 'I like to get science books or science experiments kits as presents', D) In8 – 'I like learning how things work', E) In13 – 'I am interested in learning more about how things work', and F) In14 – 'I like to learn to use new technology'.

Table 5.19. Statistical Comparison of Female and Male Responses to Interest Statements for All Participating Schools.

Interests	Gender	N	P-Value	X^2	Pre-Survey Mean	Post-Survey Mean
In5-I would like to (or already do) belong to a science or technology activities club	Female Male	248 303	0.11 0.74	6.11 1.26	2.35 2.58	2.20 2.62
In6-I get bored when I watch programs on channels like Discovery Channel, Animal Planet, Nova, Mythbusters, etc.	Female *Male	251 304	0.82 0.05	0.93 7.62	2.20 1.79	2.19 1.97
In7-I like to get science books or science experiments kits as presents	Female Male	249 304	0.98 0.62	0.21 1.79	2.10 2.38	2.13 2.33
In8-I like learning how things work	Female Male	247 300	0.39 0.14	3.03 5.56	3.11 3.39	3.14 3.37
In13-I am interested in learning more about how things work	Female Male	245 303	0.49 0.69	2.41 1.47	2.90 3.28	3.01 3.25
In14-I like to learn to use new technology	*Female Male	246 303	0.00 0.90	13.22 0.60	3.09 3.41	3.14 3.44

*Significance: p-value less than or equal to 0.05
DF = 9

The male responses for statement In6 – 'I get bored when I I watch programs on channels like Discovery Channel, Animal Planet, Nova, Mythbusters, etc.' were significantly different from pre- to post-survey. The level of agreement to the statement increased indicating that at the end of the school year, males were less interested in engaging in these types of programs.

Statement In14 – 'I like to learn to use new technology' had a small, but statistically significant shift from a pre-survey mean of 3.09 to a post-survey response of 3.14 for females. Male levels of agreement did not show a significant shift.

Table 5.20. Statistical Comparison of Pre- and Post-Survey Responses to Interest Statements for Females and Males at All Participating Schools.

Interests	Survey	N	P-Value	X^2	Female Mean	Male Mean
In5-I would like to (or already do) belong to a science or technology activities club	Pre *Post	551 553	0.06 <0.01	7.55 21.43	2.35 2.20	2.58 2.62
In6-I get bored when I watch programs on channels like Discovery Channel, Animal Planet, Nova, Mythbusters, etc.	*Pre *Post	555 551	<0.01 0.03	29.70 8.99	2.20 2.19	1.79 1.97
In7-I like to get science books or science experiments kits as presents	*Pre Post	553 550	0.01 0.14	11.42 5.48	2.10 2.13	2.38 2.33
In8-I like learning how things work	*Pre *Post	547 550	<0.01 <0.01	15.27 13.03	3.11 3.14	3.39 3.37
In13-I am interested in learning more about how things work	*Pre *Post	548 552	<0.01 0.01	25.64 12.59	2.90 3.01	3.28 3.25
In14-I like to learn to use new technology	*Pre *Post	549 549	<0.01 <0.01	18.15 22.50	3.09 3.14	3.41 3.44

*Significance: p-value less than or equal to 0.05
DF = 9

Statements In6, In7, In8, In13, and In14 all showed significant differences between how the females responded for each survey when compared to the male responses. For statement In6, ‘I get bored when I watch programs on channels like Discovery Channel, Animal Planet, Nova, Mythbusters, etc.’ the level of agreement for females was significantly higher for both surveys. For statement In7, ‘I like to get science books or science experiments kits as presents’ the male level of agreement was significantly higher. Males also had a significantly higher level of agreement to ‘I like learning how things work’, ‘I am interested in learning more about how things work’ and ‘I like to learn to use new technology’.

For statement In5, ‘I would like to (or already do) belong to a science or technology activities club’ there was not a significant difference between males and females in the pre-survey responses, but there was in the post-survey responses.

Interest Question Discussion

While female responses showed a significant increase in the number of females that stated In14 - ‘I like to learn to use new technology’, females still appear to have lower levels of interest when it comes to learning more about science and technology and how things work. With more exposure to hands-on activities in which both males and females can gain valuable experiences, it is thought that these levels of agreement will increase for both females as well as males. The other statements in the table are only included due to the fact that there is a significant difference between how males responded to these statements as compared to females for both the pre- and post-surveys.

5.4.4 Attitude and Skills Question

Figure 5.11 and corresponding Table 5.21 and Table 5.22 show a statistical comparison of pre- and post-survey responses for the significant Attitude and Skills statements.

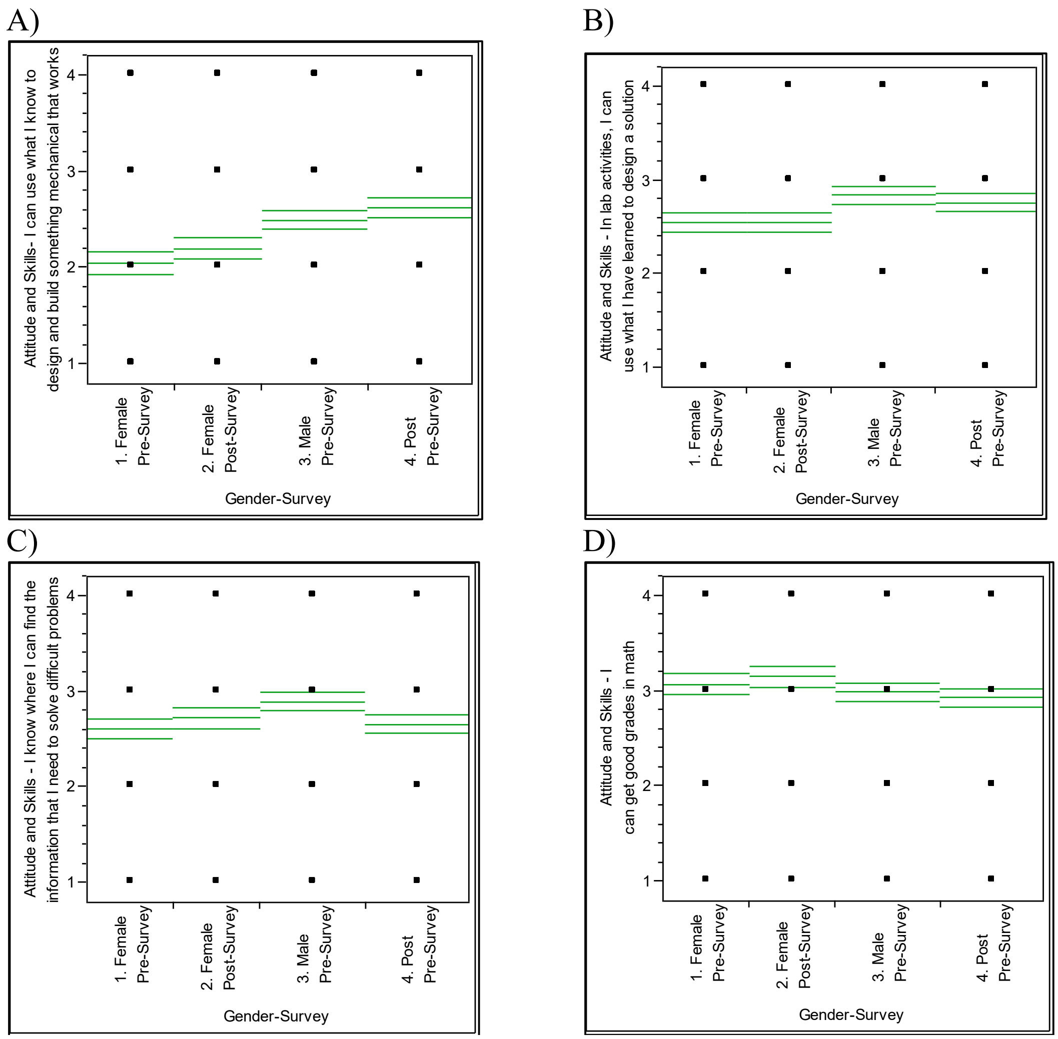


Figure 5.11. Comparing Female and vs. Male Responses for Attitude and Skills Statements. A) A2 – 'I can use what I know to design and build something mechanical that works', B) A3 – 'In lab activities, I can use what I have learned to design a solution', C) A5 – 'I know where I can find the information that I need to solve difficult problems', and D) A7 – 'I can get good grades in math'.

Table 5.21. Statistical Comparison of Female and Male Responses to Interest Statements for All Participating Schools.

Attitude and Skills	Gender	N	P-Value	X^2	Pre-Survey Mean	Post-Survey Mean
A2-I can use what I know to design and build something mechanical that works	*Female *Male	250 304	0.01 0.04	10.50 8.32	2.05 2.50	2.20 2.63
A3-In lab activities, I can use what I have learned to design a solution	Female Male	251 306	0.45 0.51	2.63 2.32	2.55 2.84	2.55 2.76
A5-I know where I can find the information that I need to solve difficult problems	Female *Male	250 304	0.17 < 0.01	4.97 13.03	2.61 2.89	2.72 2.66
A7-I can get good grades in math	Female Male	251 305	0.45 0.21	2.64 4.51	3.07 2.99	3.15 2.93

*Significance: p-value less than or equal to 0.05
DF = 9

The statement A2 – ‘I can use what I know to design and build something mechanical that works’ had a significant shift for both females and males from pre- to post-survey. The female level of agreement increased by 0.15 resulting in a post-survey mean of 2.20 and the male level of agreement increased by 0.13 resulting in a post-survey mean of 2.63.

For the statement A5 – ‘I know where I can find the information that I need to solve difficult problems’ there was a significant shift in how the males responded from pre- to post survey. The level of agreement for the males decreased by 0.23. While not significant, the female responses to this question increased from pre-to post-by 0.11.

Table 5.22. Statistical Comparison of Pre- and Post-Survey Responses to Attitude and Skills Statements for Females and Males at All Participating Schools.

Attitude and Skills	Survey	N	P-Value	X^2	Female Mean	Male Mean
A2-I can use what I know to design and build something mechanical that works	*Pre *Post	554 544	<0.01 <0.01	29.54 30.92	2.05 2.20	2.50 2.63
A3-In lab activities, I can use what I have learned to design a solution	*Pre *Post	557 544	<0.01 0.02	21.69 10.17	2.55 2.55	2.84 2.76
A5-I know where I can find the information that I need to solve difficult problems	*Pre Post	554 545	<0.01 0.50	16.29 2.34	2.61 2.72	2.89 2.66
A7-I can get good grades in math	Pre *Post	556 545	0.08 0.02	6.78 9.95	3.07 3.15	2.99 2.93

*Significance: p-value less than or equal to 0.05
DF = 9

There was a significant difference in how females versus males responded in statements A2 – 'I can use what I know to design and build something mechanical that works' and A3 – 'In lab activities, I can use what I have learned to design a solution'. For statement A3, female mean levels stayed the same, while male levels slightly decreased. The male responses even after the decrease were still higher than the female responses.

For statement A5 – 'I know where I can find the information that I need to solve difficult problems' there was a significant difference in how the genders responded on the pre-survey. Male responses were significantly higher than the female responses. Over the course of the school year, those levels of agreement shifted and while there was no longer a significant difference in the post-survey responses, the level of agreement for males not only decreased, but it resulted in a lower level of agreement than that of the females.

For statement A7 – 'I can get good grades in math' there was not a significant difference observed in the pre-survey results, but there was for the post-survey results. While male levels of agreement decreased by 0.06, the female level of agreement increased by 0.08 resulting in a final difference between the two levels of agreement of 0.22.

Attitude and Skills Question Discussion

I found it very interesting that there was a significant decrease in the male level of agreement to the statement A5 - 'I know where I can find the information that I need to solve difficult problems'. This decrease was opposite of the responses females had to this same statement, however that relationship cannot be concluded because the female response was not statistically significant.

It is thought that because the students participating in 'You're Hired!' choose their own careers and tasks for the individual activities throughout the program that females tend to take more of the 'research' roles and males tend to migrate towards the hands-on/find the solution roles. In multiple schools I observed first hand this theory where the female students would research facts and data to complement the experimentation done by the male students. I believe that more emphasis on the importance of not having the same 'job/career' each activity might help not only improve male responses for this question, but also female responses to other questions.

5.5 Impact of the 'You're Hired!' Program

While it is likely that outside influences also had an effect on the responses in Section 5.1 – Section 5.4, the information presented in this section can be directly attributed to the 'You're Hired!' program. Program impact was measured by asking, 'How much did participating in the activity impact each of the following?' on the post-survey with response options of: 'A Great Deal', 'Moderately', 'Slightly' and 'Not At All'. This question, unlike the other questions asked on the pre- and post-surveys, was directly focused on the 'You're Hired!' program. Figure 5.12 presents all Impact statements the students responded to. The y-axis lists the Impact statements along with the percentage of students that agreed, at least on some level, to the statement. The x-axis which is labeled 'Data' represents the percentage of agreement as a decimal number. In order to display the data from the Impact statements visually, the categorical data from the post-survey was summarized so that each response option had a percentage of students that had responded associated with it. The responses that showed a level of agreement ('A Great Deal', 'Moderately' and 'Slightly') were then added together to create the overall level of agreement shown in the figure. Descriptive statistics for project impact based on gender can be found in Table 5.23 and Table 5.24. In order to summarize the data for these tables, the data was converted using a Likert Scale in which 'A Great Deal' =4, 'Moderately' = 3, 'Slightly' = 2, and 'Not At All' =1. Once the categorical data was converted to numerical data using the Likert Scale, mean values as well as 95% confidence intervals could be determined.

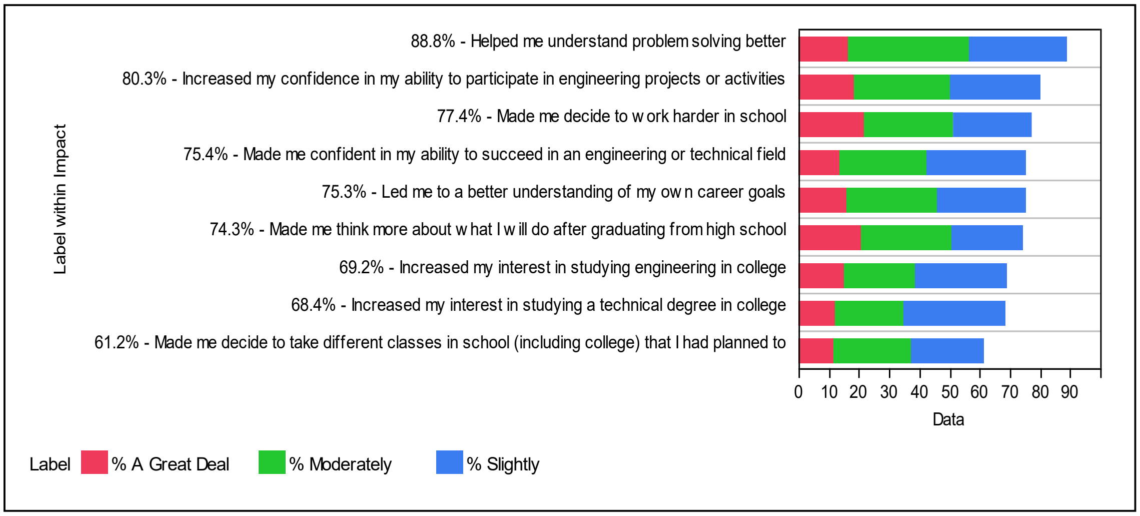


Figure 5.12. Student levels of agreement to the statement, ‘How much did participating in the activity impact each of the following?’ The highest impacts were in ‘Helped me understand problem solving better’ at 88.8% and ‘Increased my confidence in my ability to participate in engineering projects of activities’ at 80.3%.

Table 5.23. Descriptive Statistics of Responses to Impact Statements for Females and Males.

				95% C.I.	
Impact	**Gender**	**N**	**Mean**	**Lower**	**Upper**
Im1 - Helped me understand problem solving better	Female	253	2.68	2.57	2.79
	Male	308	2.57	2.47	2.67
Im2 - Led me to a better understanding of my own career goals	Female	251	2.41	2.28	2.54
	Male	307	2.34	2.23	2.46
Im3 – Increased my interest in studying engineering in college	Female	250	2.00	1.87	2.13
	Male	308	2.41	2.30	2.53
Im4 - Increased my interest in studying a technical degree in college	Female	253	1.93	1.82	2.05
	Male	307	2.34	2.22	2.45
Im5 - Made me think more about what I will do after graduating from high school	Female	253	2.49	2.35	2.62
	Male	308	2.44	2.32	2.56
Im6 - Made me decide to work harder in school	Female	253	2.55	2.41	2.68
	Male	305	2.46	2.34	2.58

Table 5.23. cont.

Impact	Gender	N	Mean	95% C.I. Lower	95% C.I. Upper
Im7 - Made me decide to take different classes in school (including college) that I had planned to	Female Male	251 306	2.14 2.07	2.01 1.95	2.27 2.19
Im8 – Made me confident in my ability to succeed in an engineering or technical field	Female Male	252 308	2.18 2.42	2.06 2.31	2.30 2.53
Im9 - Increased my confidence in my ability to participate in engineering projects or activities	Female Male	251 307	2.40 2.56	2.27 2.45	2.53 2.67

In general, the 'You're Hired!' program appears to have an impact with all means except one above a 2 (slightly). The only statement that resulted in a mean value less than a 2, or 'slightly' was the female mean for the statement, 'Increased my interest in studying a technical degree in college'. The significant responses when comparing female and male responses can be found in Table 5.24.

Table 5.24. Statistical Comparison of Responses to Impact Statements for Females and Males.

Impact	N	P-Value	X^2	Female Mean	Male Mean
Im3 - Increased my interest in studying engineering in college	558	<.01	22.66	2.00	2.41
Im4 - Increased my interest in studying a technical degree in college	560	<.01	24.46	1.93	2.34
Im8 - Made me confident in my ability to succeed in an engineering or technical field	560	0.03	9.06	2.18	2.42

For these three statements, Im3 – 'Increased my interest in studying engineering in college', Im4 – 'Increased my interest in studying a technical degree in college' and Im8 – Made me confident in my ability to succeed in an engineering or technical field' the male responses were significantly higher than the female responses.

When students were asked, 'Would you recommend that your friends participate in this activity?', overall 69.8% of students stated, 'Yes'. It is important to note that the amount of exposure to engineering and other STEM classes outside of the 'You're Hired!' activity may have impacted students as well. Table 5.25 displays the breakdown of how each school responded. There was a significant difference in how Schools responded when compared to each other, with School C and School E being the extremes.

Table 5.25. Breakdown of how School A – School E Responded to the Question, 'Would you Recommend that your Friends Participate in this Activity?'

	N	**Yes**
School A	136	77%
School B	72	73%
School C	282	61%
School D	54	83%
School E	18	94%

CHAPTER VI

CONCLUSIONS & FUTURE WORK

6.1 Conclusions

‘You’re Hired!’ appears to be a well-designed program that has increased students’ understanding and attitudes of engineering based on data collected over two years of pre- and post-surveys. Overall the student responses showed a statistically significant, positive change in their understanding and attitudes towards engineering for the statement, E2 - ‘Engineers mainly work with other people to solve problems’. This was true for the all-school experimental group data analysis as well as for both female and male responses. This initial data indicates that these positive changes in attitudes towards engineering can be most likely associated with the ‘You’re Hired!’ program. This past year the program included a control group. The control group did not see a change in attitudes towards engineering, but the students participating in the program activities did.

Other categories of questions such as Interest and Attitudes and Skills cannot be as closely linked to the ‘You’re Hired!’ program because the trends were not observant between experimental versus control groups like it was for the ‘Engineer’ category.

Pre-survey responses to the Interest statements for the experimental and control groups indicated that there was a statistical difference between the two groups of students. The experimental group responded at a greater level of agreement than the control group. When assessing the data for the Interest category by gender, female results stood out because of the increase in the level of agreement to the statement In14 - ‘I like learning how things work’.

This increase in female interest to learn how things work complements the results found for the Attitude and Skills category. When looking at gender responses, males showed a statistical drop in their level of agreement to the statement, A5 - ‘I know where I can find the information I need to solve problems.’ While not statistically significant, the female responses to this same statement showed the opposite effect. In my observations from being present at the participating schools during the activities, I would suggest that these responses observed are due to the fact that females more times than not will take on a ‘research’ style of a role whereas the males choose the ‘hands-on’ engineer and technician roles. The individuals that conduct the research for the activities get very good at learning where to look for the information that is relevant. It is possible that in the process of researching new technologies and real-world problems, that female’s interest is sparked in that they like to learn how the various ‘things’ work.

There was no change in the Attitude and Skills statements for the experimental versus control groups however both the all-school experimental group as well as both genders showed a statistical increase in their agreement to the statement A2 - ‘I can use what I know to design and build something mechanical that works.’ This also supports my conclusion that females as well as male students get engaged through the ‘You’re Hired!’ hands-on program. It is possible that with a larger sample size for the experimental versus control groups from School A, that a similar result would have been observed.

This project achieved its goal to 1) develop a program that is designed to change students' attitudes and understanding of engineering, and 2) determine the effectiveness of the program based on data from participants. From my interpretation of this data analysis I would state that 'You're Hired!' is a well-designed program that resulted in a change in student attitudes and understanding of engineering. It is likely that other factors also contributed to student responses such as a class field trip, teachers incorporating more STEM into their daily classroom, student discussions with friends or family about possible careers or any other student experiences throughout the course of the school year.

The program developed also achieve the following goals: 1) introduce a variety of engineering careers possible with an engineering degree, 2) increase students' attitudes and understanding of engineering by incorporating features that have been previously researched and are proven to show impact, 3) introduce teachers to incorporating STEM and 21st Century Skills into their classrooms with minimal additions to their already busy workload, 4) hone students' 21st Century Skills also known as engineering mindset skills or workforce skills, and 5) engage industry professionals to participate and provide feedback as well as being a positive role model for students.

The program was successful at introducing engineering careers possible with an engineering degree that are offered at local North Dakota universities. The program also increased students attitudes and understanding that engineers work with others to collaborate and problem solve as well as the understanding that engineers can choose many different kinds of jobs. An engineering career could be anything from a process engineer working in corn milling to a new products engineer that works with inventors to design, problem solve and create new devices.

The program also showed success in introducing teachers to the idea of incorporating STEM and 21st Century Skills into their daily classrooms. Multiple teachers within the five schools have asked for additional suggestions to turn their current content into a more hands-on, collaborative project for their students. The 'You're Hired!' program as well as the teacher's new STEM/21st Century Skill classroom will help students to hone their engineering mindset skills also known as workforce skills.

Throughout the program students had multiple opportunities to receive feedback from industry professionals that attended the activities. One school in particular has also started incorporating key industry professionals into their classroom STEM activities because the impact on the student efforts is so large.

Ongoing research will continue to assist in understanding what changes can be made to make the program more effective. Future plans for the project include changing the pre- and post-surveys from the original AWE design to one that works better for the project, professional development for teachers to extend engineering design principles from 'You're Hired!' into the daily classroom, research to identify program elements that contribute to positive student changes, expansion of its implementation across a tri-state region, and development of a model for sustainability and scalability into other regions.

6.2 Future Work

Through collaboration between three higher education organizations in North Dakota, University of North Dakota, North Dakota State College of Science, and North Dakota State University it is projected that the 'You're Hired!' program will continue to play a role in schools across the immediate region and into further regions. For the future, the project will need to evolve and the 'You're Hired!' research team will need to continue to redesign to ensure it is meeting the needs of the key stakeholders as mentioned in Chapter 2. While there will be aspects of the project that are always in need of redesign, there are a couple features that should be addressed sooner rather than later. Those features include the pre- and post-surveys and teacher professional development. It will also be important to continue to revisit the program elements yearly to ensure key elements are in place as well as to ensure that the 'You're Hired!' program is designed in such a way that it can scale and evolve to meet the needs of the stakeholders.

Redesign of the Pre-Survey and Post-Survey

The pre- and post-surveys that have been used for 'You're Hired!' were adopted from AWE (Assessing Women & Men in Engineering). This resource provided a very good starting point for looking at assessing the program I was designing.

After the first year of data analysis, I looked at the survey and noticed that there were statements and wording choices that I questioned. In my effort to learn more about the assessment, I reached out to an individual who worked on the development of the pre- and post-surveys to gain a better understanding of why they chose to use the questions/statements and the phrases they did. In the conversation I learned that the surveys were created by a team of researchers and due to funding running out, additional research had not been done on the surveys.

In the summer of 2014, I presented an introduction of the 'You're Hired!' program with preliminary data at the 2014 Annual ASEE Conference in Indianapolis, IN. When at the conference I was able to listen to individuals and groups talk about research that while different than mine, was very similar in some of the structuring. One group presented data in which it became very clear to me that AWE had also been a survey resource for their research. When I asked about their thoughts on the survey tool provided by AWE, they stated that they have continued to do research on their own and that they use some of the questions from the original survey, but are working on creating a new survey that better fits the needs of their program. This is also what 'You're Hired!' will do for future research. It will be important to continue to stay in contact with other groups that are doing similar research to brainstorm and learn from each other.

Work was done to address current issues with the pre- and post-surveys the 'You're Hired!' program has been using after the initial proof of concept in 2012-2013. There were also changes that needed to be made to the individual activities themselves as stated in Chapter 4. To preserve the quality of research, it was decided that changes would be made to the activities for the 2013-2014 project year. The new surveys will be debuted in the 2015-2016 project year.

Currently the pre-survey is designed with categories of questions/statements in the order of that shown in Table 6.1. These categories and questions were adopted from the original AWE survey for assessing middle and high school students conducting engineering activities.

Table 6.1. Original Categories of Questions asked by the AWE Pre-Survey for Engineering Activities.

1) Demographics
-Name -Gender -Ethnicity -Education -Name of School -Classes currently enrolled in -Are you currently enrolled in honors or advanced classes -Have you been encouraged to enroll in honors or advanced classes -Are you enrolled in a special engineering curriculum -Do you plan to enroll in honors or advanced classes next year -Has anyone talked to you about the importance of taking classes that will prepare you for college -Has anyone talked to you about the importance of math in your future career -What do you plan to do when you graduate from high school -Have either of your parents attended college or a university after high school
2) What Do Engineers Do?
Read the following statements about what engineers might do and indicate your agreement or disagreement with each statement -Mainly work on machines and computers -Mainly work with other people to solve problems -Can choose to do many different kinds of jobs -Mainly work on things that have nothing to do with me -I don't know what engineers do -If you go to college, do you think you will pursue a career in an engineering-related field -In your future, do you think you want to be an engineer -Has anyone talked to you about becoming an engineer -If yes, who
3) What Do Technicians Do?
Read the following statements about what technicians might do and indicate your agreement or disagreement with each statement -Mainly work on machines and computers -Mainly work with other people to solve problems -Work on things that help the world -Can choose to do many different kinds of jobs -Mainly work on things that have nothing to do with me -I don't know what technicians do

Table 6.1. cont.

3) What Do Technicians Do?
Read the following statements about what technicians might do and indicate your agreement or disagreement with each statement -If you go to college, do you think you will pursue a career in a technician-related field -In your future, do you think you want to be a technician -Has anyone talked to you about becoming a technician -If yes, who
4) Future Work
The following statements describe work or jobs you might do in the future. Tell us how important each of the items below is to you in your future work -Work that makes me think -Work that allows me to make lots of money -Work that allows me to use math, computers, engineering, or science skills -Work that allows me to tell other people what to do -Work that allows me to help solve problems and create solutions -Work that is fun to do -Work that allows me to have time with family -Work that allows me to help my cmomunity and/or society -Work that makes people think highly of me -Work that is satisfying to me
5) Interests
Here is a list of statements. Tell us what you think about them. -I look forward to science class in school -I look forward to math class in school -I would rather solve a problem by doing an experiment than be told the answer -More time should be spent on hands-on projects in science or technology activities at school -I would like to (or already do) belong to a science or technology activities club -I get bored when I watch programs on channels like Discovery Channel, Animal Planet, Nova, Mythbusters, etc. -I like to get science books or science experiments kits as presents -I like learning how things work -Science is too hard when it involves math -Science is a difficult subject -Doing experiments in science class is frustrating -I feel comfortable with using a computer to make graphs and tables -I am interested in learning more about how things work -I like to learn to use new technology

Table 6.1. cont.

6) Math Problem
-If you encounter a math homework problem that you don't know how to solve, what are you most likely to do -For the above problem, check the box that best describes your ability to learn to solve this example math problem
7) Attitudes and Skills
The table lists things you can do when you are working on school activities or assignments. -When I see a new math problem, I can use what I have learned to solve the problem -I can use what I know to design and build something mechanical that works -In lab activities, I can use what I have learned to design a solution -I can effectively lead a team to design and build a hands-on project -I know where I can find the information that I need to solve difficult problems -I can explain math or science to my friends to help them understand -I can get good grades in math -I can get good grades in science

I propose as part of the redesign for the project that the survey categories be reorganized to the order as shown in Table 6.2. For everyone that has taken a survey, the level of interest in the process of taking the survey decreases with the number of questions. While the students are given an electronic version which in turn takes away the visual of the total number of questions, it is still a good approach to ask the questions in the order of importance of data. While this technique was not used by AWE, asking demographic questions at the end of a survey is a technique that is encouraged by many survey collectors. Even the survey tool Surveymonkey that I have used for the 'You're Hired!' program suggests this approach. This approach is done because it is possible that when a student completes demographic questions first, the questions such as gender, race, are you in honors classes, etc. can bias a student into applying typical stereotypes onto themselves and thinking, 'I am a girl that does not have honors classes offered at my school, there is no way that I will be smart enough to be an engineer' or 'I am a girl and girls are not engineers, therefore I don't want to be an engineer'.

Table 6.2. Redesign of the Categories of Questions asked by the AWE Pre-Survey for Engineering Activities.

1) What Do Engineers Do?
2) What Do Technicians Do?
4) Self – Efficacy
5) Demographics

It is important to note that the new order of categories of questions/statements does not contain the same categories as listed in Table 6.1. That is because in addition to the re-ordering of the categories, questions/statements were also modified in order to get the most information out of the student responses in the least amount of questions. Table 6.3 contains the proposed questions/statements under the above categories shown in Table 6.2.

Table 6.3. Redesigned Categories for New Pre-Survey with Revised as well as Additional Questions/Statements.

1) What Do Engineers Do?
Read the following statements about what engineers might do and indicate your agreement or disagreement with each statement Design and create things we use every day (from a pencil you use to write to the road you took to get to school) Mainly work with other people to solve problems Use math and science principles to determine a solution to a problem Can choose to do many different kinds of jobs Engineers can work in dirty environments I don't know what engineers do In the future, do you think you want to be an engineer Has anyone talked to you about becoming an engineer, if so who

Table 6.3. cont.

2) What Do Technicians Do?
Read the following statements about what technicians might do and indicate your agreement or disagreement with each statement
Mainly work with other people to solve problems
Use hands-on approaches to find a solution to a problem
Can choose to do many different kinds of jobs
Read the following statements about what technicians might do and indicate your agreement or disagreement with each statement
Technicians can work in dirty environments
I don't know what technicians do
In the future, do you think you want to be a technician
Has anyone talked to you about becoming a technician, if so who
3) Self-Efficacy
Tell us a little about yourself
I can lead a team to succeed in a project
I am motivated to do my best in school
I am able to collaborate with my classmates on class projects
Creativity and Innovation
I can use existing knowledge to come up with new ideas, products, or processes
Communication and Collaboration
I can interact with my peers in a variety of different settings
I can work with a group to create original works or to solve problems
I respect other's ideas even if they are different than my own
I like to bounce ideas off of others when trying to solve a problem
Critical Thinking, Problem Solving, and Decision Making
When given a problem, I am able to create a plan to solve it
I am able to collect and analyze data during an experiment to identify a solution
If my first solution does not work, I am motivated to try again
I can gather information on a subject and am able to organized and use only the appropriate information
4) Demographics
Name
Gender
Ethnicity
Education
Name of School
Classes currently enrolled in
Are you currently enrolled in honors or advanced classes

Table 6.3. cont.

4) Demographics
Have you been encouraged to enroll in honors or advanced classes
Are you enrolled in a special engineering curriculum
Do you plan to enroll in honors or advanced classes next year
Has anyone talked to you about the importance of taking classes that will prepare you for college
Has anyone talked to you about the importance of math in your future career
What do you plan to do when you graduate from high school
Have either of your parents attended college or a university after high school

When looking to redesign the survey questions, I believe that two key items need to be addressed; 1) The 'What do Engineers do?' question and 2) Replace the goals, future work, attitudes questions with a hybrid that will be categorized as 'Self-Efficacy'. Self-efficacy has to do with one's capabilities or their beliefs in their ability to reach their goals. This new category will help researchers to understand with fewer questions the overall sense of ability and drive that participating students have to actually reach their goals.

The changes to the Engineer category had to do with the idea that the original survey provided statements that were either too general, or may have been difficult for the students to understand exactly what was being asked. The redesign includes slightly more detail in the statement options.

The incorporation of the Self-Efficacy category provides not only has the potential to provide very useful information regarding students' natural abilities and their abilities to work hard and reach a goal, but this section also will provide a link back to the self/peer assessments that the students take after each activity. This series of statements helps to unify the project and what the 'You're Hired!' program is about – Infusing a change students' attitudes towards engineering and engineering careers by providing hands-on, real-world problems for the students to solve in a STEM environment while infusing 21st Century Skills that will benefit the students when they leave the classroom.

The changes to the post-survey will mirror that of the pre-survey with the inclusion of the Impact statements that help researchers to understand the 'You're Hired!' specific impact. Prior to the launch of the new surveys in for the 2015-2016 school year, researchers including myself will form a focus group of students to better understand student interpretations of the questions. I will ensure that the right questions are being asked in a way that students understand and can relate to.

Professional Development for Teachers

One of the greatest advantages that 'You're Hired! has in its program design is the continuous feedback loop. This loop is not just between the program/teachers and the students, but the program and the teachers/schools. 'You're Hired!' ensures that after each activity not only do the students receive feedback based on the activity, but the teachers and schools do as well. This constant feedback between the program and the schools creates an atmosphere that assures teachers that their opinions and suggestions matter. It is critical in designing a program like this that 1) all of the design features such as real-world problem, 3 voucher/question opportunities, presenting to community members not teachers, etc. are met and 2) that the stakeholders such as the teachers, administrators, community volunteers and students understand that they are appreciated and that their opinions matter.

After the 2012-2013 pilot year, students as well as teachers provided feedback that was then implemented into the 2013-2014 program. The early changes was empowering for the schools and teachers as well as for the students and the program designers.

The 'You're Hired!' program received feedback from the schools after the 2012-2013 school year that a summer professional development would be beneficial for the teachers. The professional development would instruct the teachers how to incorporate the program's ideas and methodology into their classrooms between the three activities. After the 2013-2014 school year, the amount of feedback regarding professional development for teachers was greater. A couple of schools have innovative teachers that are using the outline of 'You're Hired!' in their everyday classrooms already, other teachers may need more guidance on how to conduct this type of a change.

The professional development could also provide an opportunity to train teachers on lessons/activities such as presentation styles, conceptualization of a project, collaboration activities, utilizing graphs with data, etc. that teachers could do in their classrooms to provide students with the important skills they will need for the future workplace. These lessons/activities also provide scaffolding that theoretically will make students more prepared for the next 'You're Hired!' activity. The 'You're Hired!' activities become an opportunity for teachers to assess students' progress in these areas as well as other areas in STEM and 21st Century Skills. Incorporating STEM into classrooms as well as how to infuse 21st Century Skills into what is already being taught are other topics that will be part of the professional development.

Over the summer of 2014, work was done by a team from the University of North Dakota to see how providing lessons/activities to students between 'You're Hired!' activities would affect their participation in the remaining activities. Students attended a

‘You’re Hired!’ summer camp that was one week long. Students participated in ‘You’re Hired!’ competition activities on Monday, Wednesday and Friday. On Tuesday and Thursday students attended a variety of sessions to provide more knowledge, scaffolding, on how to improve for the next ‘You’re Hired!’ activity. The sessions contained information on topics such as collaboration, presentations styles, the engineering design process, how to effectively use data and graphs, and more. While the results of this summer camp have not been analyzed yet, I believe from the conversations I have had with the team from the University of North Dakota that the ‘training’ the students received on data graphs, teamwork, presentation styles, etc. was beneficial in preparing for the next activity challenge.

Providing teachers with professional development to support ‘You’re Hired!’ and the incorporation of STEM and 21st Century Skills into the everyday classroom is something that teachers in the immediate area are looking for. It will be a priority for the research team from the three higher education organizations to apply for a funding source to support such an activity.

Revisiting Program Design Key Features

While the ‘You’re Hired!’ program was designed to include key design features that contributed to various successful engineering education programs, the program is very different than any other program that is being researched right now that I am aware of. There is an abundance of research being done on summer camps, after school programs, and program insertion into specific curriculum such as physics or engineering classroom, but nothing quite like ‘You’re Hired!’.

Because ‘You’re Hired!’ has the ability to reach every single student at a participating school, it is important that while the program was designed with key features that encourage students to pursue engineering, that researchers ensure that additional design features are in place to support and encourage all students and their interests. The key design elements of a summer camp, after school program, and curriculum supplement are included in the program. It is now time to determine what additional design features are needed to provide all students with a successful ‘You’re Hired!’ experience.

Preparing for Scaling, Sustaining and Evolution of the Program

The ‘You’re Hired!’ program is spreading to new schools every year by word of mouth only, no additional solicitation has been needed. Some schools participate with one sub-section of one grade, whereas other schools participate with their entire school including grades 7-12. It is important the program continues to keep the key design features while allowing for flexibility to allow the schools to make the program their own. The key design features endorse the program by providing research data as backing, however not every feature within the original program design is required to gain similar results from students.

There were five schools included in the research of this master’s study, but overall there were twenty schools that participated in the 2013-2014 school year. Of this twenty schools, 3-5 of the schools completed the activities completely on their own. I would send supplies and needed documents and the teachers at the school would complete the rest of the organizing. This type of relationship is what is desired for all participating schools. In order to meet the needs of all of the schools that are looking to take part, it is very important that the program be designed so that schools feel comfortable conducting the activities without assistance.

It is also important in terms of sustainability that new, engaging, real-world problem statements are created to keep students engaged in the activities. These problem statements need to include a hands-on experiment/project that allows student to be innovative and to determine a solution. The hands-on kit needs to be easily shipped or contain supplies that can be purchased inexpensively from a local grocery store or gas station. As the number of schools increases, it becomes more expensive to run the program. It is important that costs are kept as low as possible while still providing meaningful experiences. The 'You're Hired!' research team is also working hard to obtain funding through grants to help support the cost of the project.

Finally, it is important to prepare for possible evolutions of the project. As mentioned prior, in the summer of 2014 there was a 'You're Hired!' summer camp. While the original design behind 'You're Hired!' included the activities being done with every student in a participating school, the summer camp's preliminary information has provided insight into the benefits of this type of program. In the week long summer camp, the students completed three separate 'You're Hired!' challenge activities. One activity was on Monday, another on Wednesday, and the final on Friday of that week. On Tuesday and Thursday the students arrived at camp and received the important scaffolding, feedback, and support needed to improve for the next day's challenge. The camp contained all other design factors as determined by research to be important. The results and feedback of the scaffolding provided between the challenges will benefit the research team when designing the professional development.

Final Thoughts

I believe that the 'You're Hired!' program has been designed with very important key features for effective engineering education. I also believe that including the key stakeholders such as administrators, teachers, students and community members have helped to make this a program that is needed by many schools in the immediate research area. Finally, I feel that my role in designing and analyzing this program has put me in a position to excel in a variety of situations. In any project that is designed it is important to understand 1) key elements to the project, 2) who are the stakeholders and what are their needs, 3) what are the outside constraints that may not be readily obvious, 4) understanding current funding sources and how to find additional funding, and 5) how to collaborate and bring groups of experts and professionals together to brainstorm possible solutions to the given problem. Whether an individual is working with designing a new medical product for hospitals, a new process line in a factory, or designing an educational tool that will challenge current educational approaches, these are the skills that will allow for success.

Research does not stop at with this thesis, I expect this work to continue to redesign and create an educational tool that schools not only in the North Dakota, area use, but states across the country will use in their classrooms.

APPENDICES

APPENDIX A
SAMPLE OF STUDENT PRE- AND POST-SURVEYS

You're Hired! Pre-Survey

Assent Form

Project Title: You're Hired! – Infusing STEM and 21st Century Skills
Investigator(s): This study is being done by: Kristin Brevik, Student at UND; Dr. Frank Bowman, UND Instructor; Dr. Brian Tande, UND Instructor; Dr. Kristi Jean, NDSCS Instructor; Dr. Bradley Bowen, NDSU Instructor

We are doing a research study; a research study is a special way to find out about something. We are trying to find out if your attitude towards engineering changes over the course of the school year. We will be coming to your school 3 times to do activities that will improve your 21st century skills. Examples of 21st century skills are: teamwork, time management, collaboration, and critical thinking. These 21st century skills are skills engineers use every day.

If you want to be in this study, we will ask you to do several things:
Before the first activity we will have you fill out a pre-survey. There are no right answers. We will then be doing 3 activities with your school throughout the school year. When we come you will spend the entire school day working with us. We will give you a problem in the morning and then you and your team of classmates will have the entire day to find a solution. At the end of the day before school gets done you will have the opportunity to present your solution to judges in a board room. When you are done presenting, you will be asked to fill out an anonymous survey which will give you the chance to rate how your teammates did. You will also be given time to look back at how you did throughout the day and comment on what you would like to get better at for next time. At the end of the school year we will have you fill out a post-survey just like the pre-survey.

We want to tell you about some things that may happen to you if you are in this study: This activity takes an entire school day which may seem like a long time, but you will not be asked to do anything different than what teachers could normally have you do.

Not everyone who is in this study will benefit. A benefit means that something good happens to you. We don't know if you will benefit. But we hope to learn something that will help other people someday.

When we are done with the study, we will write a report about what we found out. We will not use your name in the report.

You do not have to be in this study. It is up to you. If you want to be in the study, but change your mind later, you can stop being in the study.

If you do not want to be in this study, your school will still have you do the project along with the assessments and surveys, we just won't be able to talk about your accomplishments in the report.

1. By checking the box by 'Yes' you have agreed to participate in this study.

◯ Yes

You're Hired! Pre-Survey

Personal Information

*2. First Name

*3. Last Name

*4. Gender

- ◯ Male
- ◯ Female

*5. Ethnicity (You may check more than one, as appropriate)

- ☐ African/Black American
- ☐ American Indian/Alaskan Native
- ☐ Asian & Pacific American
- ☐ Latina/Latino/Hispanic American
- ☐ White American

Other (please specify)

You're Hired! Pre-Survey

Education

***6. Education (Check the grade you are in now)**

- ○ 6th
- ○ 7th
- ○ 8th
- ○ 9th
- ○ 10th
- ○ 11th
- ○ 12th

***7. Name of your school:**

***8. From the list below, check the classes you are currently taking in school this year:**

- ☐ Pre-Algebra
- ☐ Algebra I
- ☐ Algebra II
- ☐ Computer Applications
- ☐ Computer Science
- ☐ Drafting or CAD (Computer-Aided Drawing)
- ☐ Earth or Physical Science
- ☐ Engineering
- ☐ English
- ☐ Foreign Language
- ☐ General Math
- ☐ Geometry
- ☐ History/Social Studies
- ☐ Music
- ☐ Physics
- ☐ Pre-Calculus
- ☐ Technology Education

Other math, engineering, or science courses:

***9. Are you currently enrolled in honors or advanced classes?**

- ○ Yes
- ○ No
- ○ Not Available

***10. Have you been encouraged to enroll in honors or advanced classes?**

- ○ Yes
- ○ No
- ○ Not Available

***11. Are you enrolled in a special engineering curriculum?**

- ○ Yes
- ○ No
- ○ Not Available

***12. Do you plan to enroll in honors or advanced classes next year?**

- ○ Yes
- ○ No
- ○ Not Available

***13. Has anyone talked to you about the importance of taking classes that will prepare you for college?**

- ○ Yes
- ○ No

You're Hired! Pre-Survey

Education

*6. Education (Check the grade you are in now)

○ 6th ○ 7th ○ 8th ○ 9th ○ 10th ○ 11th ○ 12th

*7. Name of your school:

[ ]

*8. From the list below, check the classes you are currently taking in school this year:

☐ Pre-Algebra
☐ Algebra I
☐ Algebra II
☐ Computer Applications
☐ Computer Science
☐ Drafting or CAD (Computer-Aided Drawing)
☐ Earth or Physical Science
☐ Engineering
☐ English
☐ Foreign Language
☐ General Math
☐ Geometry
☐ History/Social Studies
☐ Music
☐ Physics
☐ Pre-Calculus
☐ Technology Education

Other math, engineering, or science courses:

[ ]

*9. Are you currently enrolled in honors or advanced classes?

○ Yes ○ No ○ Not Available

*10. Have you been encouraged to enroll in honors or advanced classes?

○ Yes ○ No ○ Not Available

*11. Are you enrolled in a special engineering curriculum?

○ Yes ○ No ○ Not Available

*12. Do you plan to enroll in honors or advanced classes next year?

○ Yes ○ No ○ Not Available

*13. Has anyone talked to you about the importance of taking classes that will prepare you for college?

○ Yes ○ No

You're Hired! Pre-Survey

*** 14. Has anyone talked to you about the importance of math in your future career?**

- ◯ Yes
- ◯ No

*** 15. What do you plan to do when you graduate from high school? (Check only one.)**

- ◯ Go to a college or university
- ◯ Attend a technical school (community college, business school, beauty school, etc.)
- ◯ Attend a technical school then transfer to a college or university
- ◯ Get a full-time job
- ◯ Join the military
- ◯ Don't know

Other (please specify)

16. Have either of your parents attended college or a university after high school?

- ◯ Yes
- ◯ No
- ◯ Don't know

You're Hired! Pre-Survey

Engineers

***17. Read the following statements about what engineers might do and indicate your agreement or disagreement with each statement:**

	Agree	Disagree	Don't Know
Mainly work on machines and computers	○	○	○
Mainly work with other people to solve problems	○	○	○
Work on things that help the world	○	○	○
Can choose to do many different kinds of jobs	○	○	○
Mainly work on things that have nothing to do with me	○	○	○
I don't know what engineers do	○	○	○

Other (please write in whole sentences)

***18. If you go to college, do you think you will pursue a career in an engineering-related field?**

○ Yes ○ No ○ Don't Know

***19. In your future, do you think you want to be an engineer?**

○ Yes ○ No ○ Don't Know

***20. Has anyone talked to you about becoming an engineer?**

○ Yes ○ No

21. If yes, put a check by everyone who has talked to you about this:

☐ People in after school programs
☐ Engineering or technology teacher
☐ Family members
☐ Family friends
☐ Guidance counselor
☐ Math teacher
☐ Science teacher
☐ Computer teacher

***22. Read the following statements about what technicians might do and indicate your agreement or disagreement with each statement:**

	Agree	Disagree	Don't Know
Mainly do hands on work and experiments	○	○	○
Mainly work with other people to solve problems	○	○	○
Work on things that help the world	○	○	○
Can choose to do many different kinds of jobs	○	○	○
Mainly work on things that have nothing to do with me	○	○	○
I don't know what technicians do	○	○	○

Other (please write in whole sentences)

***23. If you further your education, do you think you will pursue a a career in a technician-related field?**

○ Yes ○ No ○ Don't Know

***24. In your future, do you think you want to be a technician?**

○ Yes ○ No ○ Don't Know

***25. Has anyone talked to you about becoming a technician?**

○ Yes ○ No ○ Don't Know

26. If yes, put a check by everyone who has talked to you about this:

- ☐ People in after school programs
- ☐ Engineering or technology teacher
- ☐ Family members
- ☐ Family friends
- ☐ Guidance counselor
- ☐ Math teacher
- ☐ Science teacher
- ☐ Computer teacher

Other (provide kind of person or teacher, not name)

You're Hired! Pre-Survey

Your Goals

*** 27. The following statements describe work or jobs you might do in the future. Tell us how important each of the items below is to you in your future work:**

	Not Important	Somewhat Important	Very Important
Work that makes me think	○	○	○
Work that allows me to make lots of money	○	○	○
Work that allows me to use math, computers, engineering, or science skills	○	○	○
Work that allows me to tell other people what to do	○	○	○
Work that allows me to help solve problems and create solutions	○	○	○
Work that is fun to do	○	○	○
Work that allows me to have time with family	○	○	○
Work that allows me to help my community and/or society	○	○	○
Work that makes people think highly of me	○	○	○
Work that is satisfying to me	○	○	○

You're Hired! Pre-Survey

*28. Here is a list of statements. Tell us what you think about them. Select a response that indicates your level of agreement.

	Strongly Disagree	Somewhat Disagree	Somewhat Agree	Strongly Agree
I look forward to science class in school	◯	◯	◯	◯
I look forward to math class in school	◯	◯	◯	◯
I would rather solve a problem by doing an experiment than be told the answer	◯	◯	◯	◯
More time should be spent on hands-on projects in science or technology activities at school	◯	◯	◯	◯
I would like to (or already do) belong to a science or technology activities club	◯	◯	◯	◯
I get bored when I watch programs on channels like Discovery Channel, Animal Planet, Nova, Mythbusters, etc.	◯	◯	◯	◯
I like to get science books or science experiments kits as presents	◯	◯	◯	◯
I like learning how things work	◯	◯	◯	◯
Science is too hard when it involves math	◯	◯	◯	◯
Science is a difficult subject	◯	◯	◯	◯
Doing experiments in science class is frustrating	◯	◯	◯	◯
I feel comfortable with using a computer to make graphs and tables	◯	◯	◯	◯
I am interested in learning more about how things work	◯	◯	◯	◯
I like to learn to use new technology	◯	◯	◯	◯

You're Hired! Pre-Survey

What You Think

*** 29. If you encounter a math homework problem that you don't know how to solve, what are you most likely to do?**

- ☐ Ask a parent or other family member for help with the problem
- ☐ Call a friend who you know is good at math and ask her or him for help so you can solve it
- ☐ Contact the Homework Hotline or similar resource
- ☐ Get help from your math teacher on this problem
- ☐ Work it out with my study group
- ☐ Go to the teacher's web page for help
- ☐ Copy the answer from one of your friends
- ☐ Search the internet for help
- ☐ Take some time and try to figure out how to best approach solving this problem

Other (please specify)

This is an example of a math problem:

(x)^3 - (2x)^2 + (3x) = 6

What values of x would solve this problem? (If you are unsure about how this problem would look when written by a teacher, please ask for help.)

*** 30. For the above problem, check the box below that best describes your ability to learn to solve this example math problem? Check only one.**

- ◯ I can solve this problem now
- ◯ I can teach myself to solve this problem
- ◯ I will be able to learn to solve this problem once I take the right classes
- ◯ Even if I took the right class, I wouldn't be able to learn to solve this problem
- ◯ I don't think I will ever take a class that has problems this hard
- ◯ I am not interested in learning to solve this type of math problem

Other (please specify)

You're Hired! Pre-Survey

*31. The table lists things you can do when you are working on school activities or assignments. Check the appropriate box to tell us how often you do each of these things.

	Never	Sometimes	Very Often	Always
I can use what I have learned to teach myself how to program a computer game.	○	○	○	○
When I see a new math problem, I can use what I have learned to solve the problem	○	○	○	○
I can use what I know to design and build something mechanical that works	○	○	○	○
In lab activities, I can use what I have learned to design a solution	○	○	○	○
I can effectively lead a team to design and build a hands-on project	○	○	○	○
I know where I can find the information that I need to solve difficult problems	○	○	○	○
I can explain math or science to my friends to help them understand	○	○	○	○
I can get good grades in math	○	○	○	○
I can get good grades in science	○	○	○	○

You're Hired! Post-Survey

Personal Information

***1. First Name**

***2. Last Name**

***3. Gender**

- Male
- Female

***4. Ethnicity (You may check more than one, as appropriate)**

- African/Black American
- American Indian/Alaskan Native
- Asian & Pacific American
- Latina/Latino/Hispanic American
- White American

Other (please specify)

You're Hired! Post-Survey

Education

*5. Education (Check the grade you are in now)

○ 6th ○ 7th ○ 8th ○ 9th ○ 10th ○ 11th ○ 12th

*6. Name of your school:

*7. Are you currently enrolled in honors or advanced classes?

○ Yes ○ No ○ Not Available

*8. Have you been encouraged to enroll in honors or advanced classes?

○ Yes ○ No ○ Not Available

*9. Are you enrolled in a special engineering curriculum?

○ Yes ○ No ○ Not Available

*10. Do you plan to enroll in honors or advanced classes next year?

○ Yes ○ No ○ Not Available

*11. Has anyone talked to you about the importance of taking classes that will prepare you for college?

○ Yes ○ No

*12. Has anyone talked to you about the importance of math in your future career?

○ Yes ○ No

*13. What do you plan to do when you graduate from high school? (Check only one.)

○ Go to a college or university

○ Attend a technical school (community college, business school, beauty school, etc.)

○ Attend a technical school then transfer to a college or university

○ Get a full-time job

○ Join the military

○ Don't know

Other (please specify)

You're Hired! Post-Survey

14. Have either of your parents attended college or a university after high school?

◯ Yes ◯ No ◯ Don't know

You're Hired! Post-Survey

Tell Us What You Think About You're Hired!

***15. Help us improve the activity by telling us what you think about the activity by checking the appropriate box:**

	Strongly Disagree	Disagree	Agree	Strongly Agree
The information I received about the activity before it began helped me to participate successfully	◯	◯	◯	◯
I found the instructions and information I received during the activity to be effective and helpful	◯	◯	◯	◯
If I needed help during the activity, it was readily available	◯	◯	◯	◯
I found it easy to get to know the other participants in this activity	◯	◯	◯	◯
The leaders for this activity were prepared	◯	◯	◯	◯
This activity was well organized	◯	◯	◯	◯
My goals for participating in this activity were met	◯	◯	◯	◯

You're Hired! Post-Survey

***16. How much did participating in the activity impact each of the following?**

	Not at All	Slightly	Moderately	A Great Deal
Helped me understand problem solving better	◯	◯	◯	◯
Led me to a better understanding of my own career goals	◯	◯	◯	◯
Increased my interest in studying engineering in college	◯	◯	◯	◯
Increased my interest in studying a technical degree in college	◯	◯	◯	◯
Made me think more about what I will do after graduating from high school	◯	◯	◯	◯
Made me decide to work harder in school	◯	◯	◯	◯
Made me decide to take different classes in school (including college) that I had planned to	◯	◯	◯	◯
Made me confident in my ability to succeed in an engineering or technical field	◯	◯	◯	◯
Increased my confidence in my ability to participate in engineering projects or activities	◯	◯	◯	◯

***17. What did you like best about this activity? (Please write in whole sentences)**

***18. If you were in charge, how would you change this activity? (Please write in whole sentences.)**

***19. Would you recommend that your friends participate in this activity?**

◯ Yes ◯ No

***20. In whole sentences, please explain why or why not:**

You're Hired! Post-Survey

Engineers

***21. Read the following statements about what engineers might do and indicate your agreement or disagreement with each statement:**

	Agree	Disagree	Don't Know
Mainly work on machines and computers	○	○	○
Mainly work with other people to solve problems	○	○	○
Work on things that help the world	○	○	○
Can choose to do many different kinds of jobs	○	○	○
Mainly work on things that have nothing to do with me	○	○	○
I don't know what engineers do	○	○	○

Other (please write in whole sentences)

***22. If you go to college, do you think you will pursue a career in an engineering-related field?**

○ Yes ○ No ○ Don't Know

***23. In your future, do you think you want to be an engineer?**

○ Yes ○ No ○ Don't Know

***24. Has anyone talked to you about becoming an engineer?**

○ Yes ○ No

25. If yes, put a check by everyone who has talked to you about this:

- ☐ People in after school programs
- ☐ Engineering or technology teacher
- ☐ Family members
- ☐ Family friends
- ☐ Guidence counselor
- ☐ Math teacher
- ☐ Science teacher
- ☐ Computer teacher

Other (provide kind of person or teacher, not name)

You're Hired! Post-Survey

Technicians

***26. Read the following statements about what technicians might do and indicate your agreement or disagreement with each statement:**

	Agree	Disagree	Don't Know
Mainly do hands on work and experiments	◯	◯	◯
Mainly work with other people to solve problems	◯	◯	◯
Work on things that help the world	◯	◯	◯
Can choose to do many different kinds of jobs	◯	◯	◯
Mainly work on things that have nothing to do with me	◯	◯	◯
I don't know what technicians do	◯	◯	◯

Other (please write in whole sentences)

***27. If you further your education, do you think you will pursue a a career in a technician-related field?**

◯ Yes ◯ No ◯ Don't Know

***28. In your future, do you think you want to be a technician?**

◯ Yes ◯ No ◯ Don't Know

***29. Has anyone talked to you about becoming a technician?**

◯ Yes ◯ No ◯ Don't Know

30. If yes, put a check by everyone who has talked to you about this:

- ☐ People in after school programs
- ☐ Engineering or technology teacher
- ☐ Family members
- ☐ Family friends
- ☐ Guidence counselor
- ☐ Math teacher
- ☐ Science teacher
- ☐ Computer teacher

Other (provide kind of person or teacher, not name)

You're Hired! Post-Survey

Your Goals

***31. The following statements describe work or jobs you might do in the future. Tell us how important each of the items below is to you in your future work:**

	Not Important	Somewhat Important	Very Important
Work that makes me think	◯	◯	◯
Work that allows me to make lots of money	◯	◯	◯
Work that allows me to use math, computers, engineering, or science skills	◯	◯	◯
Work that allows me to tell other people what to do	◯	◯	◯
Work that allows me to help solve problems and create solutions	◯	◯	◯
Work that is fun to do	◯	◯	◯
Work that allows me to have time with family	◯	◯	◯
Work that allows me to help my cmomunity and/or society	◯	◯	◯
Work that makes people think highly of me	◯	◯	◯
Work that is satisfying to me	◯	◯	◯

You're Hired! Post-Survey

***32. Here is a list of statements. Tell us what you think about them. Select a response that indicates your level of agreement.**

	Strongly Disagree	Somewhat Disagree	Somewhat Agree	Strongly Agree
I look forward to science class in school	○	○	○	○
I look forward to math class in school	○	○	○	○
I would rather solve a problem by doing an experiment than be told the answer	○	○	○	○
More time should be spent on hands-on projects in science or technology activities at school	○	○	○	○
I would like to (or already do) belong to a science or technology activities club	○	○	○	○
I get bored when I watch programs on channels like Discovery Channel, Animal Planet, Nova, Mythbusters, etc.	○	○	○	○
I like to get science books or science experiments kits as presents	○	○	○	○
I like learning how things work	○	○	○	○
Science is too hard when it involves math	○	○	○	○
Science is a difficult subject	○	○	○	○
Doing experiments in science class is frustrating	○	○	○	○
I feel comfortable with using a computer to make graphs and tables	○	○	○	○
I am interested in learning more about how things work	○	○	○	○
I like to learn to use new technology	○	○	○	○

You're Hired! Post-Survey

What You Think

***33. If you encounter a math homework problem that you don't know how to solve, what are you most likely to do?**

- [ ] Ask a parent or other family member for help with the problem
- [ ] Call a friend who you know is good at math and ask her or him for help so you can solve it
- [ ] Contact the Homework Hotline or similar resource
- [ ] Get help from your math teacher on this problem
- [ ] Work it out with my study group
- [ ] Go to the teacher's web page for help
- [ ] Copy the answer from one of your friends
- [ ] Search the internet for help
- [ ] Take some time and try to figure out how to best approach solving this problem

Other (please specify)

This is an example of a math problem:

(x)^3 - (2x)^2 + (3x) = 6

What values of x would solve this problem? (If you are unsure about how this problem would look when written by a teacher, please ask for help.)

***34. For the above problem, check the box below that best describes your ability to learn to solve this example math problem? Check only one.**

- ◯ I can solve this problem now
- ◯ I can teach myself to solve this problem
- ◯ I will be able to learn to solve this problem once I take the right classes
- ◯ Even if I took the right class, I wouldn't be able to learn to solve this problem
- ◯ I don't think I will ever take a class that has problems this hard
- ◯ I am not interested in learning to solve this type of math problem

Other (please specify)

You're Hired! Post-Survey

***35. The table lists things you can do when you are working on school activities or assignments. Check the appropriate box to tell us how often you do each of these things.**

	Never	Sometimes	Very Often	Always
When I see a new math problem, I can use what I have learned to solve the problem	○	○	○	○
I can use what I know to design and build something mechanical that works	○	○	○	○
In lab activities, I can use what I have learned to design a solution	○	○	○	○
I can effectively lead a team to design and build a hands-on project	○	○	○	○
I know where I can find the information that I need to solve difficult problems	○	○	○	○
I can explain math or science to my friends to help them understand	○	○	○	○
I can get good grades in math	○	○	○	○
I can get good grades in science	○	○	○	○

APPENDIX B
END OF THE YEAR 'YOU'RE HIRED!' REPORT THAT SCHOOLS RECEIVED

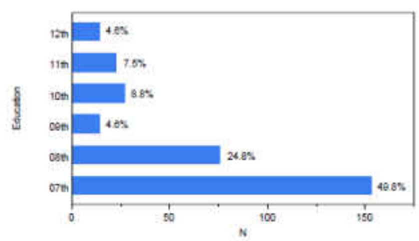
'You're Hired!' Pilot Year Results

The pilot year was a success with more than 73.5% of the students recommending that their friends participate in this activity. Greatest project impact as assessed by the students was a better understanding of problem solving at 85.1%, ranging from 'slightly' to 'a great deal'. While the interest in pursuing engineering or technology-related careers did not statistically change during the course of the year, attitudes towards these careers did change. Recognizing the important role of faculty and staff for the positive results from this pilot project, 'You're Hired!' will continue for the 2013-2014 school year.

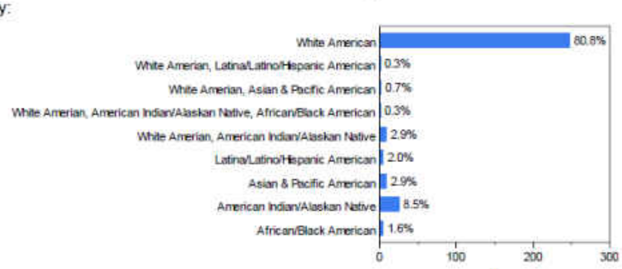
Sixteen participating schools were given the option of having students complete both a pre- and post-survey to measure their awareness and perceptions about different aspects of engineering and possible STEM career choices. The survey was adapted from the Assessing Women and Men in Engineering (AWE) Project (HRD 0120642 and HRD 0607081). Evaluation highlights are included within this report, encompassing only assent-provided student responses from the seven schools that completed both the pre- and post-surveys.

The demographics breakdown from the seven schools (N=307 overall) included 52.8% (N=162) and 47.2% (N=145) of males and females, respectively. Grades and ethnicity follow:

Grade level:



Ethnicity:



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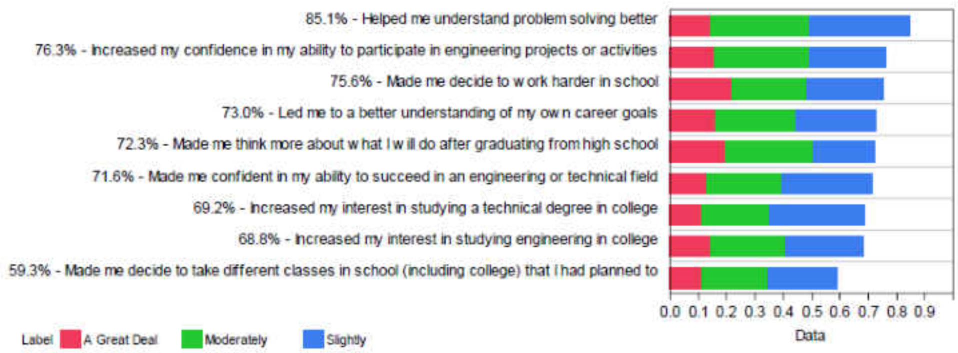
The project was a positive experience for a majority of the students, with 73.5% recommending that their friends participate in this activity. NDSCS considers this to be a very high approval rating due to the fact that schools can have 100% of their students participating, from high-risk to honor student.

Project impact was assessed by asking '***How much did participating in the activity impact each of the following?***'



The greatest project impact was a better understanding of problem solving (85.1%). Their interest in studying a technical or engineering degree also increased. Both 'made me decide to work harder in school' and 'made me think more about what I will do after graduating from high school' received the highest 'A Great Deal' ranking.

Students' self-efficacy was also assessed by '***The table lists things you can do when you are working on school activities or assignments. Check the appropriate box to tell us how often you do each of these things:***'

Attitudes and Skills	Always	Very Often	Sometimes	Never
When I see a new math problem, I can use what I have learned to solve the problem	18.3% (55) (-2.7%)	37.0% (111) (-6.3%)	40.0% (120) (7.4%)	4.7% (14) (1.7%)
I can use what I know to design and build something mechanical that works	14.3% (43) (-0.2%)	27.3% (82) (1.5%)	45.0% (135) (4.9%)	13.3% (40) (4.9%)
*In lab activities, I can use what I have learned to design a solution	20.3% (61) (2.1%)	28.0% (84) (-12.0%)	43.0% (129) (8.4%)	8.7% (26) (1.5%)
I can effectively lead a team to design and build a hands-on project	18.0% (54) (0.0%)	27.3% (82) (-4.0%)	42.7% (128) (3.6%)	12.0% (36) (0.5%)

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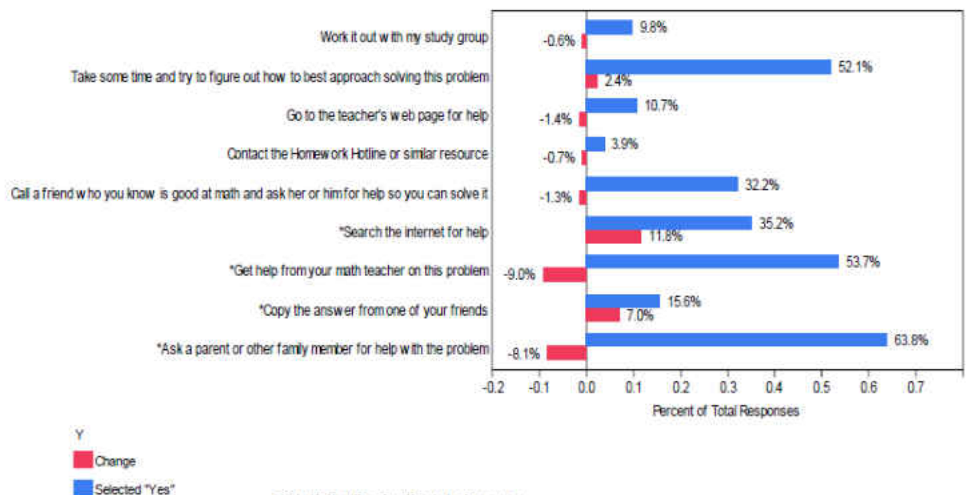
Attitudes and Skills	Always	Very Often	Sometimes	Never
I know where I can find the information that I need to solve difficult problems	22.3% (67) (0.4%)	32.3% (97) (-3.3%)	39.7% (119) (0.8%)	5.7% (17) (2.1%)
I can explain math or science to my friends to help them understand	20.4% (61) (-1.6%)	37.1% (111) (4.8%)	34.4% (103) (-3.2%)	8.0% (24) (0.0%)
I can get good grades in math	36.6% (109) (1.1%)	31.2% (93) (-6.4%)	27.2% (81) (2.3%)	5.0% (15) (3.0%)
I can get good grades in science	37.9% (106) (2.5%)	35.7% (100) (-5.8%)	25.0% (70) (3.3%)	1.4% (4) (-0.1%)

'You're Hired!' is designed to put the students in charge of their learning (self-directed learner) and encourage collaboration, instead of the student just raising their hand and asking a teacher for the answers. Students' behavior did change, with 11.8% more students recognizing that they can search the internet for help and a 9.0% decrease in the number that would go to their teacher for help. The change in students' behavior was assessed by '***If you encounter a math homework problem that you don't know how to solve, what are you most likely to do?***'



* Statistically significant changes

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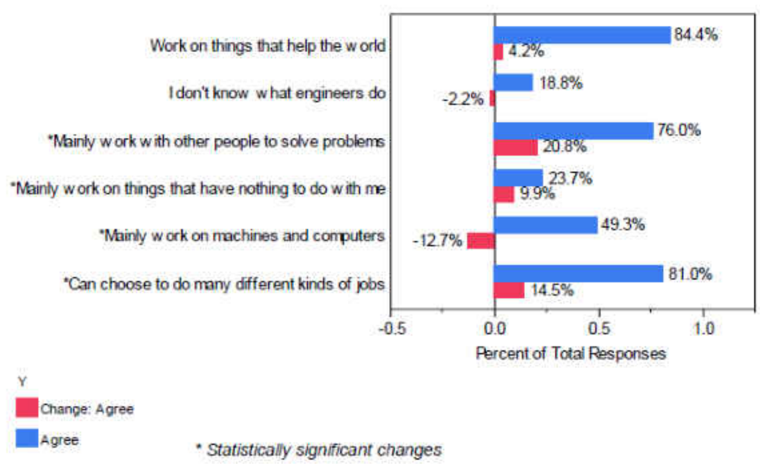
When asked '***If you go to college, do you think you will pursue a career in an engineering-related field?***', post-survey results indicated:

'yes'	'no'	'don't know'
27.2%	40.1%	32.8%

There is not a statistcal difference between the overall pre- and post-survey responses to this question, however there is an association of gender and school. The 'yes' response probability reaches 20.8% for females from three of the schools, while only 10.1% for females from the remaining schools. The 'yes' response probability is also higher for males from two of the schools (63.8%) than the remaining five schools (27.3%).

Student attitude towards engineering was assessed with '***Read the following statements about what engineers might do and indicate your level of agreement or disagreement with each statement – Engineering is:*** '



** Statistically significant changes*

Students' attitude towards engineering careers changed over the course of this project, with the biggest change in students agreeing that engineers work with other people to solve problems (increase of 20.8%). Students also agreed that engineers can choose to do many different jobs (81.0%) and work on things that help the world (84.4%).

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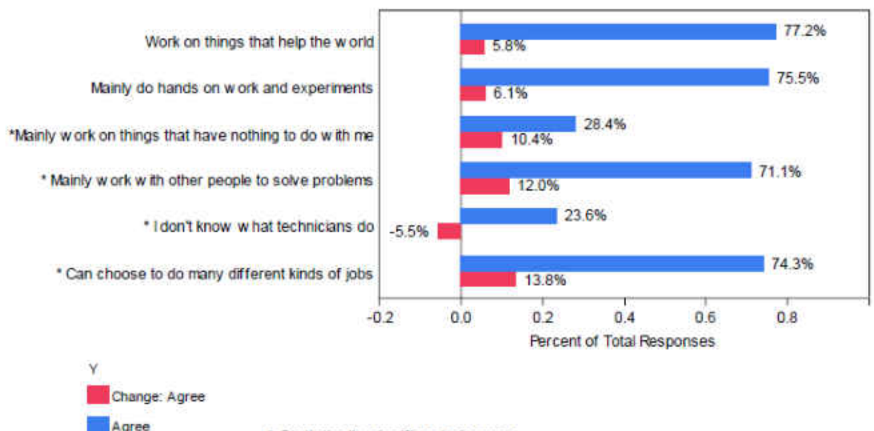
When asked '***If you go to college, do you think you will pursue a career in a technician-related field?***', post-survey results indicated:

'yes'	'no'	'don't know'
17.6%	43.5%	38.9%

There is not a statistcal difference between the overall pre- and post-survey responses to this question.

Student attitude towards technicians was assessed with '***Read the following statements about what technicians might do and indicate your level of agreement or disagreement with each statement:***'



* *Statistically significant changes*

Students' attitude towards technician careers also changed over the course of this project, with the biggest change in students agreeing that technicians can choose to do many different kinds of jobs (increase of 13.8%).

With the positive student feedback and promising changes in students' attitude, behavior and self-efficacy, NDSCS will be working with the University of North Dakota and North Dakota State University to move the 'You're Hired!' pilot project forward.

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APPENDIX C
ANALYSIS OF EVERY QUESTION/STATEMENT INCLUDED IN THE PRE- AND POST-SURVEY FOR THE EXPERIMENTAL AND CONTROL GROUPS

Engineer Questions

Engineers	**Group**	**N**	**P-Value**	X^2	**Pre-Survey Mean**	**Post-Survey Mean**
E1 - Mainly work on machines and computers	C E	134 135	0.74 0.30	0.60 2.42	2.20 2.54	2.29 2.42
E2 - Mainly work with other people to solve problems	C *E	132 133	0.30 <0.01	2.40 17.52	2.31 2.36	2.39 2.74
E3 - Work on things that help the world	C E	133 133	0.58 0.21	1.09 3.13	2.51 2.73	2.59 2.81
E4 - Can choose to do many different kinds of jobs	*C *E	130 134	0.04 <0.01	6.21 13.18	2.37 2.43	2.57 2.74
E5 - Mainly work on things that have nothing to do with me	*C E	130 133	0.01 0.12	9.87 4.20	1.75 1.70	1.60 1.63
E6 - I don't know what engineers do	C E	126 132	0.40 0.62	1.86 0.95	1.57 1.40	1.46 1.32
E7 - Pursue a career in an engineering-related field?	C E	136 136	0.32 0.20	2.27 3.23	1.66 1.95	1.74 2.06
E8 - Do you think you want to be an engineer?	C E	136 136	0.16 0.24	3.65 2.83	1.46 1.81	1.61 1.90

*Significance: p-value less than or equal to 0.05
C: ‘Control Group’ and E: ‘Experimental Group’
Degrees of Freedom (DF) =6

Future Work Questions

Future Work	Group	N	P-Value	X^2	Pre-Survey Mean	Post-Survey Mean
F1 - Work that makes me think	C E	136 133	0.51 0.46	1.35 1.56	2.46 2.49	2.47 2.56
F2 - Work that allows me to make lots of money	C E	134 135	0.87 0.20	0.29 3.26	2.59 2.59	2.56 2.51
F3 - Work that allows me to use math, computers, engineering, or science skills	C E	136 133	0.90 0.87	0.22 0.28	2.19 2.32	2.15 2.37
F4 - Work that allows me to tell other people what to do	C E	134 133	0.69 0.26	0.73 2.71	1.78 1.80	1.80 1.80
F5 - Work that allows me to help solve problems and create solutions	C E	135 133	0.21 0.52	3.12 1.29	2.16 2.43	2.31 2.48
F6 - Work that is fun to do	C E	135 135	0.84 0.23	0.34 2.95	2.73 2.79	2.76 2.85
F7 - Work that allows me to have time with family	C E	135 135	0.14 0.35	3.95 2.09	2.73 2.74	2.77 2.83
F8 - Work that allows me to help my community and/or society	C E	135 134	0.40 0.93	1.81 0.15	2.49 2.51	2.40 2.49
F9 - Work that makes people think highly of me	C E	135 134	0.43 0.34	1.68 2.16	2.26 2.31	2.23 2.28
F10 - Work that is satisfying to me	C E	135 133	0.23 0.17	2.95 3.59	2.84 2.77	2.76 2.83

*Significance: p-value less than or equal to 0.05
C: ‘Control Group’ and E: ‘Experimental Group’
Degrees of Freedom (DF) = 6

Interest Questions

Interest	Group	N	P-Value	X^2	Pre-Survey Mean	Post-Survey Mean
In1 - I look forward to science class in school	C E	136 134	0.46 0.54	2.56 2.16	2.90 3.41	2.78 3.43
In2 - I look forward to math class in school	C E	134 135	0.51 0.56	2.30 2.08	2.97 2.92	2.82 2.86
In3 - I would rather solve a problem by doing an experiment than be told the answer	C E	136 135	0.66 0.12	1.62 5.83	3.13 3.36	3.05 3.25
In4 - More time should be spent on hands-on projects in science or technology activities at school	C E	136 135	0.84 [a]	0.83 [a]	3.29 3.63	3.23 3.64
In5 - I would like to (or already do) belong to a science or technology activities club	C E	134 133	0.69 0.82	1.45 0.93	2.02 2.71	1.90 2.64
In6 - I get bored when I watch programs on channels like Discovery Channel, Animal Planet, Nova, Mythbusters, etc.	C E	136 135	0.44 0.28	2.72 3.86	2.00 1.99	2.09 1.93
In7 - I like to get science books or science experiments kits as presents	C E	136 134	0.33 0.90	3.40 0.58	2.21 2.51	2.04 2.42
In8 - I like learning how things work	C E	135 132	0.22 0.32	4.39 3.54	3.26 3.32	3.07 3.39
In9 - Science is too hard when it involves math	C *E	133 135	0.88 0.01	0.69 11.52	2.21 1.98	2.17 2.33
In10 - Science is a difficult subject	C E	133 134	0.44 0.13	2.73 5.59	2.20 1.78	2.11 2.01
In11 - Doing experiments in science class is frustrating	C *E	133 135	0.70 0.05	1.43 7.74	1.84 1.59	1.88 1.87
In12 - I feel comfortable with using a computer to make graphs and tables	C E	135 134	0.20 0.97	4.66 0.25	3.02 3.03	2.82 3.06
In13 - I am interested in learning more about how things work	C E	134 133	0.95 0.28	0.37 3.86	3.10 3.35	3.05 3.26
In14 - I like to learn to use new technology	C *E	135 135	0.15 <0.01	5.27 14.17	3.30 3.59	3.20 3.44

*Significance: p-value less than or equal to 0.05
C: 'Control Group' and E: 'Experimental Group'
DF = 9

[a] - A reliable chi^2 and p-value could not be calculated for In4 – 'More time should be spent on hands-on projects in science or technology activities at school' because one of the answer options received less than five responses.

Attitude and Skills Questions

Attitude and Skills	Group	N	P-Value	X^2	Pre-Survey Mean	Post-Survey Mean
A1 - When I see a new math problem, I can use what I have learned to solve the problem	*C E	133 134	<0.01 0.14	13.32 5.52	2.88 2.92	2.71 2.78
A2 - I can use what I know to design and build something mechanical that works	C *E	132 134	0.16 0.02	5.23 9.59	2.30 2.48	2.55 2.55
A3 - In lab activities, I can use what I have learned to design a solution	C E	133 134	0.58 0.44	1.98 2.68	2.47 2.89	2.57 2.81
A4 - I can effectively lead a team to design and build a hands-on project	C E	133 133	0.45 0.15	2.66 5.35	2.39 2.85	2.53 2.85
A5 - I know where I can find the information that I need to solve difficult problems	C E	132 134	0.94 0.26	0.38 3.97	2.81 2.89	2.83 2.72
A6 - I can explain math or science to my friends to help them understand	C E	132 134	0.97 0.19	0.27 4.77	2.56 2.82	2.55 2.67
A7 - I can get good grades in math	C E	133 134	0.79 0.66	1.03 1.59	3.01 3.14	2.91 3.01
A8 - I can get good grades in science	C E	132 132	0.71 0.73	1.36 1.30	2.92 3.35	2.89 3.25

*Significance: p-value less than or equal to 0.05
C: 'Control Group' and E: 'Experimental Group'
DF = 9

APPENDIX D
ANALYSIS OF THE DIFFERENCES BETWEEN PRE-SURVEY RESPONSES FOR EACH OF THE FIVE PARTICIPATING SCHOOLS.

Engineer Questions

			Pre-Survey Mean				
Engineers	**P-Value**	**X^2**	**A**	**B**	**C**	**D**	**E**
*E1 - Mainly work on machines and computers	<0.01	25.48	2.54	2.46	2.34	2.43	1.89
*E2 - Mainly work with other people to solve problems	<0.01	35.49	2.36	2.55	2.20	2.74	2.89
E3 - Work on things that help the world	0.10	13.25	2.73	2.82	2.65	2.83	3.00
E4 - Can choose to do many different kinds of jobs	0.20	11.11	2.43	2.55	2.44	2.68	2.78
E5 - Mainly work on things that have nothing to do with me	0.09	13.65	1.70	1.58	1.57	1.66	1.22
*E6 - I don't know what engineers do	<0.01	62.17	1.40	1.23	1.75	1.08	1.11
*E7 - Pursue a career in an engineering-related field?	<0.01	25.72	1.95	1.85	1.77	2.19	2.00
*E8 - Do you think you want to be an engineer?	<0.01	22.17	1.81	1.72	1.64	2.07	1.83

*Significance: p-value less than or equal to 0.05

Future Work Questions

Future Work	P-Value	X^2	Pre-Survey Mean				
			A	B	C	D	E
F1 - Work that makes me think	<0.01	33.00	2.49	2.57	2.31	2.65	2.72
F2 - Work that allows me to make lots of money	0.01	19.21	2.59	2.37	2.58	2.44	2.33
F3 - Work that allows me to use math, computers, engineering, or science skills	<0.01	36.91	2.32	2.38	2.11	2.65	2.50
F4 - Work that allows me to tell other people what to do	0.44	7.92	1.80	1.74	1.69	1.83	1.83
F5 - Work that allows me to help solve problems and create solutions	<0.01	41.02	2.43	2.53	2.20	2.63	2.83
F6 - Work that is fun to do	0.02	18.45	2.79	2.84	2.69	2.76	3.00
F7 - Work that allows me to have time with family	0.09	13.57	2.74	2.79	2.74	2.65	3.00
F8 - Work that allows me to help my community and/or society	<0.01	31.91	2.51	2.53	2.34	2.79	2.78
F9 - Work that makes people think highly of me	0.07	14.45	2.31	2.10	2.29	2.25	2.72
F10 - Work that is satisfying to me	0.29	9.59	2.77	2.78	2.76	2.81	2.94

*Significance: p-value less than or equal to 0.05

Interest Questions

Interest	P-Value	X^2	Pre-Survey Mean A	B	C	D	E
*In1 - I look forward to science class in school	<0.01	45.52	3.41	3.19	3.01	3.63	3.50
In2 - I look forward to math class in school	0.06	20.46	2.92	2.84	2.73	3.17	3.39
*In3 - I would rather solve a problem by doing an experiment than be told the answer	<0.01	66.08	3.36	3.27	2.87	3.46	3.83
*In4 - More time should be spent on hands-on projects in science or technology activities at school	<0.01	45.03	3.63	3.46	3.23	3.69	3.89
*In5 - I would like to (or already do) belong to a science or technology activities club	<0.01	61.84	2.71	2.47	2.19	3.17	3.06
*In6 - I get bored when I watch programs on channels like Discovery Channel, Animal Planet, Nova, Mythbusters, etc.	0.01	26.39	1.99	1.77	2.00	2.26	1.50
*In7 - I like to get science books or science experiments kits as presents	<0.01	38.76	2.51	2.23	2.05	2.75	2.00
*In8 - I like learning how things work	<0.01	35.42	3.32	3.42	3.11	3.50	3.89
*In9 - Science is too hard when it involves math	<0.01	29.56	1.98	2.07	2.29	2.17	1.78
In10 - Science is a difficult subject	0.15	16.93	1.78	1.96	2.10	2.06	1.72
*In11 - Doing experiments in science class is frustrating	0.01	26.41	1.59	1.66	1.89	1.92	1.44
*In12 - I feel comfortable with using a computer to make graphs and tables	<0.01	30.16	3.03	2.92	2.81	3.36	3.39
*In13 - I am interested in learning more about how things work	<0.01	82.80	3.35	3.28	2.80	3.60	3.89
*In14 - I like to learn to use new technology	<0.01	88.46	3.59	3.48	2.92	3.75	3.72

*Significance: p-value less than or equal to 0.05

Attitude and Skills

Attitude and Skills	P-Value	X^2	Pre-Survey Mean A	B	C	D	E
*A1 - When I see a new math problem, I can use what I have learned to solve the problem	0.03	22.26	2.92	2.85	2.61	2.92	3.06
*A2 - I can use what I know to design and build something mechanical that works	<0.01	57.65	2.48	2.24	2.08	2.81	3.06
*A3 - In lab activities, I can use what I have learned to design a solution	<0.01	49.59	2.89	2.81	2.49	3.09	3.17
*A4 - I can effectively lead a team to design and build a hands-on project	<0.01	55.52	2.85	2.72	2.33	3.04	3.06
*A5 - I know where I can find the information that I need to solve difficult problems	0.01	25.46	2.89	2.92	2.60	2.94	3.22
A6 - I can explain math or science to my friends to help them understand	0.16	16.81	2.82	2.56	2.57	2.79	2.94
A7 - I can get good grades in math	0.05	20.91	3.14	3.07	2.91	3.15	3.39
*A8 - I can get good grades in science	0.01	26.36	3.35	3.19	3.00	3.23	3.44

*Significance: p-value less than or equal to 0.05

APPENDIX E
ANALYSIS OF EVERY QUESTION/STATEMENT INCLUDED IN THE PRE- AND POST-SURVEY FOR THE ALL-SCHOOL EXPERIMENTAL GROUP

Engineer Questions

Engineers	N	P-Value	X^2	Pre-Survey Mean	Post-Survey Mean
*E1 - Mainly work on machines and computers	558	0.01	9.93	2.40	2.23
*E2 - Mainly work with other people to solve problems	556	<0.01	36.22	2.36	2.62
E3 - Work on things that help the world	554	0.33	2.24	2.72	2.75
*E4 - Can choose to do many different kinds of jobs	556	<0.01	25.11	2.49	2.69
*E5 - Mainly work on things that have nothing to do with me	553	<0.01	11.01	1.60	1.66
E6 - I don't know what engineers do	551	0.61	0.98	1.51	1.47
E7 - Pursue a career in an engineering-related field?	559	0.73	0.62	1.87	1.90
E8 - Do you think you want to be an engineer?	559	0.77	0.53	1.74	1.77

*Significance: p-value less than or equal to 0.05
DF = 2

Future Work Questions

Future Work	N	P-Value	X^2	Pre-Survey Mean	Post-Survey Mean
F1 - Work that makes me think	553	0.78	0.50	2.43	2.46
F2 - Work that allows me to make lots of money	553	0.21	3.15	2.53	2.47
F3 - Work that allows me to use math, computers, engineering, or science skills	551	0.71	0.68	2.26	2.25
*F4 - Work that allows me to tell other people what to do	552	0.05	5.92	1.74	1.83
F5 - Work that allows me to help solve problems and create solutions	553	0.97	0.05	2.36	2.37
F6 - Work that is fun to do	553	0.38	1.93	2.75	2.78
F7 - Work that allows me to have time with family	554	0.77	0.52	2.74	2.72
F8- Work that allows me to help my community and/or society	551	0.29	2.45	2.47	2.42
F9 - Work that makes people think highly of me	552	0.78	0.49	2.28	2.24
F10 - Work that is satisfying to me	549	0.28	2.51	2.78	2.75

*Significance: p-value less than or equal to 0.05
DF = 2

Interest Questions

Interest	N	P-Value	X^2	Pre-Survey Mean	Post-Survey Mean
In1 - I look forward to science class in school	554	0.30	3.67	3.21	3.11
In2 - I look forward to math class in school	550	0.76	1.16	2.86	2.87
In3 - I would rather solve a problem by doing an experiment than be told the answer	550	0.54	2.15	3.13	3.11
In4 - More time should be spent on hands-on projects in science or technology activities at school	546	0.11	5.99	3.42	3.40
In5 - I would like to (or already do) belong to a science or technology activities club	553	0.26	4.00	2.47	2.43
In6 - I get bored when I watch programs on channels like Discovery Channel, Animal Planet, Nova, Mythbusters, etc.	551	0.34	3.37	1.97	2.07
In7 - I like to get science books or science experiments kits as presents	550	0.91	0.55	2.25	2.24
In8 - I like learning how things work	550	0.06	7.39	3.26	3.27
In9 - Science is too hard when it involves math	550	0.11	6.11	2.15	2.27
*In10 - Science is a difficult subject	550	0.04	8.46	1.98	2.13
In11 - Doing experiments in science class is frustrating	549	0.10	6.25	1.77	1.91
In12 - I feel comfortable with using a computer to make graphs and tables	550	0.97	0.22	2.95	2.97
In13 - I am interested in learning more about how things work	552	0.44	2.69	3.11	3.14
*In14 - I like to learn to use new technology	549	0.03	9.26	3.27	3.30

*Significance: p-value less than or equal to 0.05
DF = 3

Attitude and Skills

Attitude and Skills	N	P-Value	X^2	Pre-Survey Mean	Post-Survey Mean
A1 - When I see a new math problem, I can use what I have learned to solve the problem	545	0.53	2.21	2.76	2.69
*A2 - I can use what I know to design and build something mechanical that works	544	<0.01	17.24	2.30	2.43
A3 - In lab activities, I can use what I have learned to design a solution	544	0.44	2.69	2.71	2.67
A4 - I can effectively lead a team to design and build a hands-on project	544	0.46	2.58	2.60	2.61
A5 - I know where I can find the information that I need to solve difficult problems	545	0.27	3.92	2.77	2.69
A6 - I can explain math or science to my friends to help them understand	544	0.71	1.37	2.66	2.65
A7 - I can get good grades in math	545	0.22	4.43	3.03	3.03
A8 - I can get good grades in science	542	0.59	1.90	3.15	3.15

*Significance: p-value less than or equal to 0.05
DF = 3

APPENDIX F
ANALYSIS OF EVERY QUESTION/STATEMENT INCLUDED IN THE PRE- AND POST-SURVEY BROKEN DOWN BY SCHOOL

Engineer Questions

Engineers	School	N	P-Value	X^2	Pre-Survey Mean	Post-Survey Mean
E1 - Mainly work on machines and computers	A	136	0.30	2.42	2.54	2.42
	B	68	0.56	1.15	2.46	2.31
	*C	282	0.04	6.33	2.34	2.15
	D	54	0.13	4.05	2.43	2.07
	E	18	0.18	1.80	1.89	2.33
E2 - Mainly work with other people to solve problems	*A	136	<0.01	17.52	2.36	2.74
	B	67	0.13	4.15	2.55	2.78
	*C	281	<0.01	18.15	2.20	2.46
	D	54	0.13	4.13	2.74	2.81
	E	18	0.31	1.03	2.89	3.00
E3 - Work on things that help the world	A	133	0.21	3.13	2.73	2.81
	B	68	0.57	1.11	2.82	2.90
	C	281	0.90	0.20	2.65	2.65
	D	54	0.18	3.38	2.83	2.83
	E	18	0.31	1.03	3.00	2.94
E4 - Can choose to do many different kinds of jobs	*A	136	<0.01	13.18	2.43	2.74
	*B	68	0.02	8.26	2.55	2.85
	*C	282	0.04	6.59	2.44	2.58
	D	52	0.10	4.60	2.68	2.88
	E	18	0.55	0.36	2.78	2.89
E5 - Mainly work on things that have nothing to do with me	A	136	0.12	4.20	1.70	1.63
	B	67	0.72	0.66	1.58	1.48
	*C	278	0.01	9.61	1.57	1.73
	D	54	0.13	4.08	1.66	1.67
	E	18	0.37	0.80	1.22	1.44
E6 - I don't know what engineers do	A	134	0.62	0.95	1.40	1.32
	B	67	0.46	1.56	1.23	1.28
	C	278	0.11	4.44	1.75	1.60
	*D	54	0.04	6.53	1.08	1.33
	E	18	0.19	3.33	1.11	1.50
E7 - Pursue a career in an engineering-related field?	A	136	0.20	3.23	1.95	2.06
	B	69	0.58	1.08	1.85	1.97
	C	282	0.94	0.13	1.77	1.77
	D	54	0.93	0.15	2.19	2.13
	E	18	0.53	1.28	2.00	1.78
E8 - Do you think you want to be an engineer?	A	136	0.24	2.83	1.81	1.90
	B	69	0.20	3.21	1.72	1.83
	C	282	0.94	0.12	1.64	1.62
	D	54	0.81	0.43	2.07	2.15
	E	18	0.75	0.58	1.83	1.72

*Significance: p-value less than or equal to 0.05

Future Work Questions

Future Work	School	N	P-Value	X^2	Pre-Survey Mean	Post-Survey Mean
F1 - Work that makes me think	A	135	0.46	1.56	2.49	2.56
	B	66	0.16	3.69	2.57	2.67
	C	281	0.45	1.60	2.31	2.30
	D	54	0.35	2.13	2.65	2.69
	E	17	0.91	0.01	2.72	2.71
F2 - Work that allows me to make lots of money	A	135	0.20	3.26	2.59	2.51
	B	65	0.89	0.22	2.37	2.42
	C	282	0.10	4.63	2.58	2.48
	D	54	0.58	1.07	2.44	2.41
	E	17	0.47	1.50	2.33	2.53
F3 - Work that allows me to use math, computers, engineering, or science skills	A	134	0.87	0.28	2.32	2.37
	B	65	0.05	5.89	2.38	2.29
	C	281	0.97	0.05	2.11	2.11
	D	54	0.72	0.66	2.65	2.63
	E	17	0.80	0.43	2.50	2.41
F4 - Work that allows me to tell other people what to do	A	135	0.26	2.71	1.80	1.80
	B	65	0.74	0.59	1.74	1.80
	*C	281	0.04	6.24	1.69	1.85
	D	54	0.83	0.36	1.83	1.81
	E	17	0.58	1.07	1.83	1.94
F5 - Work that allows me to help solve problems and create solutions	A	135	0.52	1.29	2.43	2.48
	B	65	0.86	0.29	2.53	2.51
	C	282	0.75	0.57	2.20	2.17
	D	54	0.12	4.20	2.63	2.78
	E	17	0.37	1.97	2.83	2.82
F6 - Work that is fun to do	A	135	0.23	2.95	2.79	2.85
	B	66	0.09	4.86	2.84	2.83
	C	281	0.92	0.17	2.69	2.70
	D	54	0.80	0.44	2.76	2.81
	E	17		0.00	3.00	3.00
F7 - Work that allows me to have time with family	A	135	0.35	2.09	2.74	2.83
	B	66	0.53	1.27	2.79	2.70
	C	282	0.19	3.35	2.74	2.66
	D	54	0.50	1.37	2.65	2.76
	E	17	0.30	1.09	3.00	2.94
F8- Work that allows me to help my community and/or society	A	134	0.93	0.15	2.51	2.49
	B	65	0.14	3.89	2.53	2.35
	C	281	0.78	0.50	2.34	2.33
	D	54	0.41	1.80	2.79	2.69
	E	17	0.25	2.81	2.78	2.82
F9 - Work that makes people think highly of me	A	134	0.34	2.16	2.31	2.28
	B	65	0.47	1.52	2.10	2.08
	C	282	0.64	0.88	2.29	2.25
	D	54	0.96	0.09	2.25	2.24
	E	17	0.28	2.51	2.72	2.59
F10 - Work that is satisfying to me	A	133	0.17	3.59	2.77	2.83
	B	65	0.11	4.46	2.78	2.83
	C	280	0.13	4.09	2.76	2.67
	D	54	0.58	1.08	2.81	2.76
	E	17	0.31	1.03	2.94	3.00

*Significance: p-value less than or equal to 0.05

Interest Questions

Interest	School	N	P-Value	X^2	Pre-Survey Mean	Post-Survey Mean
In1 - I look forward to science class in school	A	135	0.54	2.16	3.41	3.43
	B	66	0.17	5.09	3.19	2.91
	C	282	0.40	2.94	3.01	2.94
	D	54	0.14	5.52	3.63	3.33
	E	17	0.86	0.03	3.50	3.53
In2 - I look forward to math class in school	A	134	0.56	2.08	2.92	2.86
	B	65	0.71	1.39	2.84	2.80
	C	280	0.62	1.80	2.73	2.79
	D	54	0.24	4.19	3.17	3.31
	E	17	0.57	1.99	3.39	3.24
In3 - I would rather solve a problem by doing an experiment than be told the answer	A	134	0.12	5.83	3.36	3.25
	B	64	0.27	3.93	3.27	3.13
	C	281	0.38	3.05	2.87	2.90
	D	54	0.42	2.82	3.46	3.61
	E	17	0.94	0.01	3.83	3.82
In4 - More time should be spent on hands-on projects in science or technology activities at school	*A	133	0.01	10.47	3.63	3.64
	B	66	0.54	2.16	3.46	3.33
	C	277	0.63	1.75	3.23	3.20
	D	53	0.58	1.94	3.69	3.77
	E	17	0.58	0.31	3.89	3.82
In5 - I would like to (or already do) belong to a science or technology activities club	A	135	0.82	0.93	2.71	2.64
	B	65	0.68	1.50	2.47	2.37
	C	282	0.59	1.92	2.19	2.21
	D	54	0.40	2.96	3.17	3.02
	E	17	0.52	2.25	3.06	2.82
In6 - I get bored when I watch programs on channels like Discovery Channel, Animal Planet, Nova, Mythbusters, etc.	A	135	0.28	3.86	1.99	1.93
	B	66	0.21	4.55	1.77	2.02
	C	279	0.17	5.08	2.00	2.19
	D	54	0.65	1.65	2.26	2.00
	E	17	0.26	3.97	1.50	1.76
In7 - I like to get science books or science experiments kits as presents	A	134	0.90	0.58	2.51	2.42
	B	66	0.93	0.44	2.23	2.20
	C	279	0.81	0.97	2.05	2.09
	D	54	0.38	3.07	2.75	2.69
	E	17	0.48	2.46	2.00	2.12
In8 - I like learning how things work	A	133	0.32	3.54	3.32	3.39
	B	66	0.47	2.53	3.42	3.32
	C	280	0.31	3.55	3.11	3.12
	D	54	0.98	0.20	3.50	3.46
	E	17	0.51	1.34	3.89	3.82
In9 - Science is too hard when it involves math	*A	135	0.01	11.52	1.98	2.33
	B	66	0.65	1.66	2.07	2.23
	C	281	0.11	6.08	2.29	2.29
	D	52	0.85	0.80	2.17	2.10
	E	16	0.39	3.04	1.78	1.94
In10 - Science is a difficult subject	A	134	0.13	5.59	1.78	2.01
	B	65	0.32	3.54	1.96	2.23
	C	280	0.15	5.34	2.10	2.21
	D	54	0.81	0.97	2.06	1.89
	E	17	0.62	0.97	1.72	1.88

Interest Questions cont.

In11 - Doing experiments in science class is frustrating	A	134	0.05	7.74	1.59	1.87
	*B	66	0.01	10.66	1.66	2.18
	C	278	0.30	3.68	1.89	1.92
	D	54	0.35	3.25	1.92	1.67
	E	17	0.80	0.44	1.44	1.53
In12 - I feel comfortable with using a computer to make graphs and tables	A	135	0.97	0.25	3.03	3.06
	B	65	0.45	2.63	2.92	3.08
	C	280	0.99	0.09	2.81	2.80
	D	53	0.74	1.24	3.36	3.40
	E	17	0.26	4.03	3.39	3.24
In13 - I am interested in learning more about how things work	A	135	0.28	3.86	3.35	3.26
	B	64	0.61	1.81	3.28	3.25
	C	282	0.18	4.85	2.80	2.96
	D	54	0.67	1.56	3.60	3.46
	E	17	0.48	1.48	3.89	3.71
In14 - I like to learn to use new technology	*A	133	<0.01	14.17	3.59	3.44
	B	65	0.85	0.79	3.48	3.37
	*C	280	0.02	10.16	2.92	3.16
	D	54	0.48	2.47	3.75	3.59
	E	17	0.48	1.45	3.72	3.47

*Significance: p-value less than or equal to 0.05

Attitude and Skills

Attitude and Skills	**School**	**N**	**P-Value**	**X^2**	**Pre-Survey Mean**	**Post-Survey Mean**
A1 - When I see a new math problem, I can use what I have learned to solve the problem	A	134	0.14	5.52	2.92	2.78
	B	61	0.64	1.70	2.85	2.85
	C	279	0.43	2.76	2.61	2.53
	D	54	0.73	1.29	2.92	2.96
	E	17	0.69	1.47	3.06	3.06
A2 - I can use what I know to design and build something mechanical that works	*A	134	0.02	9.59	2.48	2.55
	B	60	0.06	7.35	2.24	2.57
	C	279	0.07	7.13	2.08	2.23
	D	54	0.60	1.89	2.81	2.87
	E	17	0.86	0.31	3.06	2.94
A3 - In lab activities, I can use what I have learned to design a solution	A	134	0.44	2.68	2.89	2.81
	B	61	0.73	1.28	2.81	2.85
	C	278	0.48	2.47	2.49	2.42
	D	54	0.46	2.60	3.09	3.07
	E	17	0.31	2.34	3.17	3.47
A4 - I can effectively lead a team to design and build a hands-on project	A	133	0.15	5.35	2.85	2.85
	B	61	0.08	6.74	2.72	2.95
	C	279	0.98	0.21	2.33	2.34
	D	54	0.38	3.05	3.04	2.93
	E	17	0.86	0.31	3.06	3.12
A5 - I know where I can find the information that I need to solve difficult problems	A	134	0.26	3.97	2.89	2.72
	B	61	0.81	0.98	2.92	2.95
	C	279	0.31	3.62	2.60	2.49
	D	54	0.32	3.50	2.94	3.13
	E	17	0.97	0.06	3.22	3.24

Attitudes and Skills cont.

A6 - I can explain math or science to my friends to help them understand	A	134	0.19	4.77	2.82	2.67
	B	61	0.17	5.06	2.56	2.85
	C	278	0.65	1.63	2.57	2.53
	D	54	0.24	4.24	2.79	2.94
	E	17	0.71	1.37	2.94	2.94
A7 - I can get good grades in math	A	134	0.66	1.59	3.14	3.01
	B	61	0.26	4.01	3.07	3.31
	C	279	0.06	7.23	2.91	2.92
	D	54	0.71	1.40	3.15	3.19
	E	17	0.64	1.69	3.39	3.41
A8 - I can get good grades in science	A	132	0.73	1.30	3.35	3.25
	B	61	0.62	0.95	3.19	3.31
	C	278	0.36	3.24	3.00	3.04
	D	54	0.43	2.74	3.23	3.20
	E	17	0.78	1.10	3.44	3.29

*Significance: p-value less than or equal to 0.05

APPENDIX G
ANALYSIS OF EVERY QUESTION/STATEMENT INCLUDED IN THE PRE- AND POST-SURVEY BY GENDER

Engineer Questions

Engineers	Gender	N	P-Value	X^2	Pre-Survey Mean	Post-Survey Mean
E1 - Mainly work on machines and computers	Female *Male	251 309	0.06 0.03	5.56 6.75	2.32 2.46	2.17 2.29
E2 - Mainly work with other people to solve problems	*Female *Male	250 304	<0.01 <0.01	18.23 19.59	2.39 2.33	2.62 2.61
E3 - Work on things that help the world	Female Male	250 304	0.39 0.67	1.91 0.81	2.75 2.70	2.80 2.70
E4 - Can choose to do many different kinds of jobs	*Female *Male	250 304	<0.01 <0.01	15.49 14.30	2.52 2.45	2.71 2.68
E5 - Mainly work on things that have nothing to do with me	Female *Male	250 302	0.13 0.02	4.10 7.97	1.62 1.59	1.61 1.70
E6 - I don't know what engineers do	Female Male	242 293	0.94 0.54	0.12 1.22	1.58 1.45	1.55 1.39
E7 - Pursue a career in an engineering-related field?	Female Male	253 311	0.68 0.89	0.77 0.23	1.61 2.08	1.63 2.11
E8 - Do you think you want to be an engineer?	Female Male	253 311	0.46 0.92	1.56 0.16	1.45 1.97	1.50 1.99

*Significance: p-value less than or equal to 0.05
DF = 6

Future Work Questions

Future Work	**Gender**	**N**	**P-Value**	X^2	**Pre-Survey Mean**	**Post-Survey Mean**
F1 - Work that makes me think	Female Male	251 309	0.93 0.84	0.15 0.36	2.48 2.39	2.50 2.42
F2 - Work that allows me to make lots of money	*Female Male	252 308	0.05 0.78	6.06 0.51	2.52 2.55	2.39 2.54
F3 - Work that allows me to use math, computers, engineering, or science skills	Female Male	253 307	0.59 0.83	1.06 0.37	2.19 2.32	2.21 2.29
F4 - Work that allows me to tell other people what to do	Female Male	252 306	0.58 0.06	1.10 5.76	1.72 1.76	1.76 1.89
F5 - Work that allows me to help solve problems and create solutions	Female Male	252 307	0.81 0.95	0.43 0.10	2.37 2.36	2.37 2.36
F6 - Work that is fun to do	Female Male	253 309	0.50 0.55	1.39 1.20	2.77 2.73	2.78 2.78
F7 - Work that allows me to have time with family	Female Male	250 306	0.57 0.99	1.13 0.03	2.81 2.69	2.77 2.68
F8 - Work that allows me to help my community and/or society	Female Male	250 306	0.30 0.64	2.39 0.88	2.56 2.39	2.48 2.38
F9 - Work that makes people think highly of me	Female Male	249 306	0.27 0.78	2.63 0.49	2.26 2.29	2.16 2.31
F10 - Work that is satisfying to me	Female Male	250 305	0.21 0.59	3.08 1.06	2.82 2.74	2.75 2.74

*Significance: p-value less than or equal to 0.05
DF = 6

Interest Questions

Interests	Gender	N	P-Value	X^2	Pre-Survey Mean	Post-Survey Mean
In1 - I look forward to science class in school	Female Male	253 308	0.62 0.21	1.76 4.53	3.14 3.26	3.06 3.16
In2 - I look forward to math class in school	Female Male	251 304	0.44 0.45	2.68 2.66	2.78 2.92	2.92 2.84
In3 - I would rather solve a problem by doing an experiment than be told the answer	Female Male	252 303	1.00 0.29	0.06 3.78	3.11 3.15	3.12 3.10
In4 - More time should be spent on hands-on projects in science or technology activities at school	Female Male	250 303	0.62 0.16	1.79 5.12	3.42 3.43	3.44 3.36
In5 - I would like to (or already do) belong to a science or technology activities club	Female Male	248 303	0.11 0.74	6.11 1.26	2.35 2.58	2.20 2.62
In6 - I get bored when I watch programs on channels like Discovery Channel, Animal Planet, Nova, Mythbusters, etc.	Female *Male	251 304	0.82 0.05	0.93 7.62	2.20 1.79	2.19 1.97
In7 - I like to get science books or science experiments kits as presents	Female Male	249 304	0.98 0.62	0.21 1.79	2.10 2.38	2.13 2.33
In8 - I like learning how things work	Female Male	247 300	0.39 0.14	3.03 5.56	3.11 3.39	3.14 3.37
In9 - Science is too hard when it involves math	Female *Male	246 302	0.66 0.04	1.61 8.54	2.28 2.05	2.27 2.26
In10 - Science is a difficult subject	Female Male	247 304	0.34 0.11	3.39 5.94	2.00 1.97	2.15 2.11
In11 - Doing experiments in science class is frustrating	Female Male	245 303	0.47 0.26	2.52 3.98	1.75 1.79	1.86 1.94
In12 - I feel comfortable with using a computer to make graphs and tables	Female Male	247 303	0.28 0.56	3.81 2.06	2.86 3.02	2.89 3.03
In13 - I am interested in learning more about how things work	Female Male	245 303	0.49 0.69	2.41 1.47	2.90 3.28	3.01 3.25
In14 - I like to learn to use new technology	*Female Male	246 303	<0.01 0.90	13.22 0.60	3.09 3.41	3.14 3.44

*Significance: p-value less than or equal to 0.05
DF = 9

Attitude and Skills

Attitude and Skills	Gender	N	P-Value	X^2	Pre-Survey Mean	Post-Survey Mean
A1 - When I see a new math problem, I can use what I have learned to solve the problem	Female Male	250 305	0.87 0.25	0.71 4.13	2.70 2.81	2.69 2.69
A2 - I can use what I know to design and build something mechanical that works	Female Male	250 304	0.01 0.04	10.50 8.32	2.05 2.50	2.20 2.63
A3 - In lab activities, I can use what I have learned to design a solution	Female Male	251 306	0.45 0.51	2.63 2.32	2.55 2.84	2.55 2.76
A4 - I can effectively lead a team to design and build a hands-on project	Female Male	251 304	0.34 0.19	3.34 4.79	2.59 2.61	2.56 2.66
A5 - I know where I can find the information that I need to solve difficult problems	Female Male	250 304	0.17 <0.01	4.97 13.03	2.61 2.89	2.72 2.66
A6 - I can explain math or science to my friends to help them understand	Female Male	251 303	0.50 0.98	2.37 0.20	2.66 2.66	2.67 2.64
A7 - I can get good grades in math	Female Male	251 305	0.45 0.21	2.64 4.51	3.07 2.99	3.15 2.93
A8 - I can get good grades in science	Female Male	250 304	0.68 0.85	1.53 0.82	3.19 3.11	3.22 3.08

*Significance: p-value less than or equal to 0.05
DF = 9

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