A PROGRAM EVALUATION OF A STEM SUMMER PROGRAM FOR MIDDLE GRADE STUDENTS AND THE INFLUENCE ON ATTITUDES TOWARD STEM AND STEM CAREERS

by
Adrienne Elizabeth Aul

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Chair of Committee: Dr. Jennifer Chauvot

Co-Chair of Committee: Dr. Justin Burris

Committee Member: Dr. Carrie Cutler

Committee Member: Dr. Miao Li

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Abstract

Background: Informal learning environments that focus on science, technology, engineering, and mathematics (STEM) provide students the opportunity to delve into hands-on problem-solving approaches in STEM disciplines, exploring in-depth areas and spending time not often available in classrooms throughout the academic year. Research shows that students' interest in STEM as a career is determined by the time they are in eighth grade. Thus, programs have emerged to provide students an opportunity to cultivate an interest in STEM at a young age. Attending a STEM summer program is one such way to cultivate interest. **Purpose:** This program evaluation investigated how participation in a weeklong STEM summer program influenced sixth, seventh, and eighth grade students' interest in STEM disciplines and in STEM careers. The program, named Investigations in Mathematics and Science (iMAS) Academy, was led by university faculty members and sponsored by a STEM Research and Learning Center at a university in East Texas. The study addressed the following questions: 1) To what extent does participating in iMAS Academy influence sixth, seventh, and eighth grade students' attitude toward STEM disciplines?, and 2) To what extent does participating in iMAS Academy influence sixth, seventh, and eighth grade students' interest in STEM careers? **Methods:** This evaluation used a Likert scale survey with additional open-response items to capture participants' interest in STEM disciplines and STEM careers before and after attending iMAS Academy. Fifty-nine students entering grades six, seven, and eight, from 22 public and private elementary and middle schools and four homeschooled participants attended iMAS Academy. The inquiry-based modules presented during iMAS Academy exposed students to chemistry, computer science, engineering-physics, and geology topics. Quantitative data was analyzed through the StatXact software, using chi-square analysis for aggregated categorical data and McNemar's Test for individual student response trends. Qualitative data was used to enhance the quantitative findings. **Results:** These analyses revealed that students' attitudes and interest in STEM and STEM careers did not change enough from the pre-surveys to the post-surveys to be statistically significant. However, qualitative data showed 10% of students changed their future career choice to a STEM career at the end of iMAS Academy, and overall, after participation in iMAS Academy students were more interested in STEM fields and STEM careers.

Table of Contents

Chapter Page

List of Tables

Table Page

List of Figures

Chapter I

Introduction

In eleven years, current middle school-age students will compete for jobs, 85% of which some experts estimate have not yet been invented (Institute for the Future, 2017). Success in these careers depends on factors including students' education and career readiness, especially in fields related to science, technology, engineering, and mathematics (STEM). The number of STEM careers is constantly growing, increasing the need for STEM education. Rapid advances in technology and science are driving forces in the creation of new jobs, and the persons required to fulfill these positions must demonstrate proficiency in science, technology, engineering, and mathematics (President's Council of Advisors on Science and Technology [PCAST], 2010). Additionally, factors such as problem-solving skills, ambition, and determination are necessary attributes that will make employees valuable in these future careers (Institute for the Future, 2017).

Research shows students determine their interest in STEM-related disciplines before entering the eighth grade (PCAST, 2010). In fact, "students who express interest in STEM in eighth grade are up to three times more likely to ultimately pursue STEM degrees later in life than students who do not express such an interest" (PCAST, 2010, p. 21). For this to happen, students need exciting experiences that connect STEM disciplines to their own lives and pique their interest. Providing students with an opportunity to receive hands-on learning in various STEM fields through informal learning experiences, those that happen outside of a regular classroom environment, allows students to obtain content knowledge that might not be possible in a traditional classroom environment

(Nugent et al., 2010). Exposure to STEM content through these informal learning environments positively influences students' interest in STEM disciplines and their motivation towards STEM careers (Mohr-Schroeder et al., 2014).

Research indicates people base their career choice upon their interest in that career and the belief in their ability to perform well in that career (Lent et al., 2005). For today's students to choose a STEM career path, they must show interest in STEM and believe they are capable of accomplishing the tasks required for such a career. Students' self-efficacy and expectancy-value beliefs are important factors in their achievement, motivation, and attitudes toward an academic subject (Eccles & Wigfield, 2002). Students with high self-efficacy in math and science are more likely to major in a STEM field during their postsecondary studies (Wang, 2013). Furthermore, student participation in out-of-school activities, especially during the late elementary years, help predict their choices, abilities, and beliefs in math and science (Simpkins et al., 2006).

Partnerships between K-12 institutions and higher education institutions have been identified as helpful in enhancing students' interest in STEM learning and their development of needed skills for various STEM disciplines (Genareo et al., 2016). In 2013, the National Research Council [NRC] released the Next Generation Science Standards [NGSS] for K-12 science education. These science standards integrate inquiry, practice, and the role of engineering (NGSS, 2013). Higher education partnership programs can provide support and professional development to K-12 educators who might lack the necessary pedagogical knowledge to incorporate state content standards within the classroom (Genareo et al., 2016). When STEM initiatives share their best practices and strengths, STEM education enhances through creating better teachers and students (Breiner et al., 2012). Creation of university partnerships with K-12 institutions can engage students in a more meaningful STEM learning environment.

Significance of Study

The STEM Research and Learning Center, founded in 2012 at a university in East Texas has developed a summer program for students, called Investigations in Mathematics and Science (iMAS) Academy. In its seventh year, iMAS Academy hosts up to 100 students per summer in a weeklong summer program for incoming sixth, seventh, and eighth graders. During this weeklong STEM program, students experience up to five modules, each centered on a different STEM discipline led by university faculty, staff, and local high school teachers. The iMAS Academy provides a variety of STEM experiences for students, rotating modules each year such that students do not participate in the same module twice if they attend all three summers in which they are eligible. University faculty and staff members work closely with the STEM Research and Learning Center to create meaningful and impactful STEM modules for each iMAS Academy. Faculty presenters seek to engage students through inquiry-based and discovery learning activities to provide an interactive STEM experience beyond what students experience in their academic classrooms throughout the school year.

The primary objective of the STEM Research and Learning Center is to increase the number of students interested in STEM careers and prepare them academically for STEM learning. This study is a program evaluation of iMAS Academy. Therefore, using a validated evaluation survey tool, this study determines how participation in iMAS Academy impacts middle school aged students' attitudes toward STEM disciplines, and their interest in STEM related careers. This research contributes to the understanding of how early exposure to hands-on, inquiry-based STEM activities can increase interest in STEM related disciplines. Additionally, this research provides practical suggestions for improvements to the current iMAS Academy program.

Research Questions

With the primary objective of the STEM Center Research and Learning Center in mind, this program evaluation answers the following research questions:

1. To what extent does participating in iMAS Academy influence sixth, seventh, and eighth grade students' attitude toward STEM disciplines?
2. To what extent does participating in iMAS Academy influence sixth, seventh, and eighth grade students' interest in STEM careers?

Definitions of Terms

This research discusses informal learning environments; therefore, it is necessary to define both formal learning and informal learning for reference, and the concept of inquiry learning.

Formal Learning Environment

A learning environment refers to the way learners receive information. The attainment of knowledge within an educational institution is a formal learning environment (Malcom et al., 2003). Typically, formal learning involves a combination of teacher-facilitated learning and skills assessments that test comprehension and mastery of particular subject areas within a classroom environment. For middle school and junior high students, formal learning environments are academic classroom settings in which students are not able to choose the area of study. Work trainings or continuing education courses are also formal learning settings.

Informal Learning Environment

An informal learning environment describes learning that takes place outside of an academic classroom (Sullenger, 2006). Often, participants choose to participate in these optional learning experiences. Examples of informal learning environments include field trips, museum trips, co-curricular programs, after school programs, weekend workshops, and summer programs (Sullenger, 2006; Weber, 2011). Informal learning environments can be short, one-hour activities, daylong events, or weeklong and month-long summer programs. These learning environments differ from formal learning environments because they occur outside of a required academic environment and encourage a less structured method for disseminating content and engaging students.

Inquiry Learning

Inquiry learning refers to a specific style of learning where students pursue information or knowledge of scientific ideas through investigations, much like a practicing scientist (NRC, 2000). The use of inquiry-based learning (IBL), especially in science disciplines, encourages students to stay curious and continue to ask questions such as “Why?” (Contant et al., 2018).

Preview of Methodology

This research is a program evaluation that measures the outcome and impact of iMAS Academy. According to Posavac (2011), a program evaluation is research gathered to help an organization improve their effectiveness and to assist with programmatic decision-making. By examining students’ comprehension of content and gauging students’ interest in STEM fields and STEM careers following the iMAS Academy program, the STEM Research and Learning Center gained insight into the effectiveness of this informal learning experience.

In April 2019, the STEM Research and Learning Center acquired permission from the Friday Institute for Educational Innovation (2012) to utilize their survey *Student Attitudes Toward STEM (S-STEM) Survey* for middle and high school students grades 6 – 12. In this study, analyzed survey data from each iMAS participant determined how participation in iMAS Academy influenced students' attitude towards STEM disciplines and STEM careers. The survey data represents quantitative data collected in this research, while additional questions created by the STEM Research and Learning Center represents the qualitative data collected from students. The use of two forms of data brings greater insight to the impact iMAS Academy has on student attitudes toward STEM than would be obtained by either type of data separately (Creswell & Plano Clark, 2018).

Summary

The purpose of this study was to determine if the weeklong summer program for middle school students, iMAS Academy, fulfilled the mission statement of the STEM Research and Learning Center. This program evaluation determined how participation in a weeklong STEM summer program influenced students' attitude toward STEM disciplines and their interest in STEM careers. The study includes the following: (1) a review of the relevant literature; (2) methods of the study; (3) results; and (4) conclusions.

Chapter II

Literature Review

The purpose of this study was to determine how student participation in a weeklong middle school summer STEM program influences students' attitudes toward STEM disciplines and their interest in STEM careers. This chapter is a review of the body of research regarding the possible benefits of summer STEM programs and informal learning environments, related to students' attitudes toward STEM. Included in this chapter are the following sections: (1) examination of informal learning environments and summer STEM programs; (2) methods for gauging students' attitudes toward STEM; (3) ways to increase student interest in STEM careers; (4) the impact of inquiry learning; and (5) a summary.

Examination of Informal Learning Environments and Summer STEM Programs

Informal learning environments, such as summer STEM programs, provide students the opportunity to actively engage and explore STEM content. Involvement in these engaging activities not only exposes students to different STEM careers, but also provides an opportunity for students to develop STEM content knowledge in an out-of-school, hands-on learning environment (Mohr-Schroeder et al., 2014). Since students' determine their interest in STEM disciplines by the time they enter the eighth grade, early exposure to STEM content and STEM experiences that allow students to connect their learning to their own lives is important (PCAST, 2010). While students learn through many avenues, it is important for them to make the connection from what they learn in a classroom environment to how those skills adapt to a real-world setting or a specific career. Environments, such as informal learning environments, can offer students an in-depth look at different STEM disciplines in a non-classroom based setting. Summer programs are just one of many types of informal learning environment possibilities.

Informal Learning Environments

As advances in science and technology transform our future and jobs are requiring more knowledge of STEM domains (PCAST, 2010), schools alone cannot provide students with all of the scientific knowledge necessary to address these needs (Bell et al., 2009). The informal learning environment setting, where learning takes place outside of a formal classroom setting, includes learning opportunities such as trips to museums and science centers (Sullenger, 2006), along with after school programs, participation in workshops, day camps, or summer programs facilitated through schools or universities (Mohr-Schroeder et al., 2014). These informal learning environments, such as a weeklong summer program, allow students to become more deeply involved in STEM activities, which might not be possible in a formal school environment (Nugent et al., 2010; Roberts et al., 2010).

Student participation in informal after school activities during the developmental years is important as it helps build students' belief about their abilities in math and science as well as their interest in STEM (Simpkins et al., 2006). Though students do not have a choice in which math and science courses they take during elementary school, they may be able to choose an after school activity related to a STEM discipline. Therefore, as students participate in more outside of school STEM activities, it is likely that their beliefs and interest in STEM areas is higher than students that do not participate in these activities. Children who believe that they have skills and interest in a particular area are more likely to pursue this area through adolescence (Simpkins et al., 2006).

Students who participate in an informal learning environment that provides hands-on participation and connects career options along with STEM learning are more interested in STEM courses and careers because of their participation (Weber, 2011). Informal STEM experiences are avenues that show students how to succeed in STEM disciplines and teaches students that STEM learning is accessible and achievable for all students (PCAST, 2010). Furthermore, these STEM experiences connect students with adults in the STEM field that can become positive STEM role models for students (PCAST, 2010; Weber, 2011). Providing students the opportunity to undertake STEM learning through informal learning environments releases the pressure of attaining good grades, and allows students to immerse themselves in STEM learning and achieve successful outcomes through their experiences.

Various studies have shown that participation in STEM-specific informal learning experiences positively influence students' interest in STEM fields and their interest in STEM careers (Dabney et al., 2012; Elam et al., 2012; Mohr-Schroeder et al., 2014; Moreno et al., 2016; PCAST, 2010; Wai et al., 2010). However, research also shows that it is important to spark students' interest in STEM during the middle school years and even earlier to increase the chance that students will continue advanced STEM education through high school and into college (Maltese & Tai, 2011; Maltese et al., 2014; PCAST, 2010). The growing body of research on the impact of informal, out-of-school learning experiences has led to the creation of STEM programs for students of all ages, which includes co-curricular programs, after school programs, weekend workshops, and summer programs (Weber, 2011). Participation in informal learning environments tangibly connects students' classroom learning of science and mathematics with physical examples and potential career opportunities, which ignites students' interest in STEM disciplines.

The *Math, Engineering, and Science Achievement* (MESA), is one example of a co-curricular program, founded in 1970 (Denson et al., 2015). Three educational systems, the California Public School System, California Community College System, and the California College System, designed the MESA program to support disadvantaged minority students through STEM disciplines. MESA supports middle and high school level students with study skills training, career and college exploration, individualized academic plans, and hands-on activities such as participating in an engineering design competition. The STEM-based informal program evaluated in this research aims to make STEM learning fun, increase student confidence, expose students to new opportunities, and provide students the opportunity to apply their learning from mathematics and science courses through tangible experiences. The MESA program expanded to eight other states after success through the initial program in California, showing that students who participate in the MESA program score higher in math and physics courses as well as on college entrance exams compared with traditional public high school students (Kotys-Schwartz et al., 2011).

Similar to MESA, the after-school program *Think Like an Astronaut* is an inquiry-based STEM program designed to cultivate the STEM knowledge and skills of fifth grade students (Moreno et al., 2016). This astronaut unit, designed for a Middle School Science Readiness Program, is the second of a three-part program. *Think Like an Astronaut* introduces students to STEM concepts associated with astronauts along with using the engineering process to think through problems that aerospace engineers might encounter.

Participation in this after school program exposes students to engineering STEM activities not taught during the school day, and improves students' STEM content knowledge. Students involved with this program show higher scores in their content courses than those who do not participate. The integration of the Middle School Science Readiness Program ultimately improves students' STEM skills and increased interest in STEM disciplines (Moreno et al., 2016).

Summer STEM Programs

Another form of informal learning environments includes summer programs. Students' participation in a STEM focused summer program provides opportunities for engagement in learning activities outside normal classroom hours. Summer programs provide valuable learning experiences to students during the academic year break, energizing students for the upcoming school year (Hayden et al., 2011). Research suggests that students who choose to be a part of a summer STEM program have more engagement throughout the program compared to students who attend because a parent signed them up for the program (Beymer et al., 2018). This suggests that students who choose to be a part of the program gain more through participation and experiences during the program than the students who did not choose to attend. However, students are still able to achieve high levels of engagement throughout a summer STEM program even if it was not their choice to attend (Beymer et al., 2018). While there are a variety of summer STEM programs available for students ranging from half-day experiences to five-week programs, what follows is an overview of summer programs, some single content specific and others with a larger STEM focus, that provide a variety of options to students, and how participation in summer STEM programs enhance students' interest and learning.

STEM Summer Programs. The *See Blue STEM Camp* is a weeklong summer day program that targets students in grades 5 through 8, providing middle grades students the opportunity to explore STEM fields through daily sessions led by university faculty (Mohr-Schroeder et al., 2014). Students participate in five different instructional sessions, one per morning, which each focus on a different STEM discipline. The afternoon sessions introduced students to LEGO® robotics, giving students an opportunity to build a robot and learn the basics to programming. Each afternoon session provided participants with different challenges to complete with their robot before participating in the LEGO® robotics competition at the end of the week. The researchers determined that involvement in these engaging activities not only exposes students to different STEM careers, but also provides an opportunity for students to develop STEM content knowledge in an out-of-school, hands-on learning environment. Students who participated in the See Blue STEM Camp showed an increase in interest in both STEM careers and STEM content. Students actively participated in learning that advanced their understanding of science, technology, engineering, and mathematics disciplines within a safe learning atmosphere created by university instructors.

In another view of summer STEM programs, Kitchen et al. (2016) investigate the impact a university- or college-run high school summer STEM program has on students' STEM career aspirations. Through this study, they surveyed 15,847 first-year college students from 46 institutions. The survey items included sections on career plan development, middle school science and mathematics experiences, high school background, STEM-related interests, and student and family characteristics. Of the students surveyed, 845 reported participating in a university- or college-run high school summer STEM program. Their findings showed that students who participated in a summer STEM program reported higher SAT mathematics scores, and took more mathematics courses in high school compared to students that did not participate in a high school summer STEM program. Furthermore, 65.2% of the students who participated in a university- or college-run high school summer STEM program reported increased STEM knowledge and skills. As for the impact a university- or college-run high school summer STEM program has on students' STEM career aspirations, the researchers found that students who participated in a summer program were 1.4 times more likely to report a STEM career goal. This number increased to 1.6 times more likely for summer STEM programs that showed the relevance of STEM content knowledge within the real world.

Science Specific Summer Programs. The *Summer Science Academy* for students in grades 6 through 12 provides IBL activities in microbiology, molecular biology, environmental health, and genetics for students over a period of two to four weeks (Knox et al., 2003). Students who attend this summer program participate in lab projects, discussion sections, field trips, scientist seminars, and a Biocomputing course. This research determined that students who attended the *Summer Science Academy* felt confident in the advanced laboratory skills they acquired throughout the camp. By participating in inquiry-based science activities, students' attitude toward science positively increased, students felt more confident in their ability to complete an advanced science course, and participants were more interested in a future career involving science. In an additional study of this *Summer Science Academy*, Markowitz (2004) surveyed past participants of the summer program as either current college students or college graduates. This research found that 68% of the college students surveyed were majoring in a science field, and 73% of college graduates had a career in a science field or were in a science graduate program. Overall, the Summer Science Academy had an impact on students' decisions about a career in science, and ultimately increased students' interest and professed abilities in science.

The design of some summer STEM programs is not to increase student interest in STEM, but to increase awareness in STEM careers. For ten years, the University of Texas at El Paso hosted a summer program called *Pathways to the Geosciences* (Carrick et al., 2016). This two-week camp introduced students to the geosciences, including environmental geology, satellite image analysis, structural geology, geophysics, and the career opportunities associated with these areas of focus. Students who attended this camp participated in field experiences and laboratory projects in and around El Paso. This summer experience increased students' awareness to the geosciences and careers that utilize this education. The researchers believe that this program can have an impact on the number of women and minority students that choose geosciences a college major and career path since 80% of participants were minority and more than 50% of participants were women.

Technology Specific Summer Programs. This section includes two summer programs involving technology, a robotics intervention camp, and a summer camp for students chosen to be leaders during the academic year for a STEM initiative within their campus. The robotics and geospatial technology summer program targets middle school students, for either a weeklong robotics intervention, or a three-hour robotics intervention (Nugent et al., 2010). Students who participate in the weeklong program build and program LEGO® Mindstorm NXT robots and use handheld global positioning system (GPS) devices and geographic information system (GIS) software. The three-hour intervention is an adapted form of the weeklong program. Students in the three-hour intervention rotate through seven or eight learning stations for approximately 20-25 minutes per station. In groups of five or six, students engage in short activities using robotics or geospatial technologies. Through their research, Nugent et al. (2010) concluded that upon completion of the weeklong summer intervention, students showed an increase in STEM learning and greater self-efficacy in STEM disciplines. Additionally, their research found that while the three-hour intervention had no impact on student learning, the intervention was successful in increasing student attitudes and interest toward robotics.

The *investigation for Quality Understanding and Engagement for Students and Teachers* (iQUEST) is a STEM initiative program that uses the integration of technology within the academic classroom to increase students' attitudes toward science and technology and encourage underrepresented students to pursue a career within a STEM field (Hayden et al., 2011). This program provides professional development for science teachers and a summer camp for students selected to be leaders within the academic classrooms. Targeting Hispanic middle school students entering the seventh and eighth grades, the iQUEST summer camp engages students in hands-on science explorations using the integration of technology within each learning experience. During this weeklong summer camp, students use digital probes to measure frequencies and wavelengths, participate in virtual dissections of cow or sheep eyes, and discuss with experts how they use technology daily within their science fields. Hayden et al. (2011)

determined that this summer program provides information to increase students' interest in science and technology. Furthermore, professional development for middle school science teachers who participate in the iQUEST program during the academic year focuses on the areas identified through the iQUEST summer program for students. This professional development provides an opportunity for teachers to integrate technology into their academic classrooms, with the aim of increasing all students' interest in science and technology, and in careers within the STEM fields.

Engineering Specific Summer Programs. Research of multiple summer programs specific to engineering shows an increase students' interest in engineering and an increase in awareness towards engineering careers (Elam et al., 2012; Hart & McAnulty, 2014; LoPresti et al., 2010; Ortiz et al., 2018; Weavers et al., 2011; Yilmaz et al., 2010). A report from the National Center for Science and Engineering Statistics (2017) shows the underrepresentation of women and minorities that include Blacks, Hispanics, American Indians, or Alaska Natives, in engineering education and employment. Summer programs that target underrepresented minorities and women can influence students' academic and career goals by providing early exposure to these underrepresented groups (Hart & McAnulty, 2014).

The *Math Options Summer Camp* is a weeklong engineering camp that focuses on the use of technology within engineering careers (Dave et al., 2010). The development of this camp began as an extension to a one-day event that introduced different career options. *Math Options Summer Camp* is for girls entering the ninth and tenth grades. On the first day of the summer camp, the participants designed helicopters using K'NEX® to help the escape from an imaginary plane crash. The rest of the camp focused on a project where participants re-engineered an existing product. During this week, participants re-engineered a pair of blue jeans into a blue jean bag. Workshops included a discussion of the engineering profession, multiple mechanical engineering labs, computer-aided-drafting (CAD), plastics engineering, and electrical engineering. The researchers found that students' attitudes toward STEM were already strong as they started the camp; therefore, there was no significant increase in attitudes toward STEM. However, participants left this weeklong engineering camp with a greater knowledge of specific disciplines within STEM, specifically different branches within engineering.

Mathematics Specific Summer Programs. There are mathematics specific summer programs that focus on remediation or interventions for students who struggle with mathematics during the academic year (Edwards et al., 2009; Tichenor & Plavchan, 2010; Turner & Tigert, 2010). While these types of summer programs typically keep the structure of a regular academic year school program, they also incorporate group learning and challenging mathematics situations that require problem-solving skills. Outcomes of these intervention programs are similar to the outcomes of other STEM summer camps. Students show increased positive attitudes towards mathematics upon completion of these summer programs. Additionally, assessment scores of students who participate in summer intervention programs show an increase.

Research shows that females tend to have less confidence when it comes to mathematics (Vermeer et al., 2000), and in general, students have a more negative attitude towards mathematics than compared to other academic subjects (Rice et al., 2013). Summer programs targeted for females that highlight mathematics, show an increase in females' attitudes toward mathematics as well as increased confidence in their mathematical abilities. These programs include a weeklong residential mathematics program for high school females, led by university mathematics faculty (Chacon & Soto-Johnson, 2003), and a five-day residential program for girls entering seventh and eighth grade (Frost & Wiest, 2007). Chacon and Soto-Johnson (2003) discuss the summer program for high school girls, Camp 1999 and Camp 2000, which received two years of grant funding and provided an exploratory mathematics sessions for students and included a variety of guest speakers. These guest speakers bridged the topic of why math is important and how they use mathematics within their careers as statisticians, engineers, computer software analysts, medical doctors, and architects. More results from this summer program include participants' willingness to persevere through challenging problems. The *Girls Math & Technology Camp* (Frost & Wiest, 2007) covered topics such as problem solving, spatial tasks, geometry, data analysis and probability, algebra, and computer classes that support mathematics objectives. Frost and Wiest interviewed participants both one month and six months after completion of the summer program and found that while most participants said their confidence increased in the first round of interviews, during the six month interview all participants said the summer camp improved their confidence toward mathematics. One camp participant said,

> I think that Math Camp built up my confidence because, at one point in time, I felt like I was the only person who didn't understand math in a way, and then I met all these other girls who were having trouble or not having trouble in the same areas that I was and it was just really nice to know that there were other people out there who were just like me. (Frost & Wiest, 2007, p. 36).

The research previously discussed illustrates the positive impacts informal learning and summer STEM programs can have on student interest, and the benefit of exposure to new STEM activities and career options. Some research supports the claim that not all programs are effective in influencing students' interest in STEM careers or STEM areas of study. A six-day summer science and algebra program that introduced middle school students to robotics, life in space, and rocketry found no significant differences from the quantitative survey data regarding students' interest in engineering careers or students' self-efficacy (Ortiz et al., 2018). However, qualitative data from the same study did provide evidence that camp participation influenced students' attitude toward engineering and other STEM careers. Other research shows that informal learning environments could be ineffective. Fredricks (2011) points out that participation in out-of-school activities throughout the academic year can distract students from their academic studies and requirements for their classes. Furthermore, with informal learning structured differently than classroom learning, students who engage in voluntary activities might not engage in classroom activities with required participation and attendance (Beymer et al., 2018; Fredricks, 2011).

While these are just some of the different models of summer STEM programs, similarities throughout the programs include providing opportunities not available to students throughout the school year, using hands-on and active learning approaches, while working closely with highly qualified STEM faculty and teachers. Differences between the programs include the age range of students, number of participants, area of study, and length of the program. This review of informal STEM learning environments, though not exhaustive, shows that an important aspect of each program for STEM is delivering content in a clear and meaningful way through interactive activities led by competent and qualified personnel. Though there are many successful informal learning programs that positively influence students interest in STEM (Weber, 2011; Beymer et al., 2018; Evans et al., 2014; Hayden et al., 2011; 2018; Mohr-Schroeder et al., 2014; Moreno et al., 2016; Roberts et al., 2018), attendance in the program is not enough for the program to be successful (Hirsch et al., 2010). To be successful, programs must engage students through active participation, and maintain quality throughout implementation by using properly trained and highly qualified facilitators, teachers, and program leaders (Hirsch et al., 2010). Additionally, informal learning experiences that show students how to connect STEM content to a real world context increases STEM career aspirations (Kitchen et al., 2016; PCAST, 2010; Roberts et al., 2018). Programs that are well researched and grounded in theory, show that students learn through hands-on interactions and collaboration with other students as well as program leaders. Participation in well-delivered, quality informal learning experiences increases students' understanding of STEM learning and positively increases students' interest in STEM disciplines.

Methods for Gauging Students' Attitudes toward STEM

STEM education is at the forefront of the 21st century, and with the number of STEM careers increasing (PCAST, 2010) students' attitudes toward STEM and their interest in STEM careers also needs to increase (Unfried et al., 2015). Most grade school children begin school interested in learning and with a positive attitude towards mathematics (Kilpatrick et al., 2001). Research shows that early mathematics achievement accompanies students' success in later academic learning (Duncan et al., 2007). Mathematics learning in early childhood programs supports the development of students' procedural and conceptual skills. Furthermore, Duncan et al. (2007) states that "early math is a more powerful predictor of later reading achievement than early reading is of later math achievement" (p. 1443).

The classroom environment created by the teacher plays an important role in a students' attitude toward STEM (Christensen et al., 2015), and teachers play a significant role in maintaining these positive attitudes toward STEM. To support and maintain students' positive attitudes toward math and science, teachers need to provide access to high-quality curriculum and be equitable in their teaching practice. The National Council of Teachers of Mathematics [NCTM] (2014) and the National Research Council [NRC] (2011) each provide guidelines for access and equity within mathematics and science learning respectively. NCTM (2000) defines equity not as identical instruction for every student, however, "that reasonable and appropriate accommodations be made as needed to promote access and attainment for all students" (p. 12). This includes being responsive and aware of students' backgrounds, previous content knowledge, cultural experiences, and ensuring the availability of high-quality lessons for all students. "The question is not whether all students can succeed in mathematics but whether the adults organizing mathematics learning opportunities can alter traditional beliefs and practices to promote success for all" (NCTM, 2014, p. 61). Teachers who provide effective, differentiated instruction can support mathematics learners despite their differences in mathematical ability and content knowledge, social background, and academic interest (NCTM, 2014). Additionally, NCTM (2014) asserts that participation in co-curricular and extracurricular mathematics opportunities "can help students achieve the highest levels of mathematical passion, creativity, and expertise, regardless of gender, ethnicity, or socioeconomic status" (p. 67). Support within mathematics education and literacy directly relates to science learning and affects students' success in science (NRC, 2011). Students are capable of achieving the science and engineering learning goals listed within the NRC (2011) framework, and "all individuals, with a small number of notable exceptions, can engage in and learn complex subject matter… when supportive conditions and feedback mechanisms are in place and the learner makes a sustained effort" (p. 280).

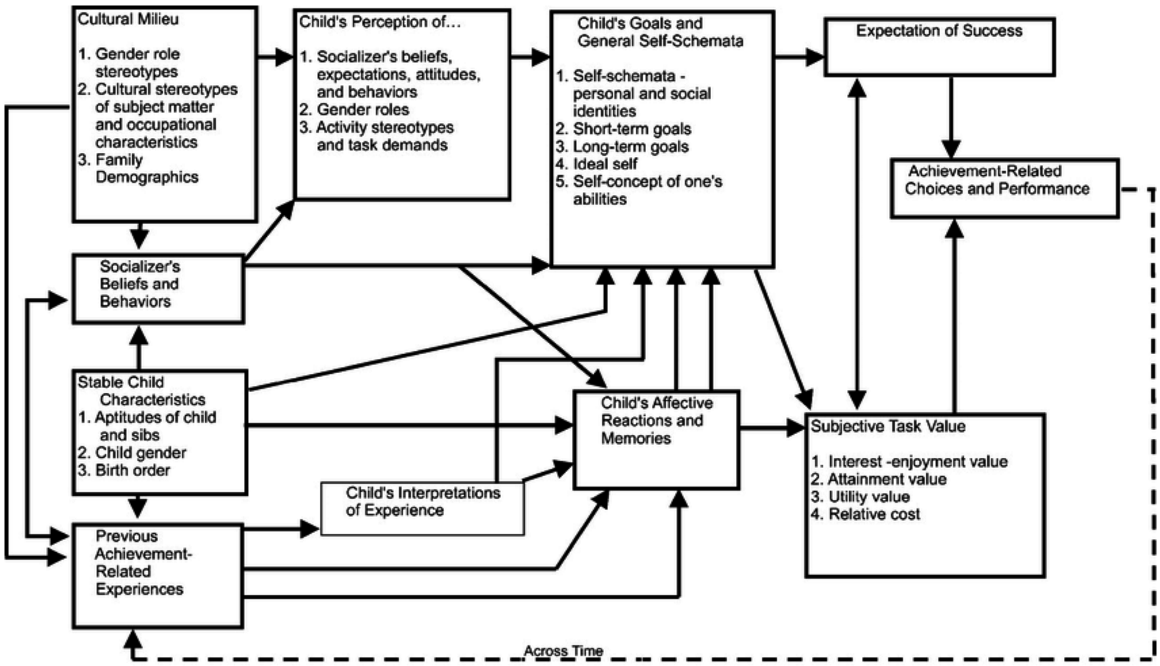
Since there is a relationship between students' attitude toward STEM and their achievement in STEM disciplines (Beaton et al., 1996; Singh et al., 2002), teachers that create lessons which are meaningful and relevant to students can help increase students' motivation to learn STEM (Singh et al., 2002). Therefore, it is important for teachers to connect how STEM learning is utilized throughout various aspects of life (PCAST, 2010). If students can make this connection and understand how STEM is useful, they are more likely to persist through STEM related disciplines (Brown et al., 2016). Scientists persist through challenges throughout their careers. Therefore, it is important for students to learn to appreciate academic challenges, and work through these encounters, making mistakes, learning from those mistakes, and persevering through the challenge (Dweck, 2008). Students must be able to see how to use STEM learning throughout their lives, and teachers must help make these connections for students while they are in the classroom.

Students' Self-Efficacy

Students' expectancy-value beliefs, which include performance, persistence, and choice, along with students' self-efficacy, are important factors in their achievement, motivation, and attitudes toward an academic subject (Eccles & Wigfield, 2002). Figure 1 shows the influence expectancy-values have on performance, persistence, and task choice.

Figure 1

The Eccles et al. Expectancy-Value Model of Achievement



Note. From “Motivational Beliefs, Values, and Goals” by, J. S. Eccles and A. Wigfield, 2002, *Annual Review of Psychology*, *53*(1), p. 119 (https://doi.org/10.1146/annurev.psych.53.100901.135153). Copyright 2002 by the Annual Review of Psychology.

Bandura (1997) defines self-efficacy as “beliefs in one’s capabilities to organize and execute the courses of action required to produce given attainments” (p. 3). For a person to attempt an action, they must first believe they can produce a result. Children learn problem-solving skills and cultivate knowledge while in school. Along with building students’ self-efficacy, educational settings teach students the skills necessary to plan, organize, and manage instruction, as well as find resources, regulate motivation, and evaluate their own knowledge and approaches to problems (Bandura, 1997, p. 175). As learning continues outside of the classroom through informal learning environments, students with higher self-efficacy engage in additional informal learning experiences on their own (Bandura, 1997). When students successfully complete a task or assignment using their learned problem-solving skills, they begin to believe they can be successful again when they encounter the next task. This increase in self-efficacy incentivizes students to continue taking part in other learning experiences. Presenting students with challenges through a growth mindset lens provides an opportunity for students to challenge themselves and persist through failure (Boaler, 2013; Dweck, 2008). Growth mindset is the method of teaching students they can develop intelligence and skills through educational practice, and leads them to discover that resilience through failure leads to successes in mathematics as well as other STEM discipline areas. Dweck shows in her research that students tend to have a more fixed mindset towards mathematical skills. A fixed mindset is the idea that individuals have a set amount of intelligence that does not increase, despite the amount of effort given towards improving their educational skills. Bolaer and Dweck’s growth mindset studies show that teaching from a growth mindset approach provides students the opportunity to learn from the mistakes they make, and ultimately value those mistakes, seeing them as learning achievements. When students work through challenges in their hands-on STEM learning experiences, they learn and work more effectively, challenging themselves and persevering through failure (Boaler, 2013).

Middle school students’ self-efficacy towards STEM and their perception of the usefulness of STEM determines their persistence in STEM disciplines (Brown et al., 2016). Ultimately, Brown et al. determined students’ interest in and self-efficacy toward

STEM are the strongest predictors to persistence in STEM. For students to feel successful and gain higher self-efficacy toward STEM disciplines, teachers must make connections between the usefulness of STEM and the STEM activities in which students participate. "Students who are less engaged in STEM group activities have lower self-efficacy beliefs, lower positive perceptions of STEM, less interest in STEM, and are less likely to persist in STEM related activities" (Brown et al., 2016, p. 31). Similarly, students on a fifth grade level with a positive attitude and high self-perceived ability in mathematics experienced a larger decrease in interest toward mathematics compared to students with a lower motivation toward mathematics in the beginning (Petersen & Hyde, 2017). Therefore, research suggests that it is important for students to develop mathematical self-efficacy before reaching high school. However, even if students possess high self-efficacy toward STEM and academic talent, they need support from educators through challenging and engaging activities that allow them to discover their full potential (Marshall et al., 2011).

In relation to self-efficacy, research found a direct variation with fifth grade students' course grades in mathematics when compared to their math self-efficacy and their interest in mathematics; however, there was not a direct variation relationship found between science grades and students' science self-efficacy and interest (Simpkins et al., 2006). Additionally, research showed that the feedback students receive on their performance in math and science influenced their beliefs about math and science. Furthermore, students are more likely to participate in after school STEM activities if they earn good grades in math and science.

In addition to self-efficacy, interest plays an important role in students' attitude toward STEM disciplines. Harackiewicz et al. (2016) states that “[i]nterest is essential to academic success” (p. 221). Using activities in the classroom that spark student attention such as situational contexts that relate specifically to known student interests and problem-based learning activities are ways to promote students’ interest in their work and maintain motivation to persist through the challenge until completion (Harackiewicz et al., 2016). Furthermore, students’ participation in collaborative, interactive STEM activities positively influences their attitudes and interest toward STEM fields (Hayden et al., 2011). In their article about a weeklong camp focusing on robotics with geospatial technologies through ands-on activities, Nugent et al. (2010) concluded that upon completion of the summer program, students showed an increase in STEM learning and greater self-efficacy in STEM disciplines. Introducing students to new ideas through short summer programs often provides limited time for students to fully learn and comprehend new content knowledge gained through the program. However, even short three-hour workshops are successful in increasing student attitudes toward robotics and more generally, STEM.

Ways to Increase Student Interest in STEM Careers

Students’ attitudes toward STEM play an important part in their decision to choose a STEM career path. Research shows that individuals tend to pursue careers based on their belief in their ability and their perception about a specific career (Lent et al., 2005). According to Wang (2013), students with high self-efficacy in math and science are more likely to major in a STEM field during their postsecondary studies. Creating an environment that makes mathematics enjoyable and teaches students the importance and significance of mathematics skills also leads to higher self-efficacy in mathematics.

Students’ self-efficacy toward mathematics and science is key to students’ STEM career choice over school and out-of-school factors, including student, parent, and teacher expectations (Sahin et al., 2017). Research shows that providing students the opportunity to participate in advanced educational STEM experiences, along with self-motivation, leads to successful outcomes in STEM later in life (PCAST, 2010; Wai et al., 2010). PCAST (2010) points out that participation in STEM programs inspired many professionals to choose a STEM career path. Furthermore, there is a positive correlation between adults with STEM accomplishments and the number of STEM experiences in their adolescence (Wai et al., 2010).

Through their study of STEM learning during a summer informal learning experience, Roberts et al. (2018) concluded that access to and participation in interactive, inquiry-based STEM activities can positively affect upper-elementary and middle grades students’ interest in STEM careers. These experiences can offer challenging content where students can participate in STEM learning and make connections concerning how these experiences apply to the real world and their own lives. Interactive STEM experiments “made the content come to life” (p. 9), providing a platform for students to connect their learning to future educational avenues and career options (Roberts et al., 2018). Experiences that include experiments which show students the connection to STEM careers not only affects students’ interest in STEM careers, but also helps maintain interest that already exists. Bachman et al. (2008) found through their research on a summer program that the students who participated in their summer science camps were already highly motivated towards STEM learning upon entering the camp, but the camp was successful in retaining students’ interest in a STEM career path. Research shows students' interest in a variety of STEM careers increase after participation in a STEM summer program even if they are already interest in STEM disciplines. A female student who participated in a summer engineering program told researchers "[the camp] helped me learn more about careers that are mostly considered men's work, I am now considering other careers that I would not have originally thought of" (Dave et al., 2010, p. 43). Through annual surveys sent to participants of the *Pathways to the Geosciences* summer program, researchers found that 55% of students selected a STEM major once in college, with 20% choosing geosciences specifically (Carrick et al., 2016).

Preparation in math and science play an important role in students' interest toward majoring in a STEM field in college (Wang 2013). Wang found that rather than students' achievement in STEM fields, the effect of students' exposure to STEM is a stronger predictor to a students' choice of pursuing a STEM degree in college. Sadler et al. (2012) determined that the career interests students' have when entering high school does not waiver much before high school graduation. They also found that students with high mathematics grades in middle school tend to be more inclined to pursue STEM beyond high school. However, preparation in math and science can happen even before grade school begins. In a joint position statement, NCTM along with the National Association for the Education of Young Children [NAEYC] show how accessible mathematics education for children ages three to six provides a crucial foundation for future mathematics learning (NAEYC and NCTM, 2002). Early childhood mathematics learning led by well-prepared teachers that strengthens problem-solving and reasoning skills and integrates mathematics with other activities can increase preschool students' natural interest in mathematics. Thus, early exposure to math and science could be an effective boost to students' interest in STEM fields (Wang, 2013).

Students who participate in an informal learning environment that provides hands-on participation and connects career options along with STEM learning are more interested in STEM courses and careers because of their participation (Weber, 2011). Furthermore, the presenters that work with and alongside students can become positive STEM role models for students. Working alongside STEM professionals also promotes a learning environment for students to deepen STEM content through practice and participation (Roberts et al., 2018). Participating in out-of-school STEM activities demonstrates the possibilities available in STEM and provides students the opportunity to envision themselves in future STEM career roles (PCAST, 2010).

The Impact of Inquiry Learning

The theoretical framework employs an inquiry model for learning STEM concepts. While many different techniques to teach math and science exist, a hands-on, activity based teaching style appears to be the most common form of instruction through the STEM programs previously mentioned. Teaching through an IBL structure allows students to the opportunity to explore new topics and ideas, using many of the same techniques scientists do in their careers (NRC, 2000).

John Dewey first considered integrating inquiry learning in 1910 because he felt classroom learning centered on students learning facts about science rather than learning how to think about science as a scientist, through problem solving and using the scientific method (Barrow, 2006). As innovation increases throughout our current society, employers want to hire people who are able to contribute new ideas and implement those designs (Acar & Tuncdogan, 2018). Therefore, it is important that students learn, through inquiry, not only how to identify questions, collect data, and investigate solutions (Knox et al., 2003), but also justify, explain, and communicate their ideas and solutions (NRC, 1996).

Scientific inquiry, or IBL, as defined by the NRC (1996) in the *National Science Education Standards*,

> …refers to the diverse ways in which scientists study the natural world and propose explanations based on the evidence derived from their work. Inquiry also refers to the activities of students in which they develop knowledge and understanding of scientific ideas, as well as an understanding of how scientists study the natural world. (p. 23)

In 1996, the NRC released the science content standards for K-12 classrooms. Table 1 shows how these National Science Education Standards promote a change in emphases to promote inquiry in the classroom.

Table 1

Changing Emphasis to Promote Inquiry

Less Emphasis On	More Emphasis On
Activities that demonstrate and verify science content	Activities that investigate and analyze science questions
Investigations confined to one class period	Investigations over extended periods of time
Process skills out of context	Process skills in context
Emphasis on individual process skills such as observation or inference	Using multiple process skills – manipulation, cognitive, procedural
Getting an answer	Using evidence and strategies for developing or revising an explanation
Science as exploration and experiment	Science as argument and explanation
Providing answers to questions about science content	Communicating science explanations
Individuals and groups of students analyzing and synthesizing data without defending a conclusion	Groups of students often analyzing and synthesizing data after defending conclusions
Doing few investigations in order to leave time to cover large amounts of content	Doing more investigations in order to develop understanding, ability, values of inquiry and knowledge of science content
Concluding inquiries with the result of the experiment	Applying the results of experiments to scientific arguments and explanations
Management of materials and equipment	Management of ideas and information
Private communication of student ideas and conclusions to teacher	Public communication of student ideas and work to classmates

Note. From "*National Science Education Standards: Observe, Interact, Change, Learn*" by NRC, 1996, p. 113.

Inquiry learning strategies extend out of the science classroom and into other areas of STEM learning as well. In a study that analyzed field data from four different countries, researchers found that using IBL techniques within math and science classrooms enhances student learning (Bando et al., 2019). This research showed that test scores in both math and science courses increased after only one year of implementing

IBL. When teaching mathematics, the desire for IBL is for students to attain a complete understanding of mathematics and math concepts that go far beyond computational and procedural mathematics learning (Jaworski, 2015). In her article on teaching mathematical thinking through inquiry, Jaworski (2015) lists how IBL tasks challenge and encourage students. Listed in Table 2 are the IBL tasks and ways inquiry teaching engages students within mathematics teaching.

Table 2

Inquiry-Based Learning in Mathematics

Inquiry Based Tasks:	IBL tasks encourage students' in/with:
• Inspire involvement	• Multiple directions of inquiry
• Provide access to mathematical ideas	• Multiple levels of engagement
• Enable everyone to make a start	• Mutual engagement and support
• Provide opportunities to ask questions, solve problems, imagine, explore, seek generality, test conjectures, express and formulate	• Differing degrees of challenge
• Encourage discussion and reasoning, diverse defections and levels of thinking, fluidity and flexibility	• Harmony in balancing sensitivity and challenge
• Encourage student centrality/ownership in/of the mathematics	• Acceptance of and respect for difference

Note. Adapted from "*Teaching for Mathematical Thinking: Inquiry in Mathematics Learning and Teaching"* by, B. Jaworski, 2015, *Mathematics Teaching, 248,* p. 31-32.

PCAST (2010) asserts, "children are naturally curious and creative" (p. 95). Therefore, STEM education should focus on discovery; allowing student to think carefully and problem solve some of the issues we see in our current society and environment (PCAST, 2010). Research shows that classes taught with IBL, particularly mathematics courses, increases students' self-efficacy and motivation (Fielding-Wells et al., 2017; Goos, 2004). Students show more interest in STEM, particularly those who struggle in traditionally taught STEM courses, when content is interactive and taught using a hands-on approach (Roberts et al., 2018).

Summary

Informal learning environments, whether they are after school programs, weekend workshops, day camps, or weeks' long summer programs, provide students an in-depth investigation into STEM content often not available for replication within a K-12 classroom (Nugent et al., 2010). Participation in STEM summer programs using IBL, not only increases students' interest in STEM and their self-efficacy toward STEM (Brown et al., 2016), but also increases students' aspirations toward a career in a STEM field (Kitchen et al., 2016; Markowitz, 2004). A student's educational journey should continually cultivate their interest in STEM to help increase self-efficacy towards STEM (Simpkins et al., 2006). Providing students the opportunity to learn through hands-on activities and ruminate over STEM topics alongside STEM teachers increases student understanding, student self-efficacy, and students' interest in STEM (Mohr-Schroder et al., 2014). Research shows that participation in informal STEM learning environments cultivates students' interest in STEM disciplines and STEM careers. In conjunction with classroom learning, informal learning helps students connect how a variety of different careers use mathematics, science, and technology. Through IBL techniques, students participate in hands-on experiments and events, which help to increase students' perceived abilities in STEM and their interest in different STEM disciplines.

Chapter III

Methodology

The purpose of this study was to (a) determine to what extent participating in iMAS Academy influences sixth, seventh, and eighth grade students' attitude toward STEM disciplines, and (b) to determine to what extent participating in iMAS Academy influences sixth, seventh, and eighth grade students' interest in STEM careers. This study used both quantitative and qualitative data and program evaluation processes, including the process of meeting the needs as defined by Posavac (2011) to evaluate the influence of iMAS Academy on middle grade students' interest in STEM disciplines and STEM careers. This research investigates a STEM summer program held at a university in East Texas and seeks to determine if the program outcomes align with the mission statement of the STEM Research and Learning Center, which plans and facilitates the program each year. This research determines if there is evidence to support the plans for the iMAS Academy program (Posavac, 2011).

This program evaluation design provided the researcher flexibility to use quantitative data from a Likert scale survey to be supported by qualitative data from questions at the end of the survey. To determine students' attitudes toward STEM disciplines and students' interest in STEM careers, the STEM Research and Learning Center attained permission to use a validated survey tool titled *Student Attitudes Toward STEM (S-STEM) Survey* for middle and high school students grades 6 – 12 (Friday Institute for Educational Innovation, 2012). This survey tool provided quantitative data for this research while additional questions created by the STEM Research and Learning Center staff acquired qualitative data.

Settings

The STEM Research and Learning Center at a university in East Texas developed a summer program called Investigations in Mathematics and Science (iMAS) Academy. In its seventh year, iMAS Academy hosts up to 100 students per summer, and is a weeklong summer program for incoming sixth through eighth graders, led by university faculty, staff, and local high school teachers with many years of teaching experience in either mathematics or science, called master teachers. Over the past seven years of iMAS Academy there have been 77, 83, 65, 77, 67, 102, and 59 students attend each year respectively. This summer program is open to all incoming sixth, seventh, and eighth graders. In order to recruit students, local area schools received informational flyers to hand out to students and parents and schools in Texas' Region 7 district received digital flyers via email. Parents of students who have previously participated in a STEM outreach event with the STEM Research and Learning Center also received the digital flyer via email. The STEM Research and Learning Center provided information about iMAS Academy on their website, including a registration link, opening spaces for anyone interested in attending iMAS Academy.

While parents can pay individually for their child to attend iMAS Academy, school districts may also sponsor groups of students. Additionally, the STEM Research and Learning Center, partners with outside sources and will sponsor a limited number of students. In 2019, the STEM Research and Learning Center along with Suddenlink Altice One provided scholarships to ten students. To select the scholarship recipients, parents completed an online scholarship application and had their child's current math or science teacher complete a teacher recommendation created by the STEM Research and Learning

Center. Members of the STEM Research and Learning Center reviewed each scholarship application and selected scholarship recipients based on need. In addition to the scholarships distributed by the STEM Research and Learning Center, 20 students from a local public school received scholarships as part of a grant awarded to the school district. This school district targeted 20 high-needs, underrepresented students to attend iMAS Academy 2019.

The iMAS Academy is a weeklong summer program hosted for one week in June. Each iMAS Academy includes up to five different modules each in a different STEM related field. This weeklong summer program begins at 8:00 am each day, and ends at 12:00 pm Monday through Thursday, with students staying Friday until 2:00 pm for a pizza and pool party to conclude the week. The STEM Research and Learning Center has hosted iMAS Academy every summer since 2012 with the exception of summer 2015. The iMAS Academy provides a variety of STEM experiences for students, rotating modules each year such that students do not participate in the same module twice if they attend all three summers in which they are eligible. University faculty members from the College of Sciences and Mathematics as well as math and science teachers from local public school districts design each iMAS module as a three and one-half hour, hands-on, interactive session. The selection of presenters varies between disciplines each year to provide students the opportunity to engage in a variety of STEM fields.

During iMAS Academy 2019, students rotated through four different modules, Monday through Thursday. On Friday, all students and the professors who presented earlier in the week, participated in an activity together and attend a Planetarium show titled *From Dream to Discovery: Inside NASA*. The STEM Research and Learning Center divided students into groups based on their grade level. This provided an opportunity for professors to differentiate their modules from day to day, meeting the needs of students as they participated in each session. Four groups were created; one group with ten sixth grade students, one group with 13 seventh grade students, and two eighth grade groups, each with 18 students. Each module was led by two university faculty and/or staff members creating at most a 1:9 ratio between student and facilitator.

Faculty presenters were selected by university department chairs and by the STEM Research and Learning Center. Once asked to participate, the university faculty members volunteered their time to create and write modules, participate in curriculum meetings with the STEM Research and Learning Center, facilitate module run-throughs prior to the event, lead their module during the week of iMAS Academy, and partake in debrief meetings upon completion of the summer academy. University faculty do not always have experience working with non-college age students. Therefore, the STEM Research and Learning Center supports the implementation of age specific learning by providing faculty participants techniques for working with middle-school-aged students. To create meaningful, inquiry-based modules that connect mathematics and science within each topic, STEM Research and Learning Center staff works with university faculty to connect the Mathematics Teaching Practices from *Principles to Actions* (NCTM, 2014, p. 10) and the Science Teaching Standards from *The National Science Education Standards* (NRC, 1996, p. 4).

The Mathematics Teaching Practices addressed with iMAS Academy 2019 faculty included: 1) implementing tasks within your module that promote reasoning and problem solving, and 2) posing purposeful questions (NCTM, 2014, p. 10). The Science

Teaching Standards addressed include: 1) guiding and facilitating student learning, and 2) creating a community of science learners (NRC, 1996, p.4). Though iMAS Academy students participate in each module for only one morning, it is important to the STEM Research and Learning Center that faculty members take measures to ensure that each module promotes rigor and uses effective teaching strategies. Providing a foundation of math and science teaching practices and standards allowed faculty members to focus students' learning for the time they spend in the module. "At all stages of inquiry, teachers guide, focus, challenge, and encourage student learning" (NRC, 1996, p. 33).

Table 3 shows a brief overview of the modules designed by the 2019 iMAS Academy faculty. A more detailed description of the modules and their objectives are in the Appendix A of this paper.

Table 3

STEM Modules from iMAS Academy 2019

Module Title	STEM Discipline	Module Overview
Crash Cars!	Engineering and Physics	Participants will learn about the physics of colliding bodies and used what they learned to engineer an apparatus that fitted to a "smart" cart in order to reduce the severity of a high-velocity collision. This module uses the Pasco Smart Cart, which records acceleration, velocity, and position data via a Bluetooth connection to a computer. Students will test the cart with various weights at different positions along a fixed track to understand the relationship between potential and kinetic energy.
Geohazards: Geological Stability of Your Home	Geology	This module assesses the impact of variable soil conditions on the stability of building construction designs for geohazard avoidance. "Geologic Stability of Your Home" introduces the concepts of geoscience engineering and soil characterization to assess ground stability, including: 1) total stress, 2) effective stress, 3) strain (compression), and 4) soil classification.
Forensic Investigation	Computer Science	Students will explore mathematical and scientific concepts performing a digital forensics investigation. The mathematical concepts include how to count numbers in a different base system, specifically binary. The encryption in this module uses an exclusive-or bit-wise operation.
The Chemistry Between Me and My Cell Phone	Chemistry	This module provides an initial foundation of the basic principles of electrochemical processes. Students enter the world of electrochemistry through investigations in electrolysis, conductivity, oxidation-reduction, and biochemical electron transport. Students will work in pairs to complete lab activities that use each area of STEM to allow them to make connections to the energy source of batteries and their bodies.
To the Moon!	Engineering and Physics	A basic component of space travel is the use of rocket propulsion. Spacecraft must defy gravity and air resistance to break through our atmosphere to reach space. In this module, students will work with their engineering group to design, build, and implement a rocket launch. Students will launch these prototypes (models) through the sky using basic pressure systems (PVC piping and a two liter bottle).

In addition to effective teaching practices for middle school students, the STEM Research and Learning Center works with faculty presenters to align their modules to the Texas Essential Knowledge and Skills [TEKS] curriculum for Texas public schools required by the State Board of Education, created and updated by the Texas Education Agency [TEA] (TEA, 2019). Table 4 shows the math and science TEKS that align with each iMAS Academy 2019 Module. The Computer Science module, Forensic Investigation, did not align with math or science TEKS. Thus, the technology application TEKS that aligned with this module are shown in Table 4.

Table 4

TEKS Addressed within iMAS Academy 2019 Modules

Module Title	TEKS Standard
Crash Cars!	Sixth Grade Science TEKS: B.8.A, B, C, and E. Seventh Grade Science TEKS: B.6.A, B, and C. Eighth Grade Science TEKS: N/A Sixth Grade Math TEKS: B.1.B, C, and B.3.C. Seventh Grade Math TEKS: B.1.B, C, and B.3.B. Eighth Grade Math TEKS: B.1.B and C.
Geohazards: Geological Stability of Your Home	Sixth Grade Science TEKS: B.2.C, D, and E. Seventh Grade Science TEKS: B.2.C, D, E, B.8.A, B, and C. Eighth Grade Science TEKS: B.9.A, B, and C. Sixth Grade Math TEKS: B.3.C, D, E, and B.12.A. Seventh Grade Math TEKS: B.3.A, B.9.A, D, and B.12.A. Eighth Grade Math TEKS: B.7.A, B.11.A.
Forensic Investigation	Sixth Grade Technology Applications TEKS: C.4.A, C, and E. Seventh Grade Technology Applications TEKS: C.4.A, C, and E. Eighth Grade Technology Applications TEKS: C.4.A, C, and E.
The Chemistry Between Me and My Cell Phone	Sixth Grade Science TEKS: B.5.A, C, and B.6.A Seventh Grade Science TEKS: B.6 Eighth Grade Science TEKS: B.5.E Sixth Grade Math TEKS: B.6.C, B.12.A Seventh Grade Math TEKS: B.6.G Eighth Grade Math TEKS: N/A
To the Moon!	Sixth Grade Science TEKS: B.8.A, B, and C Seventh Grade Science TEKS: B.6 Eighth Grade Science TEKS: B.6.A, B, and C Sixth Grade Math TEKS: N/A Seventh Grade Math TEKS: N/A Eighth Grade Math TEKS: B.6.B

Note. TEA (2019) adopted the above mentioned Science TEKS in 2017, Mathematics TEKS in 2012, and Technology Applications TEKS in 2011.

Participants

The participants of this study are the 59 middle grade students who attended the 2019 iMAS Academy. Of the 59 students, ten students were sixth graders, 13 students were seventh graders, and 36 students were eighth graders. The STEM Research and

Learning Center hosted iMAS Academy 2019 with daily modules lead by six College of Sciences and Mathematics university faculty members and lecturers, two STEM Research and Learning Center staff members, and one high school master science teacher. Other participants involved with iMAS Academy 2019 included two university STEM major volunteers, ten high school volunteers, and two STEM Research and Learning Center university student workers.

Instruments

The pre- and post-surveys used for this research can be found in Appendix B of this paper. In April 2019, the STEM Research and Learning Center acquired permission from the Friday Institute for Educational Innovation (2012) to utilize their *Student Attitudes Toward STEM (S-STEM) Survey* for middle and high school students grades 6 – 12. This survey contains eight mathematics questions, nine science questions, nine engineering and technology questions, eleven 21st century learning questions, and twelve questions asking students about their future careers. As mentioned by the survey creators, the framework for this survey was developed form Erkut and Marx (2005) and the Bureau of Labor Statistics, *Occupational Outlook Handbook* (2010-2011) (Friday Institute for Educational Innovation, 2012). The Middle/High S-STEM survey measures student attitudes toward STEM and their interest in STEM careers (Unfried et al., 2015).

An exploratory factor analysis and confirmatory factor analysis were conducted to provide evidence of the survey's content validity. The Friday Institute (2012) notes that the survey is "intended to measure changes in students' confidence and efficacy in STEM subjects, 21st century learning skills, and interest in STEM careers" (p. 1). The results of the Friday Institute's study confirm that each area, confidence and efficacy in the academic areas of STEM, 21st century learning skills, and interest in STEM careers is addressed separately in the survey and therefore not all sections need to be utilized based upon research needs. Thus, the STEM Research and Learning Center did not use the 21st century learning skills portion of the survey.

Sections of the *Student Attitudes Toward STEM (S-STEM) Survey* that were used include *Mathematics*, *Science*, *Engineering and Technology*, and *Your Future*. The STEM Research and Learning Center added questions to a final section of the survey called *More About You*. The engineering and technology questions were combined into one section with an introductory description about what engineers do, different types of engineering, and about skills used by technologists. The *Mathematics*, *Science,* and *Engineering and Technology* sections of the survey each use a five-point Likert scale. The section titled *Your Future* had an introduction explaining each of the science, technology, engineering, or mathematics jobs listed in the survey and asked students to answer each question based on how interested they are in each position. Included in the survey was the assurance that there are no right or wrong answers, and the request to answer truthfully, based on their experiences and feelings. Figure 2 shows an example question from the Engineering and Technology section and from the Your Future section of the survey.

Figure 2

Example Survey Questions

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
9. I am sure of myself when I do science.	○	○	○	○	○

	Not at all Interested	Not So Interested	Interested	Very Interested
1. Physics: is the study of basic laws governing the motion, energy, structure, and interactions of matter. This can include studying the nature of the universe. (aviation engineer, alternative energy technician, lab technician, physicist, astronomer)	○	○	○	○

Questions in the *More About You* section of the survey varied between the pre- and post-survey. Both pre- and post-surveys had an asked students to type in a response to the question “What do you want to be when they grow up?”, and asked students if they plan to attend college offering the responses of yes, no, or maybe. The pre-survey asked students if they know any adults who work as scientists, engineers, technologists, or mathematicians, offering the responses of yes, no, or not sure. The post-survey had five additional items that were a four-point Likert scale, not including an option for neutral, asking students to answer questions based on their participation in iMAS Academy. These questions are listed in Figure 3.

Figure 3

Post-Survey Likert Scale Questions

As a result of participating in iMAS Academy 2019...

	Strongly Disagree	Disagree	Agree	Strongly Agree
I am more interested in careers that use science, engineering, technology, or mathematics.	○	○	○	○
I am more interested in science.	○	○	○	○
I am more interested in technology.	○	○	○	○
I am more interested in engineering.	○	○	○	○
I am more interested in mathematics.	○	○	○	○

Procedures

The STEM Research and Learning Center requires waivers for all events that allows survey, picture, and video permission per the SFA legal counsel. Each iMAS Academy participant had a waiver on file signed by their parent or guardian giving the STEM Research and Learning Center permission to survey, photograph, and video students during the event. During iMAS Academy 2019, each student received a randomly assigned identification number to associate their pre- and post-surveys together upon completion of the event. One STEM Research and Learning staff member assigned the identification number, and they were the only person with access to this number. The staff member maintained a spreadsheet with the identification numbers on their computer and did not give any other staff member access to this identification number.

On Monday morning, as students first arrived and checked in for iMAS Academy, a staff member of the STEM Research and Learning Center administered the pre-survey via Qualtrics using a QR code. Students with their own cell phones opened the survey with their QR code. Students who did not have their own cell phone used an iPad provided by the STEM Research and Learning Center. Each participant had as long as necessary to complete the pre-survey. The STEM Research and Learning Center saved the pre-survey data online through their Qualtrics account. No staff members accessed the pre-survey data during the week of iMAS Academy. On Friday, the same staff member administered the post-survey in the same manner as Monday morning, via a Qualtrics using a QR code.

The researcher did not have access to the student identification numbers and survey responses were anonymous. After completion of the iMAS Academy, the STEM Research and Learning Center released the anonymous survey data to the researcher for data analysis.

Data Analysis

Three data analyses methods were used to interpret the data to answer the research questions. Two methods pertained to the quantitative data obtained from the *Student Attitudes Toward STEM (S-STEM) Survey*. The first analysis used aggregated data, and then a second analysis of the individual student data. A third analysis method looked at data collected from the constructed-response items of the survey. The processes and procedures are described in the next sections.

Quantitative Data Analysis Procedures

Forty-eight of the 56 students that attended iMAS Academy 2019 completed both the pre- and post-surveys given on the first and last day, respectively, during the week of the summer program. Due to the population size, the researcher analyzed all quantitative data collected using StatXact statistical software from Cytel Incorporated. StatXact software uses algorithms to create exact inferences from the categorical data collected without the need for distributional assumptions or p-value approximations. Therefore, StatXact does not require a large sample size to determine potential statistical significance. Aggregated survey data and individual student responses used for analysis from the iMAS Academy 2019 can be found in Appendix C and Appendix D respectively of this paper.

To complete the data analysis, the researcher first sorted the collected pre- and post-survey data categorically by question for comparison. The aggregated overall trends from the 48 students that completed the pre- and post-surveys were analyzed via chi-square analysis. Chi-square statistics were used in this study as the Likert-scale survey data collected from students required that students place themselves in a category of *strongly agree*, *agree, neither agree nor disagree*, *disagree*, *or strongly disagree* for each survey question. According to Sullivan and Artino (2013), though this ordinal scale survey does rate or rank student responses, there is no way to measure the distance between each response. The distance between each survey response option is not assumed to be equidistant as numerical values are not assigned to each response during the survey. Numerical values are only assigned after student categorize their responses in order to perform statistical analysis. In addition to the calculated chi-square statistic, *p*-values were calculated for each question to determine the significance of the test results.

A 2x5 table was created for each question using the pre- and post-survey responses on a five-point Likert scale from the three survey sections, *Math*, *Science*, and *Engineering and Technology*. In these three survey sections, students responded to questions regarding their attitude toward mathematics, science, engineering, and technology by answering either strongly agree, agree, neutral, disagree, or strongly disagree. With four degrees of freedom, a chi-squared test for row homogeneity, along with the calculated *p*-values, determined the statistical difference, if any, in the proportions of student responses on the pre-survey versus the post-survey. Similarly, a 2x4 table was created for each question using the pre- and post-survey responses on a four-point Likert scale from the section, *Your Future*. In this survey section, students responded to questions regarding their interest in STEM careers by selecting very interested, interested, not so interested, or not at all interested. With three degrees of freedom, a chi-squared test for row homogeneity, along with the calculated *p*-values, determined the statistical difference, if any, in the proportions of students' responses on the pre-survey versus the post-survey.

Second, the researcher separated the data based on the students' randomly assigned identification number to track changes in individual student responses. To analyze data between the pre- and post-survey, the researcher created contingency tables to compare the data on every question for each student. To track individual changes and detect directional alterations within the data, the researcher used McNemar's Test to analyze the data for individual student responses. Using data from the pre-survey to the post-survey, McNemar's Test looked for changes in student responses, such as moving from disagree on the pre-survey to agree on the post-survey, or any variations of response combinations from the Likert scale questions. Answer choices from the three survey sections *Math*, *Science*, and *Engineering and Technology* included strongly agree, agree, neutral, disagree, or strongly disagree, while answer choices from the *Your Future* section of the survey included very interested, interested, not so interested, or not at all interested. Using the respective responses would create a 5x5 contingency table with 25 possible combinations or a 4x4 contingency table with 16 possible combinations. To decrease the sparsity in the tables, data cells were combined. Therefore, all answer choices of strongly agree and agree were combined into one choice, agree, all answer choices of strongly disagree and disagree were combined into one choice, disagree, all answer choices of very interested and interested were combined into one choice, interested, and all answer choices of not so interested and not at all interested were combined into one choice, not interested. This created 3x3 and 2x2 contingency tables, respectively, for each survey question. Individual responses were aggregated and analyzed using McNemar's Test, and a two-sided p-value was calculated for each question. Table 4 shows an example of one students' data collected from question ten on the pre- and post-survey, "I would consider a career in science". Student 30 answered Neither Agree nor Disagree on the pre-survey and answered Agree on the post-survey.

Figure 4

Contingency Table for McNemar's Test

Student 30 – Question 10. I would consider a career in science.

		Post-Survey		
		Agree	Neither Agree nor Disagree	Disagree
Pre-Survey	Agree			
	Neither Agree nor Disagree	X		
	Disagree			

The individual student responses that were categorized for McNemar's Test can be found in Appendix D of this paper.

Qualitative Data Analysis Procedures

Lastly, the researcher used students' responses to the constructed-response questions as data to further understand the results from the quantitative data analysis. The supplemented qualitative data findings are supported through questions on the survey from the *More About You* section.

The additional qualitative data first determined whether students know any adults who work as scientists, engineers, technologists, or mathematicians. Looking for changes in students' responses, questions asked on both the pre- and post-surveys examined students' interest in a future STEM career, and their intent to attend college. Finally, students' interest in STEM and STEM careers were further assessed by responses to five Likert scale questions on the post-survey asking students to answer questions based on their participation in iMAS Academy 2019 from Figure 3.

Summary

This chapter explained the methodology for this study. This research is a program evaluation of a middle school summer program and this chapter explains the selection for student participants and presenters for iMAS Academy. Included is the setting for iMAS Academy, the procedures for data collection and analysis, and the validated survey instrument for quantitative data through this research. Chapter Four presents the results of this research, and Chapter Five discusses the results and how they relate back to the research presented in Chapter Two.

Chapter IV

Results

Presented are the results from the *Student Attitudes Toward STEM (S-STEM) Survey* given as both the pre- and post-survey for iMAS Academy 2019. Quantitative data analysis results first determined the difference in the proportions of students' answers from the pre-survey versus the post-survey from the aggregated survey responses. Next, quantitative data analysis results from individual student responses examined individual changes from the pre-survey responses to the post-survey responses. Qualitative findings from the *More About You* section of the survey reviewed student responses from both the pre- and post-surveys. Analysis of these data provided results for the research questions:

(1) To what extent does participating in iMAS Academy influence sixth, seventh, and eighth grade students' attitude toward STEM disciplines?

(2) To what extent does participating in iMAS Academy influence sixth, seventh, and eighth grade students' interest in STEM careers?

Quantitative data was obtained through two different analyses. Forty-eight students from iMAS Academy 2019 completed the *Math, Science, Engineering and Technology*, and *Your Future* sections on both the pre- and post-surveys given on Monday and Friday respectively during the summer program. These responses were used for qualitative data analysis. First, analysis was conducted through chi-squared testing for row homogeneity on aggregated student data to determine the statistical significance in the proportion of students who answered questions regarding their interest in STEM fields and STEM careers. Next, McNemar's Test for change was conducted on contingency tables created from individual student responses on the surveys to determine the statistical significance in students' alteration of responses from the pre-survey to the post-survey regarding their interest in STEM fields and STEM careers. Qualitative findings are presented from four questions on the *More About You* section of the pre- and post-surveys. One question from the pre-survey, two questions that appeared on both the pre- and the post-surveys, and one question from the post-survey that were used for comparison in this program evaluation. Forty-six students answered the question appearing only on the post-survey while 48 students answered the other three questions. These data results are presented in this chapter as they relate to each research question.

Students' Attitude toward STEM Disciplines

Testing for homogeneity, the chi-square test sought to determine whether frequency counts from the pre-survey and the post-survey were identically distributed across the two surveys. Chi-square statistics and *p*-values for each question on the *Math*, *Science*, and *Engineering and Technology* portions of the surveys that asked questions pertaining to students' attitudes toward STEM are presented in Table 5.

Table 5

Chi-Square Test Results for Students' Attitudes Toward STEM ($n = 48$)

Question	χ^2	p
Math		
1. Math has been my worst subject.	4.41	0.38
3. Math is hard for me.	2.28	0.69
4. I am the type of student to do well in math.	4.72	0.33
5. I can handle most subjects well, but I cannot do a good job with math.	2.80	0.60
6. I am sure I could do advanced work in math.	2.68	0.63
7. I can get good grades in math.	2.84	0.64
8. I am good at math.	1.43	0.98
Science		
9. I am sure of myself when I do science.	1.79	0.88
14. I know I can do well in science.	1.36	0.92
16. I can handle most subjects well, but I cannot do a good job with science.	2.65	0.64
17. I am sure I could do advanced work in science.	1.49	0.85
Engineering and Technology		
18. I like to imagine creating new products.	4.35	0.37
20. I am good at building and fixing things.	4.04	0.42
21. I am interested in what makes machines work.	1.17	0.89
23. I am curious about how electronics work.	3.48	0.50
25. Knowing how to use math and science together will allow me to invent useful things.	2.80	0.64

For each question tested, there was no statistically significant change ($0.01 < p < 0.05$) or strongly significant change ($p < 0.01$) in student responses from the pre-survey to the post-survey. These results indicate that there was not a significant change in the proportions of students' aggregated responses about their attitudes toward math, science, or engineering and technology between the pre-survey taken on the first day of iMAS Academy and the post-survey taken on the last day of iMAS Academy. Therefore, there was not a statistically meaningful change between the proportions of how students responded to the pre- and post-surveys regarding their attitude toward STEM.

McNemar’s Test for change was used to analyze the alteration in individual student responses from the pre-survey to the post-survey. Contingency tables created from student data were tested and analyzed to determine if there was a statistically significant $(0.01 < p < 0.05)$ or strongly significant $(p < 0.01)$ change in each individual student’s attitude toward STEM based on participation in iMAS Academy 2019. Table 6 shows *p*-values for each question related to students’ attitudes toward STEM on the *Math*, *Science*, and *Engineering and Technology* portions of the surveys.

Table 6

McNemar's Test Results for Students' Attitudes Toward STEM ($n = 48$)

Question	p
Math	
1. Math has been my worst subject.	0.23
3. Math is hard for me.	0.40
4. I am the type of student to do well in math.	0.64
5. I can handle most subjects well, but I cannot do a good job with math.	0.25
6. I am sure I could do advanced work in math.	0.58
7. I can get good grades in math.	0.63
8. I am good at math.	0.47
Science	
9. I am sure of myself when I do science.	0.59
14. I know I can do well in science.	0.31
16. I can handle most subjects well, but I cannot do a good job with science.	0.017*
17. I am sure I could do advanced work in science.	1.00
Engineering and Technology	
18. I like to imagine creating new products.	0.12
20. I am good at building and fixing things.	0.19
21. I am interested in what makes machines work.	0.81
23. I am curious about how electronics work.	0.29
25. Knowing how to use math and science together will allow me to invent useful things.	1.00

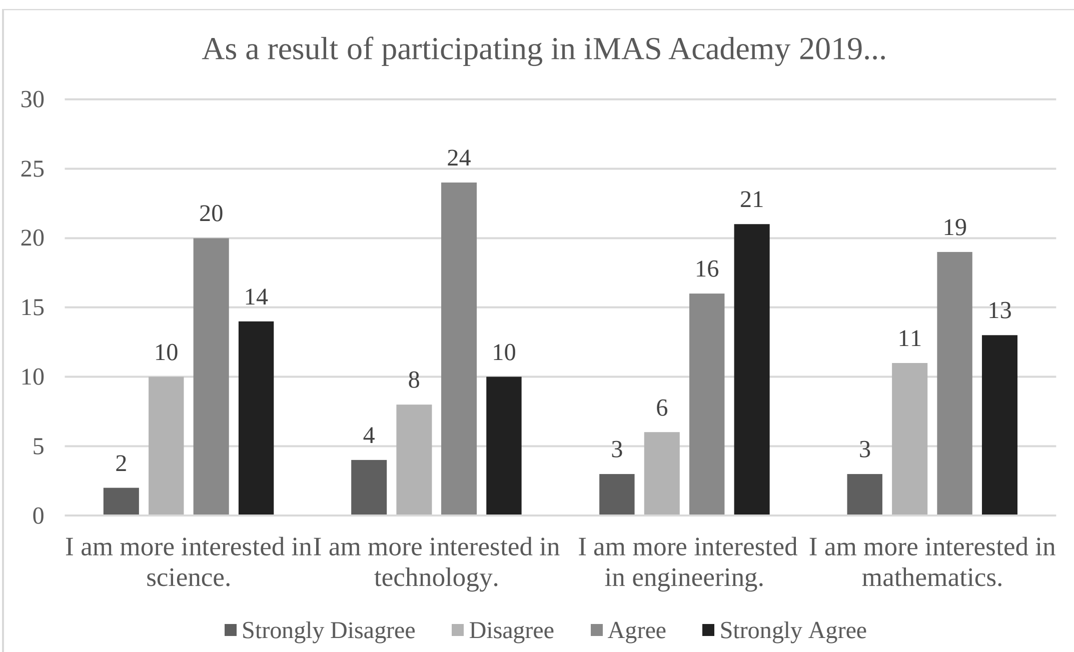
*$p < 0.05$

Analysis of these data showed a significant change in student responses to the *Science* question, "I can handle most subjects well, but I cannot do a good job with science." Data revealed the following changes in student responses to this question from the pre-survey to the post-survey. Five students disagreed on the pre-survey and agreed on the post-survey; one student neither agreed or disagreed on the pre-survey and agreed on the post-survey; four students disagreed on the pre-survey and neither agree nor disagree on the post-survey; one student agreed on the pre-survey and neither agreed nor disagreed on the post-survey; and one student neither agreed nor disagreed on the pre-survey and disagreed on the post-survey. All other survey questions showed no statistically significant change $(0.01 < p < 0.05)$ or strongly significant change $(p < 0.01)$ in individual students' responses from the pre-survey to the post-survey.

Qualitative data which represents students' attitudes toward STEM disciplines are students' responses to a four-point Likert scale question from the post-survey. Students were asked to answer questions based on their participation in iMAS Academy 2019. The four response choices were strongly disagree, disagree, agree, and strongly agree. Figure 5 shows students' responses to these questions.

Figure 5

Students' Interest in STEM Fields $(n = 46)$



Qualitative findings show that participating in the week-long summer STEM program increased students’ interest in science, technology, engineering, and mathematics. As a result of participating in iMAS Academy 2019, 73.9% of participants were more interested in science, 73.9% of participants were more interested in technology, 80.4% of participants were more interested in engineering and 69.6% of participants were more interested in mathematics.

Students’ Interest in STEM Careers

Testing again for homogeneity, the chi-square test determined whether student responses were identically distributed across the pre- and post-surveys. Chi-square statistics and *p*-values for question on the *Math*, *Science*, and *Engineering and Technology* portions of the surveys that relate to students interest in STEM careers are presented in Table 7 while Table 8 shows results from the *Your Future* portion of the survey.

Table 7

Chi-Square Test Results for Students' General Interest STEM Careers ($n = 48$)

Question	χ^2	p
Math		
2. I would consider choosing a career that uses math.	2.46	0.67
Science		
10. I would consider a career in science.	2.04	0.75
11. I expect to use science when I get out of school.	3.82	0.41
12. Knowing science will help me earn a living.	2.74	0.63
13. I will need science for my future work.	2.77	0.61
15. Science will be important to me in my life's work.	4.23	0.41
Engineering and Technology		
19. If I learn engineering, then I can improve things that people use every day.	6.15	0.16
22. Designing products or structures will be important for my future work.	3.13	0.60
24. I would like to use creativity and innovation in my future work.	2.30	0.77
26. I believe I can be successful in a career in engineering.	1.81	0.81

Table 8

Chi-Square Test Results for Students' Interest in Specific STEM Careers $(n = 48)$

Question	χ^2	p
1. Physics	0.22	0.97
2. Environmental Work	0.17	1.00
3. Biology and Zoology	2.72	0.46
4. Veterinary Work	0.61	0.90
5. Mathematics	1.41	0.71
6. Medicine	2.91	0.42
7. Earth Science	1.21	0.78
8. Computer Science	0.33	0.95
9. Medical Science	3.37	0.35
10. Chemistry	6.03	0.12
11. Energy	2.07	0.59
12. Engineering	1.84	0.64

Each question tested using chi-squared analysis showed no statistically significant change $(0.01 < p < 0.05)$ or strongly significant change $(p < 0.01)$ in student responses from the pre-survey to the post-survey. There was not a significant change in the proportions of students' aggregated responses about interest general interest in STEM careers or in their interest towards specific STEM careers between the pre-survey taken on the first day of iMAS Academy and the post-survey taken on the last day of iMAS Academy. Therefore, there was not a statistically meaningful change between the proportions of how students responded to the pre- and post-surveys regarding their interest in STEM careers.

Survey data collected on specific STEM careers, while not statistically significant, does provide information about careers linked to material covered in the iMAS Academy

2019 modules. Mathematics, computer science, and engineering each showed a percent increase in the number of students interested in a career within those fields while Earth science (the field of geology is a part of Earth science) and chemistry each showed a reduction in the number of students interested in a career within those fields of study. Table 9 shows the percent of change for careers within the STEM fields of study.

Table 9

Percent Change of Students' Interest in Specific STEM Careers Related to iMAS Academy ($n = 48$)

Question	Not Interested	Interested
5. Mathematics	-27.8%	16.7%
7. Earth Science	22.2%	-13.3%
8. Computer Science	-13.3%	6.1%
10. Chemistry	35.7%	-14.7%
12. Engineering	-16.7%	5.6%

McNemar's Test for change analyzed how individual student responses changed from the pre-survey to the post-survey. Using the contingency tables created from student responses, data was tested and analyzed to determine if there was a statistically significant ($0.01 < p < 0.05$) or strongly significant ($p < 0.01$) change in each individual student's interest in STEM careers based on participation in iMAS Academy 2019. Table 9 shows p-values for each question on the *Math*, *Science*, and *Engineering and Technology* portions of the surveys relating to career interest and Table 10 shows results from the *Your Future* portion of the surveys.

Table 10

McNemar's Test Results for Students' General Interest in STEM Careers ($n = 48$)

Question	p
Math	
2. I would consider choosing a career that uses math.	0.81
Science	
10. I would consider a career in science.	0.43
11. I expect to use science when I get out of school.	0.15
12. Knowing science will help me earn a living.	0.53
13. I will need science for my future work.	0.46
15. Science will be important to me in my life's work.	0.83
Engineering and Technology	
19. If I learn engineering, then I can improve things that people use every day.	1.00
22. Designing products or structures will be important for my future work.	0.59
24. I would like to use creativity and innovation in my future work.	0.31
26. I believe I can be successful in a career in engineering.	0.43

Table 11

McNemar's Test Results for Students' Interest in Specific STEM Careers ($n = 48$)

Question	p
1. Physics	1.00
2. Environmental Work	1.00
3. Biology and Zoology	0.69
4. Veterinary Work	1.00
5. Mathematics	0.13
6. Medicine	1.00
7. Earth Science	0.39
8. Computer Science	0.77
9. Medical Science	0.39
10. Chemistry	0.33
11. Energy	0.51
12. Engineering	0.69

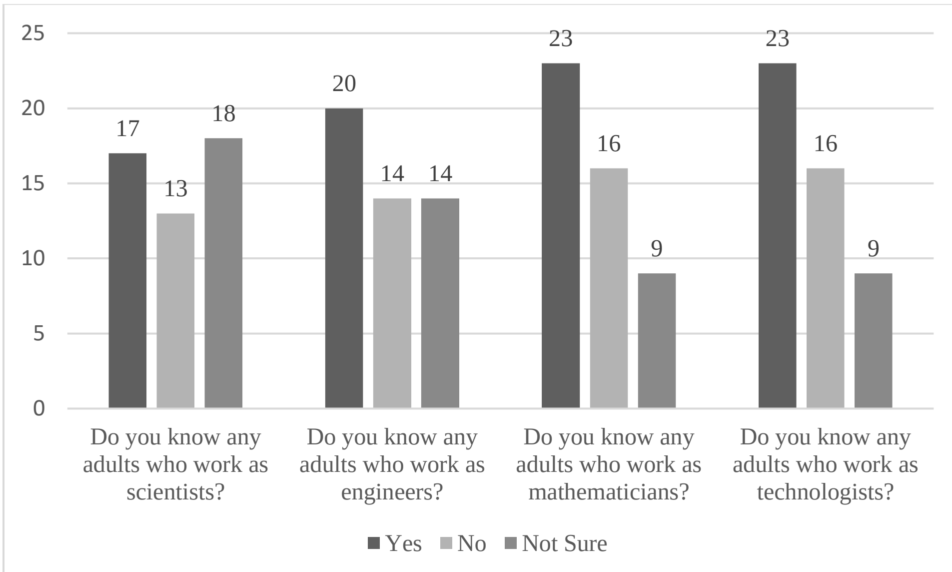
Analysis of these data showed no statistically significant change ($0.01 < p < 0.05$) or strongly significant change ($p < 0.01$) in individual students' responses from the pre-survey to the post-survey regarding their interest in STEM careers.

Qualitative findings are presented from four questions on the *More About You* section of the pre- and post-surveys. One question from the pre-survey, two questions that appeared on both the pre- and the post-surveys, and one question from the post-survey that were used for comparison in this program evaluation. Forty-six students answered the question appearing only on the post-survey while 48 students answered the other three questions.

First presented are students' answers to the pre-survey questions "Do you know any adults who work as scientists, engineers, mathematicians, or technologists." Figure 6 shows aggregated student responses to this question.

Figure 6

Student Responses to Knowing Adults Who Work in STEM Fields ($n = 48$)

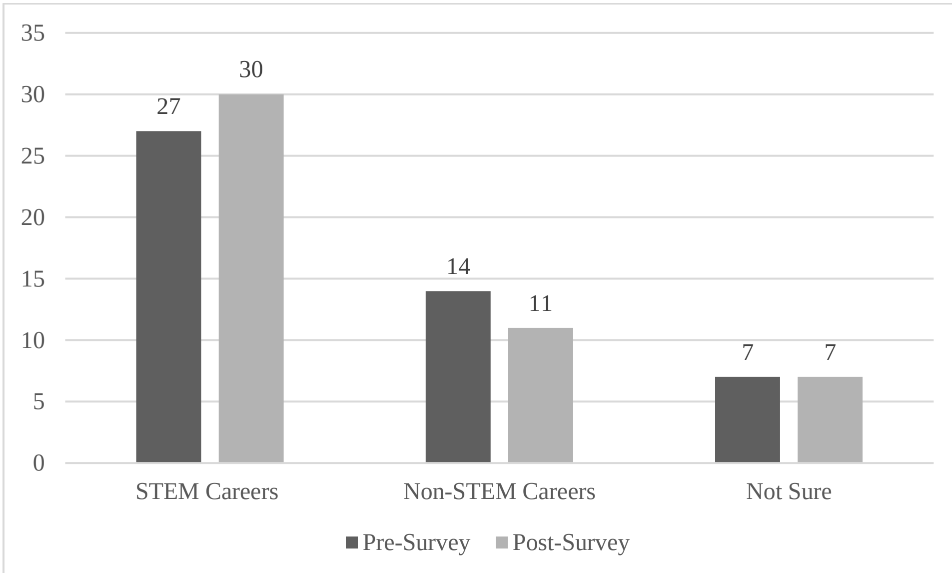


In reference to the responses noted in Figure 6, nine students, or 18.8%, answered No or Not Sure to all four questions, while seven students, or 14.6%, answered yes to all four questions.

Presented next are student responses to the question "What would you like to be when you grow up?". Students were asked this question on both the pre- and post-survey and instructed to write in their response. Student responses were reviewed and placed into three categories: STEM careers, Non-STEM careers, and Not Sure. Individual student responses are listed in Appendix D of this paper. Figure 7 shows student responses to their future career choice as indicated on the surveys.

Figure 7

Students' Future Career Interests



These responses reviewed to determine if students' choice of careers switched between STEM and Non-STEM careers, changed from one STEM fields to another, or remained the same from the pre- and post-survey responses. Responses showed five students, 10.4%, changed their career choice from a Non-STEM field to a STEM field, three students, 6.3%, changed their response from a career in a STEM field to *Not Sure*, three students, 6.3%, changed from a career choice in one STEM field to another STEM field, and 37 students, 77.1%, did not change their career choice from the pre-survey to the post-survey. Overall, after participation in iMAS Academy 2019, there was an 11.1% increase in students' interest in STEM careers. Table 11 shows the response of students who changed career interests from the pre-survey to the post-survey as they were written on the survey.

Table 12

Students' Change in Career Choices ($n = 48$)

Pre-Survey Career Choice	Post-Survey Career Choice
Non-STEM to STEM Career Choice	
Professional soccer player	Geologists
Dancer and artist	Geologists
Marine	Engineer
I don't know	Engineering
Not sure	Paleontologist
STEM Career Choice to Not Sure	
A biologist	Im not sure
Engineer	I dont know
Anathesiolgist	Anything the future has for me.
Change in STEM Career Choice	
Physicist	Engineer
An author or an architect	Author or engineer
Either a zoologist or a computer programmer	Zoologist

Note. This table shows the exact responses typed from students' pre- and post-surveys.

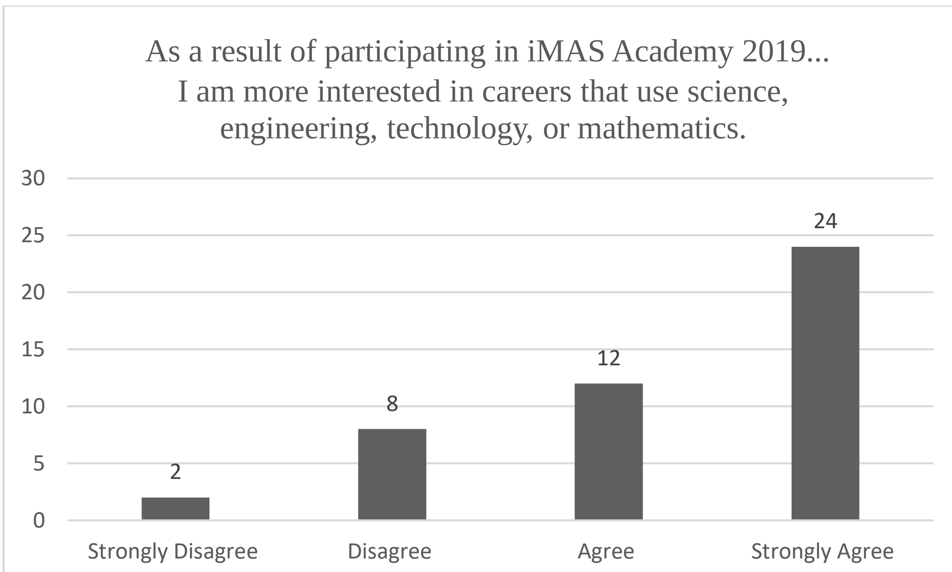
Overall, of the 30 STEM career responses on the post-survey, the majority of careers selected were in an engineering field with 46.7% choosing this career field, while the medical field was the second career choice with 20% of students choosing this STEM career field.

Students were asked on the pre- and post-surveys if they plan to attend college. On the pre-survey, forty-four students, 91.7%, said *Yes*, they plan to attend college while the remaining 4 students, 8.3%, responded *Not Sure*. When asked again on the post-survey, 50% of the students who responded *Not Sure* changed their answer to *Yes*. Additionally, one of the students who changed their response to yes also changed their career choice from “Not Sure” to “Paleontologist”.

The last data presented i students' responses to the Likert scale questions from the post-survey. Students were asked to answer the question "I am more interested in careers that use science, technology, engineering, or mathematics" based on their participation in iMAS Academy 2019. The four response choices were strongly disagree, disagree, agree, and strongly agree. Figure 8 shows students' responses to this question.

Figure 8

Students' Interest in Careers that use STEM ($n = 46$)



Results show that as a result of participating in the week-long summer STEM program, iMAS Academy, 78.3% of students are more interested in careers that use science, engineering, technology, or mathematics.

Summary

This chapter presented the results from the quantitative data analysis from the *Student Attitudes toward STEM (S-STEM) Survey* sections, *Math*, *Science*, and *Engineering and Technology*. Through chi-square analysis, results from surveys showed there was not a statistically significant change in the proportions of how students responded from the pre-survey to the post-survey regarding their interest in math, science, or engineering and technology or their interest in various STEM careers. McNemar’s Test for change showed a significant change in individual student responses to the *Science* question, “I can handle most subjects well, but I cannot do a good job with science”. Changes in student responses varied from negative to positive, neutral to positive, negative to neutral, positive to neutral, and neutral to disagree. All other survey questions tested through McNemar’s Test showed no statistically significant change. Qualitative data from the *More About You* section of the surveys revealed that the majority of participants know at least one adult who works in a STEM career, plan to attend college, and are interested in future career in a STEM field. Additional qualitative finding showed that as a result of participating in iMAS Academy 2019, participants are more interested in STEM and STEM careers. Chapter Five presents a discussion of the results from this study, a summary of the results, and implications for future research and practice.

Chapter V

Discussion

This study was a program evaluation of a week-long summer STEM program for middle grade students called iMAS Academy. The goals of this study were to determine (1) to what extent does participating in iMAS Academy influence sixth, seventh, and eighth grade students' attitude toward STEM disciplines; and (2) to what extent does participating in iMAS Academy influence sixth, seventh, and eighth grade students' interest in STEM careers. This chapter discusses the findings and results from this study and how they relate to each research question, limitations to the study, and implications for future research and practice.

Findings

The iMAS Academy summer STEM program, hosted by the STEM Research and Learning Center, endeavors to uphold the STEM Center's primary objective: to increase the number of students interested in STEM careers, and prepare them academically for STEM learning. Participation in the hands-on, inquiry-based STEM activities through iMAS Academy tangibly connected students' science and mathematics learning to activities and potential STEM career opportunities. While null findings from the quantitative data show that students' opinion toward STEM fields and STEM careers did not show a statistically significant change from the pre-survey to the post-survey, students' responses to the surveys revealed that they came to iMAS Academy with an existing interest in STEM field and STEM careers, aligning with previous research (Dave et al., 2010). Qualitative data revealed the majority of students were more interested in STEM fields and STEM careers as a result of participating in iMAS Academy. These findings from iMAS Academy 2019 align with other research (Dabney et al., 2012; Elam et al., 2012; Mohr-Schroeder et al., 2014; Moreno et al., 2016; PCAST, 2010; Wai et al., 2010), showing that participation in this STEM summer program had a positive influence on students' interest in STEM fields and their interest in STEM careers. Thus, iMAS Academy 2019 meets the primary objective of the STEM Research and Learning Center, increasing the number of students interested in STEM careers.

Students' Attitude toward STEM Disciplines

Research suggests that students determine their interest in STEM subjects by the time they enter the eighth grade (PCAST, 2010). This research was designed to determine how participation in a weeklong STEM camp influences students' attitudes toward STEM disciplines. Students' participation in three-hour modules throughout the week introduced four STEM disciplines and new topics based on TEKS for grades six through eight, as well as exposed students to various science and mathematics uses within various STEM disciplines. The survey results from this study found that though there was not a statistically significant improvement in students' attitudes toward STEM disciplines as a result of participation in iMAS Academy, students still said they were more interested in science, technology, engineering, and mathematics after completion of the program. Survey results also showed that most students who attended iMAS Academy 2019 were already interested in STEM before attending the week-long summer program. Thus, their attitudes toward STEM disciplines may not have been altered.

Math. This research found that the majority of students who attended iMAS Academy began the summer program feeling confident in their ability to perform well in mathematics. During iMAS Academy 2019 there was not a mathematics specific module.

However, faculty presenters made a conscious effort to connect mathematics within all activities presented throughout the STEM camp. Within each module, students learned how mathematics is utilized differently within different science fields. The chemistry module required students to record data comparing the conductivity of distilled water and various concentrations sodium chloride and determine the relationship between concentrations and conductivity based on the data results and subsequent graph. In computer science, students learned to convert numbers from base ten, decimal form, to binary and learned about the mathematical relationship with encryption, specifically encryption being a two-way function. The engineering physics module taught students to calculate potential and kinetic energy, and used a software program to determine peak velocity and acceleration of their vehicles, making the connection that as mass increases, the instantaneous velocity when the vehicle crashes at the end of the cart track remains relatively unchanged. Furthermore, students had to design a cost effective collision safety system by purchasing and selling items. In the geology module, students learned how to calculate stress and strain by measuring the structures the built with pier-and-beam foundations and slab foundations on different clay and sand sediments. Additionally, faculty discussed what types of mathematics courses and how many mathematics courses are required to complete a bachelor’s degree in the areas of chemistry, computer science, engineering, and geology.

Participation in this summer program showed both a slight increase in students’ self-efficacy toward mathematics and a preservation in positive attitudes toward mathematics. Research shows that a strong foundation in mathematics is an important factor in a student choosing advanced STEM courses in high school and beyond (Moreno et. al, 2016). Upon completion of iMAS Academy, fewer students felt that math was their worst subject or that math was hard for them, while more students believed they could do advanced work in mathematics and get good grades in math. Addressing the connections between mathematics and other STEM disciplines reinforced the need for a strong foundation in mathematics for future courses related to various STEM degrees.

Science. Pre-survey results show that many students began iMAS Academy with a high self-efficacy toward science, believing they can do well in science and that they were capable of advanced work in science. Results from the data analysis showed the only statistically significant change in individual student responses was to the question "I can handle most subjects well, but I cannot do a good job with science". The majority change in student responses were from students who disagreed initially with this statement and changed to either agree or neutral, reveling that these students could no longer determine if they could perform well in science.

The three science modules delivered in iMAS Academy, chemistry, computer science, and geology, were all inquiry-based, requiring students to determine amongst themselves how to reach the final products or solutions on their own. Each module required students to use reasoning and problem solving while the presenters acted as guides and facilitators for student learning, asking probing questions which allowed students to arrive at the answer on their own rather than being told what step to follow next. The students attending iMAS Academy, while introduced to matter and energy in grades six through eight, have not had the opportunity to learn about the areas of chemistry introduced during the chemistry module. Furthermore, based on the TEKS for grades six through eight, the computer science and geology curriculums addressed in this summer program were new to most students in attendance. Students first had to learn new concepts in order to produce an outcome within each of these science modules.

Inquiry-based teaching is not always found in academic classrooms. Research shows that schools often return to teacher-centered teaching and low-level learning goals to meet the demands of standardized testing (Kuhlthau et al., 2015). Teacher-centered teaching presents a concept to students then guides them step-by-step through the solution process or the necessary procedures to achieve a specific outcome. The three-hour iMAS Academy modules presented participants with a challenge or task that utilized students' funds of knowledge and innovation. Though IBL motivates learners (Kuhlthau et al., 2015), students who are not used to this type of instruction may have a harder time self-starting in these educational environments.

Without survey questions pertaining to the specific areas of science from iMAS Academy 2019, there is no way to tell if students' attitudes were changed due to participation in a specific module, or their attitudes were impacted due to their like or dislike of a particular module. However, this research shows that while there is slight variation within students' attitudes toward science, overall students' attitudes remained positive towards science.

Engineering and Technology. The areas of engineering and technology are of particular interest to many student attending the iMAS Academy STEM summer program. As with the previous sections of the pre-survey, students entered iMAS Academy with a preexisting interest in engineering and technology. Though changes from the pre-survey to the post-survey did not reveal statistically significant changes in student responses, notable areas for discussion include an increase in the number of students who believed they were good at fixing things after participating in iMAS Academy, a decrease in the number of students who said they like to imagine creating new products.

As with many school districts across the nation, familiarity with local school districts' curriculum aligns with research which says engineering and technology are not often given academic time during the school year (Nugent et al., 2010). Additionally, many students are not exposed to the type of work and engineers or technologists perform. Oftentimes students hear the term 'technology' and think of a person in IT, as in a tech person who helps with computers at school. Many students may be unaware as to the extent of what a technologist does and how it applies to STEM learning.

Research suggests that it is important for educators to make connections for students on how STEM is used outside of the academic classroom (Brown et al., 2016). During iMAS Academy, the engineering faculty discussed what it means to be an engineer, how technicians are involved in engineering, and how mathematics studies relates to these topics. As mentioned in the *Student Attitudes Toward STEM (S-STEM) Survey* administered to students,

> **Engineers** use math, science, and creativity to research and solve problems that improve everyone's life and to invent new products. Engineers design and improve things like bridges, cars, fabrics, foods, and virtual reality amusement parks. **Technologists** implement the designs that engineers develop; they build, test, and maintain products and processes (Friday Institute for Educational Innovation, 2012).

Within the engineering session, the iMAS Academy faculty discussed what engineers, engineering technologists, and technologists do in relation to engineering. Participants learned that typically, engineering technology bridges the gap between engineers and technicians. The engineering technology path requires less mathematics and takes a more specialized focus while technicians are trained to complete specific tasks and make sure the process is completed to the required specifications. Engineers then analyze and determine the outcomes from incoming data.

The engineering module in iMAS Academy 2019 gave students hands-on experience, providing an opportunity for students to use their funds of knowledge of involving kinetic and potential energy, momentum, and acceleration, along with the newly introduced topic of elastic or inelastic collisions and apply this knowledge to building an anti-collision apparatus that reduces acceleration in a car crash. This hands-on building experience could be the reason for the increase in the number of students who believed they were good at fixing things and the decrease the number of students who said they like to imagine creating new products. Participation in the engineering module provided students a tangible connection between mathematics and science. This research found that students who attended iMAS Academy had a previous interest in engineering and technology and a positive attitude toward engineering, consistent with previous findings (Dave et al., 2010). Participation in this summer program upheld students' positive attitudes toward engineering and technology.

Overall, the findings of this program evaluation of the STEM Research and Learning Center's iMAS Academy 2019 showed both a consistency and an increase in students' attitudes toward STEM disciplines. Students remained interested in mathematics, science, engineering and technology after participation in iMAS Academy, even if their interests did not increase as a result of participation. This hands-on experience with STEM role models provided students opportunities to engage in STEM activities outside of the academic classroom. This weeklong STEM experience retains students' interest in STEM. Exploration of STEM disciplines and connections with role models in various STEM fields of study maintains students' interest toward STEM disciplines and has the potential to increase students' interest in STEM through continued experiences.

Students' Interest in STEM Careers

This research study assessed students' interest in STEM careers before and after participation in a weeklong STEM summer program. Data findings revealed that many students who attended iMAS Academy already had aspirations of pursuing a STEM career. Research shows there is a link between students' self-efficacy and interest in academic disciplines (Eccles & Wigfield, 2002; Simpkins, Davis-Kean, & Eccles, 2006), and furthermore a connection between the motivation to pursue higher level STEM courses and the intent to major in a STEM field (Wang, 2013). According to the United States Bureau of Labor and Statistics (2020), seven out of the top ten fastest growing occupations are within STEM fields and six out of the top ten are related to health care. Students must first be interested in a STEM career to academically prepare for and be placed in such careers.

With iMAS Academy held in a university setting, led by university faculty and staff members, there are a percentage of students that attend this summer program who have parents that work within STEM departments on the university campus. This intimate knowledge of adults within certain disciplines potentially increases or decreases their interest in pursuing s STEM career beyond students unfamiliar with adults in such fields. Children in grade school who do not have parents that work in a STEM field may be unfamiliar with careers that involve STEM beyond adults they come in contact with in everyday life and careers seen on television. Typical STEM careers children would encounter in their everyday lives include doctors, nurses, veterinarians, and their own mathematics and science teachers. On television children witness these same fields in addition to careers such as forensic science. Research shows that students who participate in activities alongside STEM professionals not only gain positive role models but also deepen their understanding of STEM content (Roberts et al., 2018; Weber, 2011).

The survey data from iMAS Academy 2019 asked students if they knew any adults who worked in the fields of science, technology, engineering, or mathematics. Data showed there were students who said they did not know any adults who worked in a STEM field. This reveals that students may not consider their math or science teachers as persons with a STEM career and furthermore may not connect how learning math and science in school correlates with STEM careers students are familiar with. Within the summer 2019 iMAS Academy modules, faculty made an effort to connect their disciplines to career choices. Five students changed their career choice from a non-STEM career to a STEM career. The two students who changed their career choice to geology both noted on their surveys that they did not know any adults who worked as scientists. Their interactions within the geology module sparked an interest in that discipline which lead to a change in career choice. Other discoveries included students who were already interested in a STEM career and change their discipline focus after participation in iMAS Academy. One student who wanted to be either an author or an architect changed to author or engineer after participation in the engineering module. Another students mentioned they wanted to be either a zoologist or a computer programmer and after the computer forensic module decided they no longer were interested in computer programming. However, this research also determined that not all career interests showed an overall positive change. Quantitative data revealed a decrease in interest toward the areas of chemistry and geology though qualitative data showed students changing their career choice to the field of geology. Therefore, providing time for students to discover if they enjoy a particular area of focus is vital to their decisions about career choices. Participation in iMAS Academy provided students the opportunity to discover their STEM interests and make connections to STEM learning and careers while working with highly qualified STEM faculty members.

While a large percentage of students that attended iMAS Academy did not change their career interest due to participation in in this program, this research study showed participation in a STEM summer program increases the number of students interested in STEM careers. Survey data also revealed that while most students planned to attend college, two of the four that were unsure of attending changed their answer to yes. Furthermore, one of the students who decided to attend college also chose a career in STEM. Leading to the conclusion that piquing students' interest STEM fields increases awareness for the need to study math and science beyond high school. If self-efficacy and interest in STEM leads to students' increased interest in STEM careers then programs such as iMAS Academy are pivotal to providing such opportunities for students.

Limitations

As with any study conducted, limitations must be identified. This study includes several important limitations to its general application to other STEM learning settings and populations. While informal learning experiences include short activities, half-day or full-day events, fieldtrips, weeklong and month long programs, this study looks only at one weeklong summer program with student participation during the morning. The number of STEM disciplines discussed within the summer program are also limited. With each day presenting a new STEM topic or discipline, students are only exposed to at most five different areas of STEM in during each summer iMAS Academy. For summer 2019, the STEM areas of focus included engineering with physics, geology, computer science, chemistry, and mathematics with engineering. Research involving future iMAS Academies will include additional STEM areas of focus.

This study does not follow participants beyond their summer involvement in iMAS Academy. However, it is possible that what the program lacks in formal retention of knowledge, it makes up for in engagement and interest. Future iMAS Academies could involve a way to track students throughout their middle school and potentially high school careers to determine if their involvement in informal STEM learning continues Limitations of this study also include considerations of student participation. The iMAS program requires students to register and pay a fee, perhaps limiting access to the program based on socioeconomic constraints.

Additional limitations include the small sample size of this study, 56 total participants with 48 completing both the pre- and post-surveys. Only one year of archival data was available for this study which used the *Student Attitudes Toward STEM (S-STEM) Survey*. Survey limitations include students who do not take the time to read through the survey questions and choose to answer each question with the same response to complete the survey quickly. Furthermore, students may answer questions in the way they think they should answer instead of responding based on their own opinions and beliefs. Continuing to use this survey for iMAS Academy will lead to larger sample sizes of data for future research.

Implications

The findings of this study provide implications for practice and future research. Previous research showed that students who show interest in STEM by eighth grade are more likely to advance to a STEM degree (PCAST, 2010). Sparking students' interest in STEM and maintaining that interest plays an important part in students perusing a future STEM career. This research shows that it is important to continually connect how learning math and science in school is necessary and useful for STEM learning and STEM careers. Creating informal learning environments that focus on STEM disciplines and utilize role models, persons who work in careers within these disciplines, is significant. Furthermore, using inquiry-based modules that provide opportunities for students to ponder over topics facilitated by well-trained presenters can create a thought-provoking environment which leads to the increase and preservation of student interest in STEM disciplines and STEM careers. Providing such opportunities for students in elementary and middles grades expects piqued student interest at an early age which can remain throughout high school and beyond.

Future research might examine other aspects of student data. Qualitative findings that include personal interviews and focus groups could get an alternate perspective of this STEM summer programs. Additionally, following up with students beyond their participation in this program to determine if they attend iMAS Academy or other STEM programs in the future and the impact this participation has on their future degree and career choice. There is a cost involved to participate in iMAS Academy. Future studies should take into consideration STEM programs run through grant funding or funding agencies and determine whether students enter these program with a positive attitude toward STEM disciplines and a high interest in STEM careers because this could have implications on student outcomes. Furthermore, continuing research to determine if there is a connection between students who know adults with careers in a STEM field and the desire to pursue a STEM career.

Conclusions

The intent of iMAS Academy is to positively influence students' interest in STEM and increase their interest in STEM careers. Additionally, the aim of such STEM summer programs is to equip students with the necessary knowledge and skills to be successful both academically and in a STEM career. Qualitative and quantitative findings suggest that participating in a STEM summer program such as iMAS Academy can both increase students' interest in STEM disciplines and STEM careers as well as maintain students' interests in STEM if they attend such programs due to an established interest in STEM topics and future STEM careers. Continuing to provide opportunities for students to participate in STEM activities outside of the classroom is important in maintaining students' interest in STEM disciplines and STEM careers. Providing opportunities to explore different areas of STEM gives students time to determine their areas of interest and disinterest. These research findings can provide a model for potentially effective informal STEM programs. Successful STEM programs engage students through lessons and activities lead by highly qualified presenters who connect STEM content to STEM careers and real world experiences. Providing hands-on, inquiry-based STEM activities beyond what students are exposed to within their academic classrooms, increases students' self-efficacy toward STEM disciplines, making students aware of the importance of math and science education, leading to an increased interest in STEM careers.

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Appendix A

2019 iMAS Academy Module Overviews

Chemistry

<u>The Chemistry between Me and My Cell Phone</u>

Module Overview:

Electrochemical processes occur in many different areas of science, technology, engineering, and math. This module provides an initial foundation of the basic principles of electrochemical processes. Students will enter the world of electrochemistry through investigations in electrolysis, conductivity, oxidation-reduction, and biochemical electron transport. Students will work in pairs to complete lab activities that will use each area of STEM to allow them to make connections to the energy source of batteries and their bodies.

In 1793, Alessandro Volta discovered that electricity could be produced by placing different metals on the opposite sides of a wet paper or cloth. He made his first battery by placing Ag and Zn on the opposite sides of a moistened cloth with salt or weak acid solution. Therefore, these batteries acquired the name voltaic cells. **Voltaic (galvanic) cells** are electrochemical cells that contain a spontaneous reaction, and always have a positive voltage. The electrical energy released during the reaction can be used to do work. A voltaic cell consists of two compartments called half-cells. The half-cell where oxidation occurs is called the **anode**. The other half-cell, where reduction occurs, is called the **cathode**. The electrons in voltaic cells flow from the negative electrode to the positive electrode—from anode to cathode (see figure below). (Note: the electrodes are the sites of the oxidation and reduction reactions). The following acronym is useful in keeping this information straight:

Red Cat and **An Ox**

Reduction **Cat**hode and **An**ode **Ox**idation

For an oxidation-reduction reaction to occur, the two substances in each respective half-cell are connected by a closed circuit such that electrons can flow from the reducing agent to the oxidizing agent. A salt bridge is also required to maintain electrical neutrality and allow the reaction to continue.

Zn(s) is continuously oxidized, producing aqueous Zn^{+2}:
$Zn(s) \rightarrow Zn^{+2}(aq) + 2e^{-}$

Cu^{+2} is reduced and continuously deposits onto the copper bar:
$Cu^{+2}(aq) + 2e^{-} \rightarrow Cu(s)$

As a result, the zinc solution becomes more positively charged as the solution containing Cu(s) becomes more negatively charged. For the voltaic cell to work, the solutions in the two half-cells must remain electrically neutral. Therefore, a salt bridge containing KNO_3 is added to keep the solutions neutral by adding NO_3^-, an anion, into the anode solution and K^+, a cation, into the cathode solution. (salts such as sodium sulfate can also be used). As oxidation and reduction proceed, ions from the salt bridge migrate to prevent charge buildup in the cell compartments.

Objectives:
Students will:

- electrolyze a bubble solution using aluminum foil electrodes and if possible, light the bubbles on fire for a fun and safe explosion to introduce electrolytic cells.
- characterize conductors and insulators. Eighth grade students will dig deeper into conductivity in part two by investigating what happens when electrodes are in water and salt solution.
- make connections with the previous activities on oxidation-reduction reactions.
- conduct an experiment to explore the results of cellular respiration and experience data collection and analysis.
- build and study the parts of a galvanic cell. This activity can include measuring electrochemical potential.
- rank the results of an electrochemical circuit's power and design a battery using food items to power a cell phone.

Computer Science

Who Dun It?
(Investigations in binary numbers, cryptography, and digital forensics)

Module Overview:

The module will have students explore mathematical and scientific concepts performing a digital forensics investigation. The mathematical concepts are expressed in learning how to count numbers in a different base system, in this case binary. The scientific method is expressed with a hands on forensics investigation. Students will explore how numbers are represented in binary and different logical operations we can perform with binary symbols. The encryption used is an exclusive-or bit-wise operation and students will get to write simple programs utilizing this encryption method.

Objectives:

Students will:

- convert numbers from decimal to binary.
- demonstrate the ability to perform bit-wise logical operations with binary numbers.
- observe the mathematical relationship with encryption. Specifically encryption being a two-way function.
- use informal language and formal vocabulary to describe binary data.
- analyze encrypted data to construct a timeline.
- investigate a cyber-crime using their analysis, critical thinking, and cryptography skills.

Engineering Physics

Crash Cars!
(Investigations into the Physics and Engineering of Collisions)

Module Overview:

Participants will learn about the physics of colliding bodies and use what they learn to engineer an apparatus to be fitted to a "smart" cart in order to reduce the severity of a high-velocity collision. The module is centered around the use of the Pasco Smart Cart (shown below) which is capable of recording acceleration, velocity, and position data via a Bluetooth connection to a computer.

Students will be working in teams on a computer which will be in direct contact with their smart cart. They will test the cart with various weights and at different positions along a fixed track to better understand the relationship between potential and kinetic energy. As velocity or mass increase it should be clear that the energy of the cart also increases – much like we experience when driving an automobile.

Next the participants will set up their cart on a crash-course and record acceleration/gyroscopic data from the cart to learn more about impulse and momentum. Students will start to gain an appreciation for elastic vs. inelastic collisions. Why do auto manufacturers use "crumple zones" to protect the people riding inside their product? Students will experience how inelastic collisions, where both bodies do not separate after impact, are preferable to elastic collisions in their cart.

Finally, students will be provided with materials which they must purchase in order to develop the safest collision safety system device for their smart cart. A budget will be given to each team and they will purchase materials to test various anti-crash designs of their own creation. Assessment of each team's ability to decrease the acceleration felt by the cart will be made and students will be encouraged to develop the lowest-cost solution that yields the best results in protecting the cart.

Objectives:

Students will:

- record data from their smart cart using different positions along a track with various weights to investigate kinetic and potential energy.
- investigate the link between momentum of an object and the impulse required to change that momentum to zero.
- compare and determine which type of collision, elastic or inelastic, would yield the lowest acceleration felt by the cart.
- design, using various materials, and affix an anti-collision apparatus to their cart to reduce the acceleration recorded by their smart cart in a constant velocity impact with a wall.

Geology

Geohazards: Geological Stability of Your Home
"Who is the Big Bad Wolf?"

Module Overview:

This module is designed to assess the impact of variable soil conditions on the stability of building construction designs for geohazard avoidance. Changes in moisture content in many soils induces shrink/swell characteristics that cause building foundations, and associated construction, to crack, tilt and move differentially. "Geologic Stability of Your Home" introduces the concepts of geoscience engineering and soil characterization to assess ground stability, including: 1) total stress, 2) effective stress, 3) strain (compression), and 4) soil classification. Students will evaluate structural loading on different soil types with varying moisture content to determine the effects of anthropogenically-induced stress on variable geologic media. Students will learn about the key aspects of geohazards and the effects of human activity through physical modeling and demonstrations of exceptional circumstances involving soluble geologic media. The conclusion of this module applies the principles of geohazard assessment for consideration of home construction within East Texas.

Objective:

Students will apply analytical and mathematical skills associated with geohazard potential characterization. Students will investigate scenarios for building construction (slab foundation vs. pier-and-beam foundation) in different soil types. Through laboratory analyses, students will evaluate the relationship between stress and strain (compression) in soils. Students will formulate hypotheses and investigate geohazard characteristics, including:

- The susceptibility of common buildings to geohazards.
- Geologic engineering parameters of stress (total, effective, pore pressure) and strain (compression).
- Correlation of soil composition and moisture content to soil stability.
- Mathematical and scientific skills necessary in assessing geological systems.
- Relation of soil type to the determination of failure susceptibility of different construction types.

Appendix B

Pre-Survey and Post-Survey

Both pre- and post-surveys used the same questions from the sections titled "Math", "Science", "Engineering and Technology", and "Your Future". Differing questions are found in the "*More About You*" sections.

Math

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
1. Math has been my worst subject.	o	o	o	o	o
2. I would consider choosing a career that uses math.	o	o	o	o	o
3. Math is hard for me.	o	o	o	o	o
4. I am the type of student to do well in math.	o	o	o	o	o
5. I can handle most subjects well, but I cannot do a good job with math.	o	o	o	o	o
6. I am sure I could do advanced work in math.	o	o	o	o	o
7. I can get good grades in math.	o	o	o	o	o
8. I am good at math.	o	o	o	o	o

Science

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
9. I am sure of myself when I do science.	o	o	o	o	o
10. I would consider a career in science.	o	o	o	o	o
11. I expect to use science when I get out of school.	o	o	o	o	o
12. Knowing science will help me earn a living.	o	o	o	o	o
13. I will need science for my future work.	o	o	o	o	o
14. I know I can do well in science.	o	o	o	o	o
15. Science will be important to me in my life's work.	o	o	o	o	o
16. I can handle most subjects well, but I cannot do a good job with science.	o	o	o	o	o
17. I am sure I could do advanced work in science.	o	o	o	o	o

Engineering and Technology

<u>Please read this paragraph before you answer the questions.</u>

Engineers use math, science, and creativity to research and solve problems that improve everyone's life and to invent new products. There are many different types of engineering, such as chemical, electrical, computer, mechanical, civil, environmental, and biomedical. Engineers design and improve things like bridges, cars, fabrics, foods, and virtual reality amusement parks. **Technologists** implement the designs that engineers develop; they build, test, and maintain products and processes.

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
18. I like to imagine creating new products.	o	o	o	o	o
19. If I learn engineering, then I can improve things that people use every day.	o	o	o	o	o
20. I am good at building and fixing things.	o	o	o	o	o
21. I am interested in what makes machines work.	o	o	o	o	o
22. Designing products or structures will be important for my future work.	o	o	o	o	o
23. I am curious about how electronics work.	o	o	o	o	o
24. I would like to use creativity and innovation in my future work.	o	o	o	o	o
25. Knowing how to use math and science together will allow me to invent useful things.	o	o	o	o	o
26. I believe I can be successful in a career in engineering.	o	o	o	o	o

Your Future

Here are descriptions of subject areas that involve math, science, engineering and/or technology, and lists of jobs connected to each subject area. As you read the list below, you will know how interested you are in the subject and the jobs. Fill in the circle that relates to how interested you are.

There are no "*right*" or "*wrong*" answers. The only correct responses are those that are true for you.

	Not at all Interested	Not So Interested	Interested	Very Interested
1. Physics: is the study of basic laws governing the motion, energy, structure, and interactions of matter. This can include studying the nature of the universe.	o	o	o	o

(aviation engineer, alternative energy technician, lab technician, physicist, astronomer)				
2. Environmental Work: involves learning about physical and biological processes that govern nature and working to improve the environment. This includes finding and designing solutions to problems like pollution, reusing waste and recycling. (pollution control analyst, environmental engineer or scientist, erosion control specialist, energy systems and maintenance technician)	o	o	o	o
3. Biology and Zoology: involve the study of living organisms (such as plants and animals) and the processes of life. This includes working with farm animals and in areas like nutrition and breeding. (biological technician, biological scientist, plant breeder, crop lab technician, animal scientist, geneticist, zoologist)	o	o	o	o
4. Veterinary Work: involves the science of preventing or treating disease in animals. (veterinary assistant, veterinarian, livestock producer, animal caretaker)	o	o	o	o
5. Mathematics: is the science of numbers and their operations. It involves computation, algorithms and theory used to solve problems and summarize data. (accountant, applied mathematician, economist, financial analyst, mathematician, statistician, market researcher, stock market analyst)	o	o	o	o
6. Medicine: involves maintaining health and preventing and treating disease. (physician's assistant, nurse, doctor, nutritionist, emergency medical technician, physical therapist, dentist)	o	o	o	o
7. Earth Science: is the study of earth, including the air, land, and ocean. (geologist, weather forecaster, archaeologist, geoscientist)	o	o	o	o
8. Computer Science: consists of the development and testing of computer systems, designing new programs and helping others to use computers. (computer support specialist, computer programmer, computer and network technician, gaming designer, computer software engineer, information technology specialist)	o	o	o	o
9. Medical Science: involves researching human disease and working to find new solutions to human health problems. (clinical laboratory technologist, medical scientist, biomedical engineer, epidemiologist, pharmacologist)	o	o	o	o
10. Chemistry: uses math and experiments to search for new chemicals, and to study the structure of matter and how it behaves. (chemical technician, chemist, chemical engineer)	o	o	o	o

11. Energy: involves the study and generation of power, such as heat or electricity. (electrician, electrical engineer, heating, ventilation, and air conditioning (HVAC) technician, nuclear engineer, systems engineer, alternative energy systems installer or technician)	o	o	o	o
12. Engineering: involves designing, testing, and manufacturing new products (like machines, bridges, buildings, and electronics) through the use of math, science, and computers. (civil, industrial, agricultural, or mechanical engineers, welder, auto-mechanic, engineering technician, construction manager)	o	o	o	o

More About You

Pre-survey Questions:

What grade will you be in next year?

- ○ 6th grade
- ○ 7th grade
- ○ 8th grade

	Yes	No	Not Sure
Do you know any adults who work as scientists?	○	○	○
Do you know any adults who work as engineers?	○	○	○
Do you know any adults who work as mathematicians?	○	○	○
Do you know any adults who work as technologists?	○	○	○

What would you like to be when you grow up?

____

Do you plan to go to college?

- ○ Yes
- ○ No
- ○ Not Sure

If you plan to go to college, which college(s) are you interested in attending?

____

Post-survey Questions:

As a result of participating in iMAS Academy 2019...

	Strongly Disagree	Disagree	Agree	Strongly Agree
I am more interested in careers that use science, engineering, technology, or mathematics.	o	o	o	o
I am more interested in science.	o	o	o	o
I am more interested in technology.	o	o	o	o
I am more interested in engineering.	o	o	o	o
I am more interested in mathematics.	o	o	o	o

What would you like to be when you grow up?

___

Do you plan to go to college?

- ○ Yes
- ○ No
- ○ Not Sure

If you plan to go to college, which college(s) are you interested in attending?

___

Appendix C

Aggregated Survey Data

MATH

Question	Strongly Disagree (Pre)	Strongly Disagree (Post)	Disagree (Pre)	Disagree (Post)	Neither Agree nor Disagree (Pre)	Neither Agree nor Disagree (Post)	Agree (Pre)	Agree (Post)	Strongly Agree (Pre)	Strongly Agree (Post)
1. Math has been my worst subject.	19	27	19	13	5	6	4	1	1	1
2. I would consider choosing a career that uses math.	1	3	3	1	19	21	16	13	9	10
3. Math is hard for me.	20	20	15	19	8	4	4	3	1	2
4. I am the type of student to do well in math.	0	1	3	0	8	9	18	22	19	16
5. I can handle most subjects well, but I cannot do a good job with math.	16	23	19	16	8	6	3	1	2	2
6. I am sure I could do advanced work in math.	1	3	5	2	10	8	19	20	13	15
7. I can get good grades in math.	1	1	1	1	2	5	24	17	20	24
8. I am good at math.	0	1	1	2	7	7	18	18	22	20

SCIENCE

Question	Strongly Disagree (Pre)	Strongly Disagree (Post)	Disagree (Pre)	Disagree (Post)	Neither Agree nor Disagree (Pre)	Neither Agree nor Disagree (Post)	Agree (Pre)	Agree (Post)	Strongly Agree (Pre)	Strongly Agree (Post)
9. I am sure of myself when I do science.	0	1	4	3	8	11	22	21	14	12
10. I would consider a career in science.	1	2	5	3	16	13	12	17	14	13
11. I expect to use science when I get out of school.	0	1	9	4	11	11	12	17	16	15
12. Knowing science will help me earn a living.	0	1	2	1	16	12	13	18	17	16
13. I will need science for my future work.	2	2	2	2	17	13	9	16	18	15
14. I know I can do well in science.	1	1	0	1	7	8	22	23	18	15
15. Science will be important to me in my life's work.	0	2	3	2	19	15	12	18	14	11
16. I can handle most subjects well, but I cannot do a good job with science.	20	16	18	15	6	9	3	6	1	2
17. I am sure I could do advanced work in science.	3	2	1	3	10	9	20	18	14	16

ENGINEERING AND TECHNOLOGY

Question	Strongly Disagree (Pre)	Strongly Disagree (Post)	Disagree (Pre)	Disagree (Post)	Neither Agree nor Disagree (Pre)	Neither Agree nor Disagree (Post)	Agree (Pre)	Agree (Post)	Strongly Agree (Pre)	Strongly Agree (Post)
18. I like to imagine creating new products.	1	1	1	6	10	8	19	20	17	13
19. If I learn engineering, then I can improve things that people use every day.	0	1	5	1	5	11	21	18	17	17
20. I am good at building and fixing things.	1	1	6	1	11	14	17	19	13	13
21. I am interested in what makes machines work.	1	2	5	5	6	9	19	17	17	15
22. Designing products or structures will be important for my future work.	1	1	5	4	14	22	14	12	14	9
23. I am curious about how electronics work.	1	4	5	4	7	7	16	20	19	13
24. I would like to use creativity and innovation in my future work.	1	1	1	1	8	14	22	20	16	12
25. Knowing how to use math and science together will allow me to invent useful things.	0	1	3	1	5	8	20	20	20	18
26. I believe I can be successful in a career in engineering.	1	1	4	4	10	15	18	13	15	15

YOUR FUTURE								
Question	Not at all Interested (Pre)	Not at all Interested (Post)	Not So Interested (Pre)	Not So Interested (Post)	Interested (Pre)	Interested (Post)	Very Interested (Pre)	Very Interested (Post)
1. Physics: is the study of basic laws governing the motion, energy, structure, and interactions of matter. This can include studying the nature of the universe. (aviation engineer, alternative energy technician, lab technician, physicist, astronomer)	2	2	23	22	17	19	6	5
2. Environmental Work: involves learning about physical and biological processes that govern nature and working to improve the environment. This includes finding and designing solutions to problems like pollution, reusing waste and recycling. (pollution control analyst, environmental engineer or scientist, erosion control specialist, energy systems and maintenance technician)	3	4	19	19	20	19	6	6
3. Biology and Zoology: involve the study of living organisms (such as plants and animals) and the processes of life. This includes working with farm animals and in areas like nutrition and breeding. (biological technician, biological scientist, plant breeder, crop lab technician, animal scientist, geneticist, zoologist)	8	4	11	17	20	18	9	9
4. Veterinary Work: involves the science of preventing or treating disease in animals. (veterinary assistant, veterinarian, livestock producer, animal caretaker)	7	6	24	25	12	10	5	7
5. Mathematics: is the science of numbers and their operations. It involves computation, algorithms and theory used to solve problems and summarize data. (accountant, applied mathematician, economist, financial analyst, mathematician, statistician, market researcher, stock market analyst)	4	2	14	11	19	22	11	13
6. Medicine: involves maintaining health and preventing and treating disease. (physicianâ€™s assistant, nurse, doctor, nutritionist, emergency medical technician, physical therapist, dentist)	8	7	12	13	21	15	7	13
7. Earth Science: is the study of earth, including the air, land, and ocean. (geologist, weather forecaster, archaeologist, geoscientist)	5	4	13	18	20	17	10	9
8. Computer Science: consists of the development and testing of computer systems, designing new programs and helping others to use computers. (computer support specialist, computer programmer, computer and network technician, gaming designer, computer software engineer, information technology specialist)	4	4	11	9	19	19	14	16
9. Medical Science: involves researching human disease and working to find new solutions to human health problems. (clinical laboratory technologist, medical scientist, biomedical engineer, epidemiologist, pharmacologist)	7	7	22	18	13	10	6	13
10. Chemistry: uses math and experiments to search for new chemicals, and to study the structure of matter and how it behaves. (chemical technician, chemist, chemical engineer)	5	3	9	16	26	16	8	13
11. Energy: involves the study and generation of power, such as heat or electricity. (electrician, electrical engineer, heating, ventilation, and air conditioning (HVAC) technician, nuclear engineer, systems engineer, alternative energy systems installer or technician)	4	6	17	18	22	16	5	8
12. Engineering: involves designing, testing, and manufacturing new products (like machines, bridges, buildings, and electronics) through the use of math, science, and computers. (civil, industrial, agricultural, or mechanical engineers, welder, auto-mechanic, engineering technician, construction manager)	5	2	7	8	13	11	23	27

MORE ABOUT YOU				
What grade will you be in next year?				
Answer	Count			
6th grade	10			
7th grade	10			
8th grade	28			
Total	48			
Question	Yes	No	Not Sure	
Do you know any adults who work as scientists?	17	13	18	48
Do you know any adults who work as engineers?	20	14	14	48
Do you know any adults who work as mathematicians?	23	16	9	48
Do you know any adults who work as technologists?	23	16	9	48

Do you plan to go to college?

Answer	**PRE**	**Post**
Yes	44	46
No	0	0
Not Sure	4	2
Total	48	48

As a result of participating in iMAS Academy 2019...	Strongly Disagree	Disagree	Agree	Strongly Agree
I am more interested in careers that use science, engineering, technology, or mathematics.	2	8	12	24
I am more interested in science.	2	10	20	14
I am more interested in technology.	4	8	24	10
I am more interested in engineering.	3	6	16	21
I am more interested in mathematics.	3	11	19	13

Appendix D

Individual Student Survey Data

Qualitative Data Table Key

Student ID Number	#
Math - 1. Math has been my worst subject.	Math 1
Math - 2. I would consider choosing a career that uses math.	Math 2
Math - 3. Math is hard for me.	Math 3
Math - 4. I am the type of student to do well in math.	Math 4
Math - 5. I can handle most subjects well, but I cannot do a good job with math.	Math 5
Math - 6. I am sure I could do advanced work in math.	Math 6
Math - 7. I can get good grades in math.	Math 7
Math - 8. I am good at math.	Math 8
Science - 9. I am sure of myself when I do science.	Science 9
Science - 10. I would consider a career in science.	Science 10
Science - 11. I expect to use science when I get out of school.	Science 11
Science - 12. Knowing science will help me earn a living.	Science 12
Science - 13. I will need science for my future work.	Science 13
Science - 14. I know I can do well in science.	Science 14
Science - 15. Science will be important to me in my life's work.	Science 15
Science - 16. I can handle most subjects well, but I cannot do a good job with science.	Science 16
Science - 17. I am sure I could do advanced work in science.	Science 17
Engineering and Technology 18. I like to imagine creating new products.	Engineering/Tech 18
Engineering and Technology 19. If I learn engineering, then I can improve things that people use every day.	Engineering/Tech 19
Engineering and Technology 20. I am good at building and fixing things.	Engineering/Tech 20
Engineering and Technology 21. I am interested in what makes machines work.	Engineering/Tech 21
Engineering and Technology 22. Designing products or structures will be important for my future work.	Engineering/Tech 22
Engineering and Technology 23. I am curious about how electronics work.	Engineering/Tech 23
Engineering and Technology 24. I would like to use creativity and innovation in my future work.	Engineering/Tech 24
Engineering and Technology 25. Knowing how to use math and science together will allow me to invent useful things.	Engineering/Tech 25
Engineering and Technology 26. I believe I can be successful in a career in engineering.	Engineering/Tech 26
Your Future 1. Physics: is the study of basic laws governing the motion, energy, structure, and interactions of matter. This can include studying the nature of the universe. (aviation engineer, alternative energy technician, lab technician, physicist, astronomer)	Your Future 1

Your Future 2. Environmental Work: involves learning about physical and biological processes that govern nature and working to improve the environment. This includes finding and designing solutions to problems like pollution, reusing waste and recycling. (pollution control analyst, environmental engineer or scientist, erosion control specialist, energy systems and maintenance technician)	Your Future 2
Your Future 3. Biology and Zoology: involve the study of living organisms (such as plants and animals) and the processes of life. This includes working with farm animals and in areas like nutrition and breeding. (biological technician, biological scientist, plant breeder, crop lab technician, animal scientist, geneticist, zoologist)	Your Future 3
Your Future 4. Veterinary Work: involves the science of preventing or treating disease in animals. (veterinary assistant, veterinarian, livestock producer, animal caretaker)	Your Future 4
Your Future 5. Mathematics: is the science of numbers and their operations. It involves computation, algorithms and theory used to solve problems and summarize data. (accountant, applied mathematician, economist, financial analyst, mathematician, statistician, market researcher, stock market analyst)	Your Future 5
Your Future 6. Medicine: involves maintaining health and preventing and treating disease. (physician's assistant, nurse, doctor, nutritionist, emergency medical technician, physical therapist, dentist)	Your Future 6
Your Future 7. Earth Science: is the study of earth, including the air, land, and ocean. (geologist, weather forecaster, archaeologist, geoscientist)	Your Future 7
Your Future 8. Computer Science: consists of the development and testing of computer systems, designing new programs and helping others to use computers. (computer support specialist, computer programmer, computer and network technician, gaming designer, computer software engineer, information technology specialist)	Your Future 8
Your Future 9. Medical Science: involves researching human disease and working to find new solutions to human health problems. (clinical laboratory technologist, medical scientist, biomedical engineer, epidemiologist, pharmacologist)	Your Future 9
Your Future 10. Chemistry: uses math and experiments to search for new chemicals, and to study the structure of matter and how it behaves. (chemical technician, chemist, chemical engineer)	Your Future 10
Your Future 11. Energy: involves the study and generation of power, such as heat or electricity. (electrician, electrical engineer, heating, ventilation, and air conditioning (HVAC) technician, nuclear engineer, systems engineer, alternative energy systems installer or technician)	Your Future 11
Your Future 12. Engineering: involves designing, testing, and manufacturing new products (like machines, bridges, buildings, and electronics) through the use of math, science, and computers. (civil, industrial, agricultural, or mechanical engineers, welder, auto-mechanic, engineering technician, construction manager)	Your Future 12

	#	Math 1	Math 2	Math 3	Math 4	Math 5	Math 6	Math 7	Math 8
Pre	3	Agree	Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Disagree	Agree	Neither Agree nor Disagree
Post	3	Neither Agree nor Disagree	Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Agree	Neither Agree nor Disagree
Pre	4	Disagree	Agree	Disagree	Agree	Agree	Agree	Agree	Agree
Post	4	Strongly Disagree	Agree	Strongly Disagree	Strongly Agree	Strongly Disagree	Strongly Agree	Strongly Agree	Strongly Agree
Pre	7	Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Agree	Disagree	Disagree	Agree	Strongly Agree
Post	7	Strongly Disagree	Neither Agree nor Disagree	Disagree	Agree	Strongly Disagree	Strongly Disagree	Agree	Agree
Pre	12	Disagree	Neither Agree nor Disagree	Disagree	Agree	Disagree	Strongly Agree	Agree	Agree
Post	12	Strongly Disagree	Agree	Disagree	Agree	Disagree	Agree	Strongly Agree	Strongly Agree
Pre	13	Neither Agree nor Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Agree	Neither Agree nor Disagree	Agree	Neither Agree nor Disagree
Post	13	Disagree	Neither Agree nor Disagree	Disagree	Neither Agree nor Disagree	Disagree	Agree	Neither Agree nor Disagree	Neither Agree nor Disagree
Pre	14	Neither Agree nor Disagree	Agree	Agree	Disagree	Neither Agree nor Disagree	Disagree	Disagree	Disagree
Post	14	Disagree	Agree	Neither Agree nor Disagree	Neither Agree nor Disagree	Disagree	Disagree	Neither Agree nor Disagree	Agree
Pre	16	Disagree	Neither Agree nor Disagree	Strongly Disagree	Strongly Agree	Disagree	Agree	Strongly Agree	Agree
Post	16	Strongly Disagree	Neither Agree nor Disagree	Disagree	Agree	Strongly Disagree	Agree	Strongly Agree	Agree
Pre	17	Strongly Disagree	Agree	Strongly Disagree	Strongly Agree	Strongly Disagree	Agree	Strongly Agree	Strongly Agree
Post	17	Strongly Disagree	Neither Agree nor Disagree	Strongly Disagree	Strongly Agree	Strongly Disagree	Agree	Strongly Agree	Strongly Agree
Pre	19	Strongly Disagree	Agree	Disagree	Agree	Disagree	Strongly Agree	Strongly Agree	Strongly Agree
Post	19	Disagree	Neither Agree nor Disagree	Disagree	Strongly Agree	Strongly Disagree	Strongly Agree	Strongly Agree	Strongly Agree
Pre	20	Disagree	Agree	Disagree	Agree	Neither Agree nor Disagree	Neither Agree nor Disagree	Strongly Agree	Agree
Post	20	Strongly Disagree	Neither Agree nor Disagree	Disagree	Agree	Disagree	Neither Agree nor Disagree	Agree	Agree
Pre	22	Strongly Disagree	Strongly Agree	Disagree	Agree	Strongly Disagree	Strongly Disagree	Strongly Disagree	Strongly Agree
Post	22	Strongly Disagree	Strongly Agree	Strongly Disagree	Strongly Agree	Strongly Disagree	Agree	Strongly Agree	Strongly Agree
Pre	23	Neither Agree nor Disagree	Agree	Neither Agree nor Disagree	Agree	Neither Agree nor Disagree	Neither Agree nor Disagree	Agree	Neither Agree nor Disagree
Post	23	Disagree	Neither Agree nor Disagree	Disagree	Agree	Neither Agree nor Disagree	Agree	Agree	Agree
Pre	24	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree
Post	24	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree
Pre	25	Disagree	Neither Agree nor Disagree	Strongly Disagree	Strongly Agree	Strongly Disagree	Agree	Agree	Strongly Agree
Post	25	Strongly Disagree	Neither Agree nor Disagree	Disagree	Agree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
Pre	28	Disagree	Neither Agree nor Disagree	Disagree	Agree	Disagree	Neither Agree nor Disagree	Agree	Agree
Post	28	Neither Agree nor Disagree	Agree	Disagree	Agree	Disagree	Neither Agree nor Disagree	Agree	Neither Agree nor Disagree
Pre	29	Agree	Neither Agree nor Disagree	Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Strongly Agree	Agree	Agree
Post	29	Neither Agree nor Disagree	Neither Agree nor Disagree	Disagree	Neither Agree nor Disagree	Disagree	Agree	Agree	Agree
Pre	30	Neither Agree nor Disagree	Strongly Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Agree	Neither Agree nor Disagree
Post	30	Agree	Strongly Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree
Pre	31	Disagree	Disagree	Strongly Disagree	Strongly Agree	Strongly Disagree	Strongly Agree	Strongly Agree	Strongly Agree
Post	31	Strongly Disagree	Neither Agree nor Disagree	Strongly Disagree	Agree	Disagree	Strongly Disagree	Strongly Agree	Agree
Pre	33	Strongly Disagree	Agree	Strongly Disagree	Agree	Disagree	Neither Agree nor Disagree	Agree	Agree
Post	33	Strongly Disagree	Agree	Disagree	Agree	Strongly Disagree	Agree	Agree	Agree
Pre	34	Disagree	Neither Agree nor Disagree	Strongly Disagree	Agree	Strongly Disagree	Agree	Agree	Agree
Post	34	Strongly Disagree	Neither Agree nor Disagree	Strongly Disagree	Strongly Agree	Strongly Disagree	Strongly Agree	Strongly Agree	Strongly Agree
Pre	36	Disagree	Agree	Disagree	Disagree	Disagree	Agree	Agree	Agree
Post	36	Disagree	Agree	Disagree	Agree	Disagree	Agree	Agree	Agree
Pre	38	Strongly Disagree	Strongly Agree	Strongly Disagree	Strongly Agree	Disagree	Strongly Agree	Strongly Agree	Strongly Agree
Post	38	Strongly Disagree	Strongly Agree	Strongly Disagree	Strongly Agree	Disagree	Strongly Agree	Strongly Agree	Strongly Agree
Pre	39	Strongly Disagree	Strongly Agree	Strongly Disagree	Strongly Agree	Strongly Disagree	Strongly Agree	Strongly Agree	Strongly Agree
Post	39	Strongly Disagree	Strongly Agree	Strongly Disagree	Strongly Agree	Strongly Disagree	Strongly Agree	Strongly Agree	Strongly Agree
Pre	40	Strongly Disagree	Agree	Strongly Disagree	Strongly Agree	Strongly Disagree	Agree	Strongly Agree	Strongly Agree
Post	40	Strongly Disagree	Strongly Agree	Strongly Disagree	Strongly Agree	Strongly Disagree	Strongly Agree	Strongly Agree	Strongly Agree
Pre	41	Strongly Disagree	Neither Agree nor Disagree	Strongly Disagree	Strongly Agree	Strongly Disagree	Strongly Agree	Strongly Agree	Strongly Agree
Post	41	Strongly Disagree	Neither Agree nor Disagree	Strongly Disagree	Strongly Agree	Strongly Disagree	Strongly Agree	Strongly Agree	Strongly Agree

	#	Math 1	Math 2	Math 3	Math 4	Math 5	Math 6	Math 7	Math 8
Pre	42	Strongly Disagree	Agree	Neither Agree nor Disagree	Strongly Agree	Strongly Disagree	Strongly Agree	Strongly Agree	Strongly Agree
Post	42	Strongly Disagree	Strongly Agree	Strongly Disagree	Strongly Agree	Strongly Disagree	Strongly Agree	Strongly Agree	Strongly Agree
Pre	43	Strongly Disagree	Agree	Disagree	Agree	Disagree	Agree	Agree	Neither Agree nor Disagree
Post	43	Disagree	Agree	Disagree	Agree	Disagree	Agree	Agree	Neither Agree nor Disagree
Pre	44	Strongly Disagree	Strongly Agree	Strongly Disagree	Strongly Agree	Strongly Disagree	Agree	Strongly Agree	Agree
Post	44	Strongly Disagree	Strongly Agree	Strongly Disagree	Strongly Agree	Strongly Disagree	Strongly Agree	Strongly Agree	Strongly Agree
Pre	45	Strongly Disagree	Agree	Strongly Disagree	Strongly Agree	Disagree	Strongly Agree	Strongly Agree	Strongly Agree
Post	45	Strongly Disagree	Strongly Agree	Strongly Disagree	Agree	Strongly Disagree	Agree	Strongly Agree	Agree
Pre	46	Disagree	Agree	Disagree	Neither Agree nor Disagree	Disagree	Neither Agree nor Disagree	Agree	Agree
Post	46	Disagree	Strongly Agree	Disagree	Agree	Disagree	Neither Agree nor Disagree	Strongly Agree	Agree
Pre	47	Strongly Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Strongly Agree	Strongly Disagree	Strongly Agree	Strongly Agree	Strongly Agree
Post	47	Strongly Disagree	Neither Agree nor Disagree	Strongly Disagree	Strongly Agree	Strongly Disagree	Strongly Agree	Strongly Agree	Strongly Agree
Pre	51	Disagree	Agree	Neither Agree nor Disagree	Neither Agree nor Disagree	Disagree	Agree	Agree	Agree
Post	51	Neither Agree nor Disagree	Neither Agree nor Disagree	Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Agree	Agree	Agree
Pre	52	Strongly Disagree	Strongly Agree	Strongly Disagree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree
Post	52	Strongly Disagree	Strongly Disagree	Strongly Agree	Strongly Disagree	Strongly Disagree	Strongly Disagree	Strongly Disagree	Strongly Disagree
Pre	54	Disagree	Disagree	Disagree	Agree	Disagree	Neither Agree nor Disagree	Agree	Agree
Post	54	Disagree	Strongly Disagree	Neither Agree nor Disagree	Agree	Disagree	Neither Agree nor Disagree	Agree	Neither Agree nor Disagree
Pre	55	Disagree	Agree	Disagree	Agree	Disagree	Agree	Agree	Agree
Post	55	Disagree	Agree	Disagree	Neither Agree nor Disagree	Strongly Disagree	Agree	Agree	Agree
Pre	56	Strongly Disagree	Strongly Agree	Strongly Disagree	Strongly Agree	Strongly Disagree	Agree	Strongly Agree	Strongly Agree
Post	56	Strongly Disagree	Neither Agree nor Disagree	Strongly Disagree	Strongly Agree	Strongly Disagree	Strongly Agree	Strongly Agree	Strongly Agree
Pre	57	Neither Agree nor Disagree	Strongly Agree	Agree	Agree	Disagree	Agree	Strongly Agree	Agree
Post	57	Disagree	Agree	Agree	Agree	Strongly Disagree	Strongly Agree	Agree	Agree
Pre	59	Agree	Neither Agree nor Disagree	Agree	Neither Agree nor Disagree	Agree	Disagree	Agree	Neither Agree nor Disagree
Post	59	Neither Agree nor Disagree	Neither Agree nor Disagree	Agree	Neither Agree nor Disagree	Strongly Agree	Neither Agree nor Disagree	Agree	Neither Agree nor Disagree
Pre	60	Strongly Disagree	Neither Agree nor Disagree	Strongly Disagree	Strongly Agree	Strongly Disagree	Agree	Agree	Strongly Agree
Post	60	Strongly Disagree	Neither Agree nor Disagree	Strongly Disagree	Agree	Strongly Disagree	Disagree	Disagree	Disagree
Pre	63	Disagree	Neither Agree nor Disagree	Strongly Disagree	Agree	Disagree	Agree	Agree	Strongly Agree
Post	63	Strongly Disagree	Neither Agree nor Disagree	Strongly Disagree	Strongly Agree	Strongly Disagree	Agree	Strongly Agree	Strongly Agree
Pre	64	Disagree	Neither Agree nor Disagree	Disagree	Disagree	Neither Agree nor Disagree	Agree	Agree	Agree
Post	64	Disagree	Neither Agree nor Disagree	Disagree	Agree	Neither Agree nor Disagree	Agree	Agree	Agree
Pre	65	Strongly Disagree	Strongly Agree	Strongly Disagree	Strongly Agree	Disagree	Agree	Agree	Strongly Agree
Post	65	Strongly Disagree	Strongly Agree	Strongly Disagree	Strongly Agree	Disagree	Strongly Agree	Strongly Agree	Agree
Pre	66	Agree	Neither Agree nor Disagree	Agree	Agree	Neither Agree nor Disagree	Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree
Post	66	Neither Agree nor Disagree	Agree	Agree	Neither Agree nor Disagree	Agree	Agree	Neither Agree nor Disagree	Disagree
Pre	67	Strongly Disagree	Neither Agree nor Disagree	Disagree	Agree	Disagree	Agree	Strongly Agree	Strongly Agree
Post	67	Disagree	Agree	Disagree	Agree	Disagree	Agree	Agree	Agree
Pre	68	Disagree	Neither Agree nor Disagree	Disagree	Agree	Disagree	Neither Agree nor Disagree	Agree	Agree
Post	68	Disagree	Neither Agree nor Disagree	Disagree	Agree	Disagree	Agree	Strongly Agree	Agree
Pre	69	Disagree	Agree	Strongly Disagree	Strongly Agree	Strongly Disagree	Strongly Agree	Strongly Agree	Strongly Agree
Post	69	Strongly Disagree	Agree	Strongly Disagree	Agree	Strongly Disagree	Agree	Strongly Agree	Strongly Agree
Pre	70	Disagree	Neither Agree nor Disagree	Strongly Disagree	Neither Agree nor Disagree	Strongly Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Agree
Post	70	Strongly Disagree	Agree	Strongly Disagree	Agree	Strongly Disagree	Strongly Agree	Neither Agree nor Disagree	Strongly Agree
Pre	29536	Strongly Disagree	Neither Agree nor Disagree	Strongly Disagree	Strongly Agree	Strongly Disagree	Agree	Strongly Agree	Strongly Agree
Post	29536	Strongly Disagree	Neither Agree nor Disagree	Strongly Disagree	Agree	Neither Agree nor Disagree	Agree	Strongly Agree	Strongly Agree

	#	Science 9	Science 10	Science 11	Science 12	Science 13	Science 14	Science 15	Science 16	Science 17
Pre	3	Agree	Neither Agree nor Disagree	Neither Agree nor Disagree	Agree	Neither Agree nor Disagree	Agree	Neither Agree nor Disagree	Disagree	Agree
Post	3	Agree	Agree	Strongly Agree	Agree	Neither Agree nor Disagree	Agree	Neither Agree nor Disagree	Disagree	Strongly Agree
Pre	4	Agree	Neither Agree nor Disagree	Agree	Neither Agree nor Disagree	Agree	Agree	Neither Agree nor Disagree	Strongly Disagree	Strongly Agree
Post	4	Strongly Agree	Strongly Agree	Agree	Agree	Agree	Strongly Agree	Agree	Strongly Disagree	Strongly Agree
Pre	7	Agree	Neither Agree nor Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Strongly Agree	Neither Agree nor Disagree	Strongly Disagree	Disagree
Post	7	Neither Agree nor Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Pre	12	Disagree	Disagree	Disagree	Neither Agree nor Disagree	Strongly Disagree	Neither Agree nor Disagree	Disagree	Agree	Neither Agree nor Disagree
Post	12	Disagree	Disagree	Disagree	Neither Agree nor Disagree	Strongly Disagree	Neither Agree nor Disagree	Strongly Disagree	Agree	Disagree
Pre	13	Agree	Neither Agree nor Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Agree	Neither Agree nor Disagree	Disagree	Agree
Post	13	Neither Agree nor Disagree	Agree	Agree	Agree	Agree	Neither Agree nor Disagree	Agree	Disagree	Agree
Pre	14	Agree	Agree	Agree	Disagree	Agree	Agree	Agree	Disagree	Strongly Disagree
Post	14	Neither Agree nor Disagree	Agree	Neither Agree nor Disagree	Neither Agree nor Disagree	Agree	Neither Agree nor Disagree	Agree	Disagree	Neither Agree nor Disagree
Pre	16	Agree	Neither Agree nor Disagree	Agree	Neither Agree nor Disagree	Neither Agree nor Disagree	Agree	Neither Agree nor Disagree	Strongly Disagree	Agree
Post	16	Agree	Agree	Agree	Agree	Agree	Agree	Agree	Strongly Disagree	Agree
Pre	17	Agree	Agree	Agree	Agree	Neither Agree nor Disagree	Agree	Neither Agree nor Disagree	Strongly Disagree	Agree
Post	17	Agree	Neither Agree nor Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Agree	Neither Agree nor Disagree	Strongly Disagree	Neither Agree nor Disagree
Pre	19	Agree	Agree	Strongly Agree	Agree	Neither Agree nor Disagree	Strongly Agree	Agree	Disagree	Strongly Agree
Post	19	Strongly Agree	Strongly Agree	Agree	Agree	Strongly Agree	Strongly Agree	Agree	Disagree	Strongly Agree
Pre	20	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Disagree	Strongly Agree
Post	20	Agree	Agree	Agree	Agree	Agree	Agree	Agree	Disagree	Agree
Pre	22	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Disagree	Strongly Agree
Post	22	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Disagree	Strongly Agree
Pre	23	Agree	Agree	Disagree	Neither Agree nor Disagree	Disagree	Agree	Disagree	Disagree	Agree
Post	23	Agree	Neither Agree nor Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Agree	Neither Agree nor Disagree	Neither Agree nor Disagree	Agree
Pre	24	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree
Post	24	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree
Pre	25	Neither Agree nor Disagree	Strongly Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Strongly Disagree	Strongly Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Strongly Disagree
Post	25	Neither Agree nor Disagree	Agree	Agree	Agree	Agree	Agree	Neither Agree nor Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree
Pre	28	Disagree	Neither Agree nor Disagree	Disagree	Agree	Neither Agree nor Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Agree	Neither Agree nor Disagree
Post	28	Disagree	Strongly Disagree	Neither Agree nor Disagree	Disagree	Disagree	Neither Agree nor Disagree	Disagree	Agree	Neither Agree nor Disagree
Pre	29	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Disagree	Strongly Agree
Post	29	Agree	Agree	Agree	Agree	Agree	Agree	Agree	Disagree	Agree
Pre	30	Agree	Agree	Neither Agree nor Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Agree	Neither Agree nor Disagree	Disagree	Agree
Post	30	Agree	Neither Agree nor Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Agree	Neither Agree nor Disagree	Disagree	Neither Agree nor Disagree
Pre	31	Agree	Neither Agree nor Disagree	Agree	Strongly Agree	Strongly Agree	Agree	Agree	Strongly Disagree	Agree
Post	31	Agree	Agree	Agree	Strongly Agree	Agree	Strongly Agree	Neither Agree nor Disagree	Disagree	Strongly Agree
Pre	33	Neither Agree nor Disagree	Disagree	Disagree	Agree	Neither Agree nor Disagree	Agree	Neither Agree nor Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree
Post	33	Agree	Disagree	Disagree	Agree	Neither Agree nor Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree
Pre	34	Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Disagree	Strongly Agree
Post	34	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Disagree	Strongly Agree
Pre	36	Neither Agree nor Disagree	Neither Agree nor Disagree	Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree
Post	36	Neither Agree nor Disagree	Neither Agree nor Disagree	Agree	Agree	Neither Agree nor Disagree	Neither Agree nor Disagree	Agree	Neither Agree nor Disagree	Agree
Pre	38	Agree	Neither Agree nor Disagree	Disagree	Agree	Agree	Agree	Agree	Disagree	Agree
Post	38	Agree	Neither Agree nor Disagree	Neither Agree nor Disagree	Agree	Agree	Agree	Agree	Agree	Neither Agree nor Disagree
Pre	39	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Disagree	Strongly Agree
Post	39	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Disagree	Strongly Agree
Pre	40	Strongly Agree	Strongly Agree	Strongly Agree	Agree	Agree	Strongly Agree	Agree	Strongly Disagree	Agree
Post	40	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Agree	Strongly Disagree	Strongly Agree
Pre	41	Strongly Agree	Neither Agree nor Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Strongly Agree	Neither Agree nor Disagree	Strongly Disagree	Strongly Agree
Post	41	Agree	Neither Agree nor Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Strongly Agree	Neither Agree nor Disagree	Strongly Disagree	Strongly Agree

	#	Science 9	Science 10	Science 11	Science 12	Science 13	Science 14	Science 15	Science 16	Science 17
Pre	**42**	Neither Agree nor Disagree	Agree	Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Post	**42**	Neither Agree nor Disagree	Agree	Agree	Agree	Neither Agree nor Disagree	Agree	Neither Agree nor Disagree	Strongly Disagree	Disagree
Pre	**43**	Neither Agree nor Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Agree	Agree	Agree	Agree	Disagree	Agree
Post	**43**	Neither Agree nor Disagree	Neither Agree nor Disagree	Agree	Neither Agree nor Disagree	Agree	Agree	Neither Agree nor Disagree	Neither Agree nor Disagree	Agree
Pre	**44**	Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Agree	Strongly Agree	Strongly Disagree	Agree
Post	**44**	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Disagree	Strongly Agree
Pre	**45**	Agree	Disagree	Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Agree	Neither Agree nor Disagree
Post	**45**	Neither Agree nor Disagree	Agree	Agree	Strongly Agree	Strongly Agree	Agree	Strongly Agree	Neither Agree nor Disagree	Neither Agree nor Disagree
Pre	**46**	Neither Agree nor Disagree	Agree	Neither Agree nor Disagree	Neither Agree nor Disagree	Agree	Neither Agree nor Disagree	Neither Agree nor Disagree	Disagree	Neither Agree nor Disagree
Post	**46**	Agree	Agree	Strongly Agree	Strongly Agree	Strongly Agree	Agree	Strongly Agree	Disagree	Agree
Pre	**47**	Neither Agree nor Disagree	Disagree	Disagree	Agree	Strongly Agree	Neither Agree nor Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree
Post	**47**	Disagree	Disagree	Disagree	Strongly Agree	Strongly Agree	Disagree	Agree	Neither Agree nor Disagree	Disagree
Pre	**51**	Agree	Strongly Agree	Strongly Agree	Agree	Neither Agree nor Disagree	Agree	Neither Agree nor Disagree	Disagree	Agree
Post	**51**	Strongly Agree	Neither Agree nor Disagree	Agree	Neither Agree nor Disagree	Neither Agree nor Disagree	Strongly Agree	Agree	Disagree	Agree
Pre	**52**	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Disagree	Strongly Agree
Post	**52**	Strongly Disagree	Strongly Disagree	Strongly Disagree	Strongly Disagree	Strongly Disagree	Strongly Disagree	Strongly Disagree	Strongly Agree	Strongly Disagree
Pre	**54**	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Disagree	Agree
Post	**54**	Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Disagree	Strongly Agree
Pre	**55**	Agree	Agree	Agree	Agree	Agree	Agree	Agree	Disagree	Agree
Post	**55**	Agree	Agree	Agree	Agree	Agree	Agree	Agree	Agree	Agree
Pre	**56**	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Disagree	Agree
Post	**56**	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Disagree	Strongly Agree
Pre	**57**	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Agree	Strongly Disagree	Strongly Agree
Post	**57**	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Agree	Strongly Disagree	Strongly Agree
Pre	**59**	Strongly Agree	Neither Agree nor Disagree	Agree	Neither Agree nor Disagree	Neither Agree nor Disagree	Strongly Agree	Neither Agree nor Disagree	Disagree	Strongly Agree
Post	**59**	Agree	Agree	Agree	Agree	Agree	Agree	Agree	Agree	Agree
Pre	**60**	Agree	Neither Agree nor Disagree	Disagree	Disagree	Disagree	Agree	Disagree	Disagree	Neither Agree nor Disagree
Post	**60**	Agree	Neither Agree nor Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Agree	Neither Agree nor Disagree	Disagree	Agree
Pre	**63**	Agree	Neither Agree nor Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Agree	Neither Agree nor Disagree	Disagree	Agree
Post	**63**	Agree	Neither Agree nor Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Agree	Neither Agree nor Disagree	Strongly Disagree	Strongly Agree
Pre	**64**	Disagree	Disagree	Neither Agree nor Disagree	Agree	Neither Agree nor Disagree	Neither Agree nor Disagree	Agree	Neither Agree nor Disagree	Agree
Post	**64**	Neither Agree nor Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Agree	Neither Agree nor Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Agree	Agree
Pre	**65**	Agree	Agree	Agree	Neither Agree nor Disagree	Strongly Agree	Agree	Agree	Strongly Disagree	Agree
Post	**65**	Agree	Agree	Strongly Agree	Agree	Agree	Agree	Agree	Strongly Disagree	Agree
Pre	**66**	Agree	Agree	Agree	Strongly Agree	Strongly Agree	Agree	Strongly Agree	Disagree	Strongly Agree
Post	**66**	Agree	Agree	Agree	Agree	Agree	Agree	Neither Agree nor Disagree	Disagree	Agree
Pre	**67**	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Agree	Strongly Agree	Agree	Strongly Disagree	Agree
Post	**67**	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Agree	Agree	Agree	Strongly Disagree	Agree
Pre	**68**	Agree	Agree	Agree	Agree	Agree	Agree	Agree	Neither Agree nor Disagree	Neither Agree nor Disagree
Post	**68**	Agree	Agree	Agree	Agree	Agree	Agree	Agree	Disagree	Agree
Pre	**69**	Strongly Agree	Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Disagree	Strongly Agree
Post	**69**	Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Disagree	Strongly Agree
Pre	**70**	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	Strongly Agree	Neither Agree nor Disagree	Strongly Agree	Disagree	Agree
Post	**70**	Neither Agree nor Disagree	Agree	Strongly Agree	Strongly Agree	Strongly Agree	Agree	Strongly Agree	Neither Agree nor Disagree	Agree
Pre	**29536**	Neither Agree nor Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Agree	Neither Agree nor Disagree	Strongly Disagree	Neither Agree nor Disagree
Post	**29536**	Neither Agree nor Disagree	Neither Agree nor Disagree	Disagree	Neither Agree nor Disagree	Disagree	Neither Agree nor Disagree	Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree

	#	Engineering/Tech 18	Engineering/Tech 19	Engineering/Tech 20	Engineering/Tech 21	Engineering/Tech 22	Engineering/Tech 23	Engineering/Tech 24	Engineering/Tech 25	Engineering/Tech 26
Pre	3	Neither Agree nor Disagree	Agree	Neither Agree nor Disagree	Agree	Neither Agree nor Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree
Post	3	Neither Agree nor Disagree	Agree	Neither Agree nor Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Agree	Neither Agree nor Disagree	Agree	Neither Agree nor Disagree
Pre	4	Agree	Agree	Agree	Agree	Agree	Agree	Agree	Agree	Agree
Post	4	Agree	Agree	Strongly Agree	Agree	Agree	Disagree	Agree	Strongly Agree	Strongly Agree
Pre	7	Agree	Agree	Strongly Agree	Agree	Neither Agree nor Disagree	Strongly Agree	Neither Agree nor Disagree	Agree	Neither Agree nor Disagree
Post	7	Agree	Agree	Agree	Strongly Agree	Neither Agree nor Disagree	Strongly Agree	Neither Agree nor Disagree	Agree	Neither Agree nor Disagree
Pre	12	Agree	Neither Agree nor Disagree	Agree	Strongly Agree	Neither Agree nor Disagree	Strongly Agree	Agree	Neither Agree nor Disagree	Neither Agree nor Disagree
Post	12	Agree	Agree	Agree	Agree	Neither Agree nor Disagree	Agree	Agree	Neither Agree nor Disagree	Neither Agree nor Disagree
Pre	13	Neither Agree nor Disagree	Agree	Neither Agree nor Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Agree	Agree	Agree	Agree
Post	13	Neither Agree nor Disagree	Agree	Neither Agree nor Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Agree	Agree	Agree
Pre	14	Strongly Disagree	Disagree	Disagree	Disagree	Agree	Disagree	Neither Agree nor Disagree	Disagree	Neither Agree nor Disagree
Post	14	Disagree	Neither Agree nor Disagree	Agree	Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Disagree	Disagree	Disagree
Pre	16	Neither Agree nor Disagree	Agree	Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Disagree	Agree	Agree	Neither Agree nor Disagree
Post	16	Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Disagree	Disagree	Disagree	Agree	Neither Agree nor Disagree	Neither Agree nor Disagree
Pre	17	Neither Agree nor Disagree	Neither Agree nor Disagree	Agree	Agree	Neither Agree nor Disagree	Agree	Neither Agree nor Disagree	Agree	Agree
Post	17	Agree	Agree	Agree	Agree	Neither Agree nor Disagree	Agree	Agree	Agree	Agree
Pre	19	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree
Post	19	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree
Pre	20	Disagree	Disagree	Disagree	Disagree	Disagree	Disagree	Disagree	Neither Agree nor Disagree	Disagree
Post	20	Neither Agree nor Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree
Pre	22	Strongly Agree	Agree	Strongly Disagree	Strongly Disagree	Strongly Disagree	Agree	Strongly Disagree	Strongly Agree	Neither Agree nor Disagree
Post	22	Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Disagree	Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Agree	Disagree
Pre	23	Agree	Agree	Neither Agree nor Disagree	Agree	Neither Agree nor Disagree	Agree	Agree	Agree	Agree
Post	23	Agree	Neither Agree nor Disagree	Agree	Agree	Neither Agree nor Disagree	Agree	Agree	Neither Agree nor Disagree	Agree
Pre	24	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree
Post	24	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree
Pre	25	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree
Post	25	Strongly Agree	Strongly Agree	Strongly Agree	Agree	Strongly Agree	Strongly Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Agree
Pre	28	Agree	Agree	Disagree	Agree	Neither Agree nor Disagree	Agree	Agree	Agree	Neither Agree nor Disagree
Post	28	Agree	Agree	Neither Agree nor Disagree	Agree	Neither Agree nor Disagree	Agree	Neither Agree nor Disagree	Agree	Neither Agree nor Disagree
Pre	29	Agree	Strongly Agree	Agree	Agree	Agree	Agree	Neither Agree nor Disagree	Neither Agree nor Disagree	Agree
Post	29	Agree	Agree	Agree	Agree	Neither Agree nor Disagree	Agree	Agree	Agree	Neither Agree nor Disagree
Pre	30	Neither Agree nor Disagree	Disagree	Disagree	Disagree	Disagree	Disagree	Neither Agree nor Disagree	Disagree	Disagree
Post	30	Disagree	Neither Agree nor Disagree	Disagree	Disagree	Disagree	Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Disagree
Pre	31	Strongly Agree	Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree
Post	31	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree
Pre	33	Agree	Neither Agree nor Disagree	Neither Agree nor Disagree	Agree	Agree	Agree	Strongly Agree	Agree	Agree
Post	33	Agree	Neither Agree nor Disagree	Neither Agree nor Disagree	Agree	Agree	Agree	Agree	Agree	Agree
Pre	34	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Agree	Strongly Agree	Strongly Agree
Post	34	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Neither Agree nor Disagree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree
Pre	36	Agree	Agree	Agree	Agree	Agree	Agree	Agree	Agree	Agree
Post	36	Agree	Agree	Agree	Agree	Agree	Agree	Agree	Agree	Agree
Pre	38	Agree	Agree	Agree	Agree	Agree	Agree	Agree	Strongly Agree	Agree
Post	38	Agree	Agree	Agree	Agree	Agree	Agree	Agree	Agree	Agree
Pre	39	Agree	Strongly Agree	Agree	Strongly Agree	Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree
Post	39	Agree	Strongly Agree	Agree	Strongly Agree	Agree	Strongly Agree	Agree	Strongly Agree	Strongly Agree
Pre	40	Neither Agree nor Disagree	Strongly Agree	Strongly Agree	Strongly Agree	Agree	Strongly Agree	Agree	Agree	Strongly Agree
Post	40	Neither Agree nor Disagree	Strongly Agree	Strongly Agree	Strongly Agree	Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree
Pre	41	Strongly Agree	Strongly Agree	Agree	Strongly Agree	Neither Agree nor Disagree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree
Post	41	Agree	Strongly Agree	Agree	Strongly Agree	Neither Agree nor Disagree	Strongly Agree	Strongly Agree	Agree	Neither Agree nor Disagree

	#	Engineering/Tech 18	Engineering/Tech 19	Engineering/Tech 20	Engineering/Tech 21	Engineering/Tech 22	Engineering/Tech 23	Engineering/Tech 24	Engineering/Tech 25	Engineering/Tech 26
Pre	42	Strongly Agree	Strongly Agree	Neither Agree nor Disagree	Strongly Agree	Neither Agree nor Disagree	Strongly Agree	Agree	Strongly Agree	Strongly Agree
Post	42	Strongly Agree	Strongly Agree	Neither Agree nor Disagree	Strongly Agree	Neither Agree nor Disagree	Strongly Agree	Agree	Strongly Agree	Strongly Agree
Pre	43	Agree	Agree	Neither Agree nor Disagree	Disagree	Agree	Neither Agree nor Disagree	Agree	Agree	Agree
Post	43	Disagree	Neither Agree nor Disagree	Agree	Agree	Agree	Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Disagree
Pre	44	Strongly Agree	Agree	Agree	Strongly Agree	Strongly Agree	Agree	Agree	Strongly Agree	Agree
Post	44	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree
Pre	45	Strongly Agree	Strongly Agree	Agree	Neither Agree nor Disagree	Agree	Strongly Agree	Strongly Agree	Agree	Agree
Post	45	Strongly Agree	Strongly Agree	Agree	Neither Agree nor Disagree	Strongly Agree	Neither Agree nor Disagree	Strongly Agree	Strongly Agree	Neither Agree nor Disagree
Pre	46	Strongly Agree	Strongly Agree	Neither Agree nor Disagree	Agree	Neither Agree nor Disagree	Strongly Agree	Strongly Agree	Strongly Agree	Agree
Post	46	Neither Agree nor Disagree	Agree	Neither Agree nor Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Agree	Agree	Neither Agree nor Disagree	Neither Agree nor Disagree
Pre	47	Agree	Strongly Agree	Neither Agree nor Disagree	Agree	Agree	Agree	Strongly Agree	Strongly Agree	Agree
Post	47	Agree	Strongly Agree	Neither Agree nor Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Strongly Agree	Neither Agree nor Disagree	Strongly Agree	Agree
Pre	51	Agree	Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Agree	Strongly Agree	Agree
Post	51	Strongly Agree	Agree	Strongly Agree	Strongly Agree	Agree	Agree	Agree	Strongly Agree	Strongly Agree
Pre	52	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree
Post	52	Strongly Disagree	Strongly Disagree	Strongly Disagree	Strongly Disagree	Strongly Disagree	Strongly Disagree	Strongly Disagree	Strongly Disagree	Strongly Disagree
Pre	54	Strongly Agree	Agree	Agree	Agree	Neither Agree nor Disagree	Agree	Agree	Agree	Neither Agree nor Disagree
Post	54	Agree	Neither Agree nor Disagree	Agree	Neither Agree nor Disagree	Neither Agree nor Disagree	Agree	Agree	Agree	Neither Agree nor Disagree
Pre	55	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree
Post	55	Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Agree	Strongly Agree	Strongly Agree	Strongly Agree
Pre	56	Neither Agree nor Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Disagree	Disagree	Disagree	Agree	Strongly Agree	Disagree
Post	56	Neither Agree nor Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Strongly Disagree	Neither Agree nor Disagree	Strongly Disagree	Neither Agree nor Disagree	Strongly Agree	Neither Agree nor Disagree
Pre	57	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree
Post	57	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Agree	Strongly Agree	Strongly Agree	Strongly Agree
Pre	59	Strongly Agree	Agree	Strongly Agree	Strongly Agree	Strongly Agree	Neither Agree nor Disagree	Strongly Agree	Agree	Strongly Agree
Post	59	Strongly Agree	Strongly Agree	Agree	Strongly Agree	Strongly Agree	Neither Agree nor Disagree	Agree	Agree	Strongly Agree
Pre	60	Agree	Strongly Agree	Neither Agree nor Disagree	Agree	Strongly Agree	Strongly Agree	Strongly Agree	Agree	Strongly Agree
Post	60	Strongly Agree	Agree	Neither Agree nor Disagree	Strongly Agree	Agree	Strongly Agree	Agree	Agree	Agree
Pre	63	Agree	Agree	Agree	Neither Agree nor Disagree	Agree	Neither Agree nor Disagree	Agree	Agree	Agree
Post	63	Agree	Agree	Neither Agree nor Disagree	Neither Agree nor Disagree	Agree	Agree	Agree	Agree	Agree
Pre	64	Agree	Disagree	Agree	Agree	Neither Agree nor Disagree	Neither Agree nor Disagree	Agree	Agree	Neither Agree nor Disagree
Post	64	Agree	Agree	Strongly Agree	Agree	Neither Agree nor Disagree	Agree	Neither Agree nor Disagree	Agree	Neither Agree nor Disagree
Pre	65	Strongly Agree	Strongly Agree	Agree	Agree	Agree	Neither Agree nor Disagree	Agree	Strongly Agree	Agree
Post	65	Agree	Strongly Agree	Agree	Agree	Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree
Pre	66	Neither Agree nor Disagree	Disagree	Agree	Neither Agree nor Disagree	Disagree	Neither Agree nor Disagree	Agree	Disagree	Disagree
Post	66	Disagree	Disagree	Neither Agree nor Disagree	Disagree	Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Agree	Agree
Pre	67	Neither Agree nor Disagree	Agree	Agree	Agree	Neither Agree nor Disagree	Agree	Agree	Agree	Agree
Post	67	Neither Agree nor Disagree	Agree	Agree	Agree	Neither Agree nor Disagree	Agree	Agree	Agree	Agree
Pre	68	Agree	Agree	Neither Agree nor Disagree	Agree	Disagree	Agree	Neither Agree nor Disagree	Agree	Neither Agree nor Disagree
Post	68	Neither Agree nor Disagree	Agree	Agree	Agree	Neither Agree nor Disagree	Agree	Neither Agree nor Disagree	Agree	Neither Agree nor Disagree
Pre	69	Agree	Agree	Agree	Agree	Strongly Agree	Agree	Agree	Neither Agree nor Disagree	Agree
Post	69	Agree	Agree	Agree	Agree	Agree	Agree	Agree	Agree	Agree
Pre	70	Agree	Agree	Disagree	Neither Agree nor Disagree	Agree	Strongly Disagree	Neither Agree nor Disagree	Agree	Strongly Disagree
Post	70	Agree	Strongly Agree	Agree	Agree	Neither Agree nor Disagree	Strongly Disagree	Neither Agree nor Disagree	Strongly Agree	Strongly Agree
Pre	29536	Neither Agree nor Disagree	Neither Agree nor Disagree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree
Post	29536	Strongly Agree	Neither Agree nor Disagree	Strongly Agree	Neither Agree nor Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	Strongly Agree	Neither Agree nor Disagree

	#	Your Future 1	Your Future 2	Your Future 3	Your Future 4	Your Future 5	Your Future 6	Your Future 7	Your Future 8	Your Future 9	Your Future 10	Your Future 11	Your Future 12
Pre	3	Not So Interested	Not So Interested	Interested	Interested	Not So Interested	Interested	Interested	Interested	Interested	Not So Interested	Interested	Interested
Post	3	Not So Interested	Interested	Interested	Not So Interested	Interested	Interested	Interested	Very Interested	Very Interested	Very Interested	Interested	Very Interested
Pre	4	Interested	Interested	Not So Interested	Not So Interested	Interested	Interested	Interested	Not So Interested	Not So Interested	Interested	Not So Interested	Not So Interested
Post	4	Interested	Interested	Not So Interested	Not So Interested	Interested	Interested	Interested	Interested	Interested	Interested	Not So Interested	Not So Interested
Pre	7	Interested	Very Interested	Interested	Not So Interested	Not So Interested	Not at all Interested	Interested	Very Interested	Not at all Interested	Interested	Interested	Very Interested
Post	7	Not So Interested	Very Interested	Interested	Not So Interested	Interested	Not at all Interested	Interested	Interested	Not at all Interested	Interested	Interested	Very Interested
Pre	12	Interested	Not So Interested	Not at all Interested	Not So Interested	Interested	Not So Interested	Not at all Interested	Very Interested	Not So Interested	Interested	Interested	Very Interested
Post	12	Interested	Not So Interested	Not So Interested	Not So Interested	Very Interested	Not So Interested	Not So Interested	Interested	Not So Interested	Not So Interested	Interested	Interested
Pre	13	Not So Interested	Interested	Interested	Very Interested	Not So Interested	Very Interested	Very Interested	Not So Interested	Interested	Interested	Not So Interested	Interested
Post	13	Not So Interested	Interested	Very Interested	Very Interested	Not So Interested	Very Interested	Interested	Interested	Very Interested	Interested	Not So Interested	Not So Interested
Pre	14	Not So Interested	Not So Interested	Interested	Interested	Interested	Interested	Interested	Interested	Interested	Interested	Not So Interested	Interested
Post	14	Interested	Not So Interested	Not So Interested	Not So Interested	Interested	Interested	Interested	Not So Interested	Interested	Not So Interested	Not So Interested	Interested
Pre	16	Not So Interested	Interested	Interested	Not So Interested	Not So Interested	Interested	Interested	Not at all Interested	Not So Interested	Not So Interested	Not So Interested	Interested
Post	16	Not So Interested	Not So Interested	Interested	Not So Interested	Not So Interested	Not So Interested	Interested	Interested	Not So Interested	Interested	Not So Interested	Not So Interested
Pre	17	Not So Interested	Not So Interested	Not So Interested	Not So Interested	Very Interested	Not So Interested	Interested	Very Interested	Not So Interested	Not So Interested	Not So Interested	Very Interested
Post	17	Not So Interested	Not So Interested	Not So Interested	Not So Interested	Interested	Not So Interested	Not So Interested	Interested	Not So Interested	Not So Interested	Not So Interested	Very Interested
Pre	19	Very Interested	Interested	Not So Interested	Not at all Interested	Not So Interested	Interested	Interested	Not So Interested	Interested	Interested	Very Interested	Very Interested
Post	19	Interested	Interested	Not So Interested	Not at all Interested	Not So Interested	Not So Interested	Not So Interested	Interested	Not So Interested	Interested	Interested	Very Interested
Pre	20	Interested	Interested	Interested	Interested	Not So Interested	Interested	Interested	Not at all Interested	Interested	Very Interested	Interested	Not So Interested
Post	20	Very Interested	Very Interested	Very Interested	Interested	Interested	Very Interested	Very Interested	Not So Interested	Very Interested	Very Interested	Very Interested	Very Interested
Pre	22	Not So Interested	Not at all Interested	Not at all Interested	Not So Interested	Interested	Very Interested	Not So Interested	Interested	Very Interested	Interested	Not at all Interested	Not at all Interested
Post	22	Not at all Interested	Not So Interested	Not at all Interested	Not So Interested	Interested	Very Interested	Not at all Interested	Interested	Very Interested	Not at all Interested	Interested	Not at all Interested
Pre	23	Interested	Not So Interested	Not at all Interested	Not at all Interested	Not So Interested	Not at all Interested	Not at all Interested	Interested	Not at all Interested	Not at all Interested	Not at all Interested	Interested
Post	23	Not So Interested	Not at all Interested	Not So Interested	Not So Interested	Not So Interested	Interested	Not So Interested	Very Interested	Interested	Interested	Interested	Very Interested
Pre	24	Interested	Interested	Interested	Interested	Interested	Interested	Interested	Interested	Interested	Interested	Interested	Interested
Post	24	Very Interested	Very Interested	Very Interested	Very Interested	Very Interested	Very Interested	Very Interested	Very Interested	Very Interested	Very Interested	Very Interested	Very Interested
Pre	25	Not So Interested	Very Interested	Interested	Not at all Interested	Interested	Not at all Interested	Very Interested	Very Interested	Not So Interested	Interested	Interested	Very Interested
Post	25	Not So Interested	Interested	Not So Interested	Not So Interested	Interested	Not So Interested	Very Interested	Very Interested	Not at all Interested	Interested	Not at all Interested	Very Interested
Pre	28	Not So Interested	Not So Interested	Not at all Interested	Not at all Interested	Not at all Interested	Not at all Interested	Not So Interested	Not So Interested	Not at all Interested	Not at all Interested	Not So Interested	Very Interested
Post	28	Not So Interested	Not So Interested	Not So Interested	Not So Interested	Not So Interested	Not So Interested	Not So Interested	Not So Interested	Not So Interested	Not at all Interested	Not So Interested	Interested
Pre	29	Not So Interested	Interested	Interested	Interested	Not So Interested	Interested	Interested	Not So Interested	Interested	Interested	Not So Interested	Interested
Post	29	Interested	Interested	Interested	Interested	Not So Interested	Interested	Interested	Interested	Very Interested	Interested	Not So Interested	Interested
Pre	30	Not at all Interested	Interested	Very Interested	Interested	Not at all Interested	Interested	Interested	Not So Interested	Interested	Interested	Not at all Interested	Not at all Interested
Post	30	Not at all Interested	Not So Interested	Interested	Not So Interested	Not at all Interested	Not So Interested	Interested	Not at all Interested	Not So Interested	Not So Interested	Not at all Interested	Not So Interested
Pre	31	Interested	Not at all Interested	Not at all Interested	Not So Interested	Not So Interested	Interested	Not at all Interested	Very Interested	Not So Interested	Not at all Interested	Very Interested	Very Interested
Post	31	Not So Interested	Not at all Interested	Not at all Interested	Not at all Interested	Interested	Interested	Not at all Interested	Very Interested	Not So Interested	Very Interested	Not at all Interested	Very Interested
Pre	33	Not So Interested	Not So Interested	Not So Interested	Not So Interested	Interested	Not So Interested	Not So Interested	Not So Interested	Not So Interested	Not So Interested	Interested	Interested
Post	33	Not So Interested	Not at all Interested	Not So Interested	Not So Interested	Interested	Not So Interested	Interested	Not at all Interested	Not So Interested	Not So Interested	Not So Interested	Very Interested
Pre	34	Very Interested	Interested	Very Interested	Not So Interested	Very Interested	Interested	Very Interested	Very Interested	Very Interested	Very Interested	Interested	Very Interested
Post	34	Interested	Interested	Very Interested	Very Interested	Very Interested	Very Interested	Very Interested	Not So Interested	Very Interested	Very Interested	Very Interested	Interested
Pre	36	Not So Interested	Not So Interested	Not at all Interested	Not at all Interested	Not So Interested	Not at all Interested	Not So Interested	Interested	Not at all Interested	Not So Interested	Interested	Interested
Post	36	Not So Interested	Not So Interested	Not So Interested	Not at all Interested	Not So Interested	Not at all Interested	Not So Interested	Interested	Not So Interested	Not So Interested	Interested	Very Interested
Pre	38	Not So Interested	Not So Interested	Interested	Interested	Very Interested	Interested	Not So Interested	Very Interested	Interested	Very Interested	Not So Interested	Very Interested
Post	38	Not So Interested	Interested	Interested	Not So Interested	Very Interested	Interested	Interested	Interested	Not So Interested	Interested	Not So Interested	Very Interested
Pre	39	Interested	Not So Interested	Interested	Not So Interested	Interested	Very Interested	Very Interested	Very Interested	Very Interested	Very Interested	Interested	Interested
Post	39	Interested	Not So Interested	Interested	Not So Interested	Interested	Very Interested	Not So Interested	Very Interested	Very Interested	Very Interested	Interested	Interested
Pre	40	Very Interested	Not So Interested	Not So Interested	Not So Interested	Very Interested	Interested	Not So Interested	Very Interested	Not So Interested	Very Interested	Interested	Very Interested
Post	40	Very Interested	Interested	Not So Interested	Not So Interested	Very Interested	Interested	Not So Interested	Very Interested	Not So Interested	Very Interested	Very Interested	Very Interested
Pre	41	Interested	Not So Interested	Interested	Not So Interested	Interested	Interested	Interested	Interested	Not So Interested	Interested	Not So Interested	Very Interested
Post	41	Interested	Interested	Interested	Not So Interested	Interested	Very Interested	Interested	Interested	Very Interested	Very Interested	Not So Interested	Very Interested

	#	Your Future 1	Your Future 2	Your Future 3	Your Future 4	Your Future 5	Your Future 6	Your Future 7	Your Future 8	Your Future 9	Your Future 10	Your Future 11	Your Future 12
Pre	42	Interested	Interested	Interested	Very Interested	Very Interested	Not So Interested	Not So Interested	Very Interested	Not So Interested	Interested	Interested	Very Interested
Post	42	Interested	Not So Interested	Interested	Interested	Very Interested	Not at all Interested	Not So Interested	Interested	Not at all Interested	Interested	Not So Interested	Very Interested
Pre	43	Not So Interested	Interested	Interested	Not So Interested	Very Interested	Interested	Interested	Interested	Interested	Interested	Not So Interested	Not So Interested
Post	43	Not So Interested	Not So Interested	Not So Interested	Interested	Interested	Interested	Not So Interested	Not So Interested	Interested	Not So Interested	Not So Interested	Not So Interested
Pre	44	Interested	Very Interested	Very Interested	Not So Interested	Very Interested	Not at all Interested	Interested	Not So Interested	Not at all Interested	Interested	Very Interested	Very Interested
Post	44	Interested	Not So Interested	Interested	Not at all Interested	Very Interested	Not at all Interested	Not So Interested	Very Interested	Not at all Interested	Very Interested	Very Interested	Very Interested
Pre	45	Interested	Not So Interested	Not So Interested	Not So Interested	Interested	Not So Interested	Interested	Interested	Not So Interested	Interested	Interested	Interested
Post	45	Not So Interested	Interested	Not So Interested	Interested	Very Interested	Interested	Very Interested	Interested	Interested	Not So Interested	Not So Interested	Very Interested
Pre	46	Not So Interested	Not at all Interested	Not at all Interested	Not So Interested	Not at all Interested	Not So Interested	Not So Interested	Very Interested	Not So Interested	Interested	Not So Interested	Not So Interested
Post	46	Not So Interested	Not at all Interested	Not at all Interested	Not at all Interested	Interested	Not at all Interested	Not at all Interested	Very Interested	Not at all Interested	Not So Interested	Not at all Interested	Not So Interested
Pre	47	Not So Interested	Interested	Not So Interested	Not at all Interested	Very Interested	Interested	Very Interested	Very Interested	Not So Interested	Not at all Interested	Interested	Very Interested
Post	47	Interested	Not So Interested	Not at all Interested	Not So Interested	Very Interested	Very Interested	Very Interested	Very Interested	Interested	Not So Interested	Interested	Very Interested
Pre	51	Interested	Very Interested	Very Interested	Interested	Interested	Not So Interested	Interested	Interested	Interested	Interested	Interested	Very Interested
Post	51	Interested	Very Interested	Very Interested	Not So Interested	Very Interested	Interested	Very Interested	Very Interested	Not So Interested	Very Interested	Very Interested	Very Interested
Pre	52	Very Interested	Very Interested	Very Interested	Very Interested	Very Interested	Very Interested	Very Interested	Very Interested	Very Interested	Very Interested	Very Interested	Very Interested
Post	52	Very Interested	Very Interested	Very Interested	Very Interested	Very Interested	Very Interested	Very Interested	Very Interested	Very Interested	Very Interested	Very Interested	Very Interested
Pre	54	Very Interested	Interested	Interested	Not So Interested	Not at all Interested	Not So Interested	Very Interested	Interested	Not So Interested	Not So Interested	Not So Interested	Not So Interested
Post	54	Very Interested	Interested	Interested	Not So Interested	Not at all Interested	Not So Interested	Very Interested	Interested	Not So Interested	Very Interested	Not So Interested	Interested
Pre	55	Interested	Not So Interested	Interested	Interested	Not So Interested	Interested	Not So Interested	Not So Interested	Not So Interested	Interested	Not So Interested	Very Interested
Post	55	Interested	Not So Interested	Interested	Interested	Interested	Not at all Interested	Not at all Interested	Not at all Interested	Not at all Interested	Not at all Interested	Not at all Interested	Very Interested
Pre	56	Not So Interested	Interested	Very Interested	Very Interested	Interested	Very Interested	Not So Interested	Not at all Interested	Very Interested	Interested	Not So Interested	Not at all Interested
Post	56	Not So Interested	Not So Interested	Interested	Interested	Very Interested	Very Interested	Not So Interested	Not at all Interested	Very Interested	Not So Interested	Not at all Interested	Not at all Interested
Pre	57	Interested	Not So Interested	Not So Interested	Not So Interested	Interested	Interested	Very Interested	Very Interested	Not So Interested	Very Interested	Very Interested	Very Interested
Post	57	Interested	Interested	Interested	Interested	Interested	Interested	Interested	Very Interested	Interested	Interested	Interested	Very Interested
Pre	59	Not So Interested	Interested	Not So Interested	Interested	Not So Interested	Interested	Not at all Interested	Not at all Interested	Interested	Interested	Interested	Very Interested
Post	59	Not So Interested	Not So Interested	Not So Interested	Interested	Not So Interested	Very Interested	Not So Interested	Not So Interested	Very Interested	Not So Interested	Interested	Very Interested
Pre	60	Not So Interested	Not So Interested	Interested	Not So Interested	Not So Interested	Interested	Interested	Interested	Not So Interested	Interested	Interested	Very Interested
Post	60	Not So Interested	Not So Interested	Not So Interested	Not So Interested	Not So Interested	Not So Interested	Not So Interested	Not So Interested	Not So Interested	Interested	Interested	Very Interested
Pre	63	Not So Interested	Not So Interested	Not at all Interested	Not at all Interested	Interested	Not So Interested	Not So Interested	Interested	Not So Interested	Not So Interested	Interested	Very Interested
Post	63	Not So Interested	Interested	Interested	Not So Interested	Interested	Interested	Interested	Very Interested	Not So Interested	Not So Interested	Interested	Very Interested
Pre	64	Not at all Interested	Interested	Interested	Interested	Interested	Not So Interested	Interested	Interested	Not So Interested	Not So Interested	Not So Interested	Not So Interested
Post	64	Not So Interested	Very Interested	Very Interested	Very Interested	Interested	Not So Interested	Not So Interested	Very Interested	Not So Interested	Not So Interested	Not So Interested	Not So Interested
Pre	65	Interested	Not So Interested	Interested	Not So Interested	Very Interested	Not So Interested	Interested	Not So Interested	Not So Interested	Not So Interested	Interested	Very Interested
Post	65	Interested	Interested	Interested	Not at all Interested	Very Interested	Not at all Interested	Interested	Not So Interested	Not at all Interested	Interested	Not So Interested	Very Interested
Pre	66	Not So Interested	Interested	Very Interested	Very Interested	Interested	Very Interested	Not So Interested	Interested	Interested	Interested	Not So Interested	Not So Interested
Post	66	Not So Interested	Not So Interested	Interested	Very Interested	Not So Interested	Interested	Not So Interested	Interested	Interested	Not So Interested	Not So Interested	Not So Interested
Pre	67	Not So Interested	Interested	Interested	Not So Interested	Not So Interested	Not So Interested	Not So Interested	Interested	Not So Interested	Interested	Not So Interested	Interested
Post	67	Not So Interested	Interested	Very Interested	Not So Interested	Not So Interested	Not So Interested	Interested	Very Interested	Not So Interested	Interested	Interested	Interested
Pre	68	Interested	Very Interested	Very Interested	Interested	Interested	Very Interested	Interested	Interested	Very Interested	Interested	Interested	Interested
Post	68	Interested	Interested	Very Interested	Very Interested	Interested	Very Interested	Not So Interested	Not So Interested	Very Interested	Very Interested	Interested	Interested
Pre	69	Very Interested	Not So Interested	Not So Interested	Not So Interested	Interested	Not at all Interested	Not at all Interested	Interested	Not at all Interested	Very Interested	Interested	Very Interested
Post	69	Interested	Not So Interested	Not So Interested	Not So Interested	Interested	Not So Interested	Not So Interested	Interested	Not So Interested	Interested	Very Interested	Very Interested
Pre	70	Not So Interested	Interested	Very Interested	Not So Interested	Very Interested	Not at all Interested	Very Interested	Interested	Not at all Interested	Interested	Interested	Not at all Interested
Post	70	Interested	Interested	Interested	Interested	Interested	Interested	Interested	Interested	Interested	Interested	Interested	Interested
Pre	29536	Not So Interested	Interested	Not So Interested	Not So Interested	Interested	Interested	Very Interested	Not So Interested	Not So Interested	Not at all Interested	Not at all Interested	Not at all Interested
Post	29536	Interested	Interested	Not So Interested	Not So Interested	Interested	Very Interested	Interested	Interested	Interested	Not So Interested	Not So Interested	Interested

#	What grade will you be in next year?	Do you know any adults who work as scientists?	Do you know any adults who work as engineers?	Do you know any adults who work as mathematicians ?	Do you know any adults who work as technologists?
3	6th grade	No	No	No	No
4	8th grade	No	Yes	No	No
7	6th grade	Not Sure	Not Sure	No	Yes
12	8th grade	Yes	Not Sure	Not Sure	Not Sure
13	8th grade	Not Sure	No	No	No
14	7th grade	Yes	Yes	Yes	Yes
16	7th grade	No	No	Yes	No
17	8th grade	No	Yes	No	Yes
19	8th grade	Yes	Yes	Yes	No
20	7th grade	Not Sure	Not Sure	Not Sure	Not Sure
22	8th grade	Yes	Yes	No	Yes
23	8th grade	No	Not Sure	No	Yes
24	8th grade	No	Yes	Yes	Yes
25	8th grade	No	Yes	Yes	Yes
28	8th grade	Yes	No	Yes	No
29	8th grade	No	No	No	No
30	8th grade	Not Sure	No	Not Sure	No
31	7th grade	Yes	Yes	Yes	Yes
33	8th grade	Not Sure	Not Sure	Yes	Not Sure
34	8th grade	Yes	Yes	Not Sure	Yes
36	8th grade	No	No	No	No
38	8th grade	No	Yes	Yes	Yes
39	7th grade	Not Sure	Not Sure	Yes	Not Sure
40	7th grade	Yes	Yes	Yes	Yes
41	6th grade	Yes	Not Sure	Yes	Yes
42	8th grade	Not Sure	Not Sure	Not Sure	Not Sure
43	8th grade	Not Sure	Yes	Yes	Not Sure
44	6th grade	Not Sure	No	Yes	No
45	8th grade	Not Sure	Yes	Yes	Yes
46	8th grade	Not Sure	Not Sure	No	No
47	6th grade	Not Sure	No	Yes	No
51	6th grade	Yes	Yes	Yes	Yes
52	8th grade	Yes	Yes	Yes	Yes
54	7th grade	Not Sure	Not Sure	No	No
55	6th grade	Not Sure	No	Yes	No
56	8th grade	Yes	Not Sure	Yes	Not Sure
57	8th grade	Yes	Yes	Yes	Yes
59	8th grade	No	No	No	No
60	7th grade	Yes	Not Sure	Yes	Not Sure
63	7th grade	Yes	No	Not Sure	Not Sure
64	7th grade	No	No	No	Yes
65	6th grade	Not Sure	Yes	Not Sure	Yes
66	8th grade	Yes	Yes	Yes	Yes
67	8th grade	Not Sure	Not Sure	No	Yes
68	8th grade	Yes	Not Sure	No	No
69	6th grade	Not Sure	Yes	Not Sure	Yes
70	6th grade	No	No	No	Yes
29536	8th grade	Not Sure	Yes	Not Sure	Yes

	What would you like to be when you grow up?		Do you plan to go to college?	
#	PRE	POST	PRE	POST
3	Professional soccer player	Geologists	Yes	Yes
4	Idk maybe a lawyer	Idk maybe a lawyer	Yes	Yes
7	Don't know	No idea	Not Sure	Not Sure
12	An author or an architect	Author or engineer	Yes	Yes
13	Vetenarian	Vetenaria	Yes	Yes
14	Work for Nasa	Employee at Nasa	Yes	Yes
16	I don't know	I don't know	Yes	Yes
17	Marine	Engineer	Yes	Yes
19	Electrical engineer	NASA engineer	Yes	Yes
20	A biologist	Im not sure	Yes	Yes
22	Obgyn	Obgyn	Yes	Yes
23	Not sure	Work at Tacos don Julio	Yes	Yes
24	Marine	Marine	Yes	Yes
25	Singer	Singer or an artist	Not Sure	Yes
28	Welder	welder	Yes	Yes
29	Physical therapist	Physical Therapist	Yes	Yes
30	An Author and illustrater	Author and illustrator	Yes	Yes
31	Computer Engineer	Engineer	Yes	Yes
33	Engineer	engineer	Yes	Yes
34	Pilot	Pilot	Yes	Yes
36	Nothing	Nothing	Yes	Yes
38	I don't know	Engineering	Yes	Yes
39	Forensic medical detective	Forensic pathologist	Yes	Yes
40	Electrical engineer	Engineer	Yes	Yes
41	Get a band and start out preforming at wedding party's then go to big BIG concerts.	In a band that preforms at wedding party's.	Yes	Yes
42	Engineer	I dont know	Yes	Yes
43	Translator	Translator	Yes	Yes
44	Engineer	Engineer (give mr al a raise)	Yes	Yes
45	Architect	Architect	Yes	Yes
46	Video game developer	Video game developer	Yes	Yes
47	Pilot	Pilot	Yes	Yes
51	Not sure	Paleontologist	Not Sure	Yes
52	Anathesiolgist	Anything the future has for me.	Yes	Yes
54	Earth Scientist	Earth scientist	Yes	Yes
55	Structural engineer	Structural engineer	Yes	Yes
56	OBGYN or any kind of doctor	Doctor	Yes	Yes
57	Architect	Architect	Yes	Yes
59	Mechanical engineer	Mechanical engineering	Yes	Yes
60	A engenier	A enginer	Yes	Yes
63	Electrical Engineer	Engineer	Yes	Yes
64	Either a zoologist or a computer programmer	Zoologist	Yes	Yes
65	Engineer	Engineer	Yes	Yes
66	Veterinarian	Veterinarian	Yes	Yes
67	Don't know yet	I don't know yet	Yes	Yes
68	Nurse/doctor	Nurse/doctor	Yes	Yes
69	Physicist	Engineer	Yes	Yes
70	Dancer and artist	Geologists	Not Sure	Not Sure
29536	You tuber	youtuber	Yes	Yes