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INTRODUCTION TO AND ADVANCEMENT OF MINORITY INTEREST IN ENGINEERING AND STEM RELATED FIELDS

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by

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I. Abstract

This project was aimed at developing a methodology for improving the enrollment statistics of underrepresented students in STEM degree programs. An assessment was administered drawing inference from the correlation between academic performance, perception of engineering and decision to pursue a STEM degree. Strong correlations were observed between academic performance, perception of engineering, importance of Mathematics and one's choice to pursue a STEM degree. A project-based curriculum addendum was proposed and a private sector engineering design program was developed and implemented.

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III. Table of Contents

III. Table of Tables

IV. Table of Figures

1. Introduction

The current documented percentage of minority students pursuing STEM related fields as undergrads is minimal in comparison to the percentage of their Asian and White counterparts in the overall student population. Socio-economic issues beyond our scope of rectification are at the heart of this issue. Students of color and minority ethnic decent have an out worldly outlook far different than those outside of their socioeconomic status. The thought of pursuing a degree in higher education let alone a STEM related field is beyond the scope of understanding and acceptance of many students falling within this range of socioeconomic struggle. To believe that one can pursue or better oneself when the world around you seems to force you into a state of debasement and acceptance that you will not succeed is this internalized issue that many of these students face as they step out of their homes to head to school and as they sit in class looking out the window into their life. The students turn to examples or identities that they can readily relate to in an attempt to find some form of acceptance or guidance. (Rothman, 1954)

Numerous programs have been established and implemented throughout the nation that present various solutions to this socioeconomic issue by transporting these students to secondary school institutions of learning outside of their socioeconomic status in hopes that it would allow these students to understand that there is a better life or in the least a definite chance to better oneself. One such program, Metco, first established in 1966 and currently 3,300 students in 34 school districts in the Commonwealth of Massachusetts participating, is a grant program intended to expand educational opportunities and reduce racial imbalance by transporting students from a lower socioeconomic status to a school of a higher socioeconomic status.

Other than the socioeconomic issue that we as a country struggle with, the group postulates that the low percentage of Minorities pursuing STEM related fields is a result of the lack of diversity and engineering principles in the current Mathematics and Science High School Curriculums, as well as, the decrease or lack thereof conceptual hands-on project-based teaching methods and learning within our secondary school institutions. Many of the texts used in these classes lean towards the bias of white males, which in turn discourages minority students to pursue such fields. Students of ethnic decent are on a mission to find what courses relate to them so that they will be able to choose a field to study upon graduating High School.

Many of the engineering concepts are studied within mathematics and science classes; however, students are not being introduced to the fact that engineering is simply the use of mathematics and science principles in unison towards a solution. Basically the notion of Engineering as a Discipline is not made understood. With the introduction of engineering principles and conceptual hands-on activities and learning, students will be able to realize the common ground between all the mathematics and science courses and will then find reason in the need to study those classes. The introduction of a conceptual hands-on project-based engineering multicultural curriculum into the current Mathematics and Science curriculum in theory should contribute to the diversification of minorities interested in pursuing engineering as an undergrad and the awareness of engineering principles to all students.

According to assessment tests and other measures, Massachusetts schools are among the nation’s best. Students here rank fourth nationally in reading, sixth in math, and eighth in science on the

National Assessment of Educational Progress, administered by the U.S. Department of Education. They scored higher this spring in reading than 69 percent of their peers across the country on the Iowa Test of Basic Skills; a third of the state's third graders were at the advanced level, compared to 19 percent nationwide. A Boston College correlation of NAEP results with international tests found that in eighth-grade science Massachusetts students performed as well as, or better than, their counterparts in 40 out of 41 other countries, including Germany and Japan; only kids in Singapore were rated higher." (Bolon, 2000)

There has been no real individual measure of a student's performance in the Massachusetts School Systems of late. By March of 1996 the Department of Education had completed a Common Core of Learning, released six of seven planned curriculum frameworks based on it, and began the development of the MCAS based on the frameworks. These frameworks are based on the statistics of Massachusetts schools as a whole and do not as many statewide statistics reflect the individual achievements and failures of the schools that comprise it. The Worcester Public School System is one school system that falls under the category of systems that have continuously performed under the state level. Looking at the MCAS assessment test scores, an increasing number of students are falling under the "Needs Improvement" or "Failure" categories of the MCAS assessment test statistics. What is more alarming is the fact that the vast majority of these students are of minority descent. Schools are recently focusing more on the statistics of the school and have abandoned the fundamental notion of fostering the intelligence and furthering such intelligence of the students that comprise this system.

Engineering is defined as the application of scientific and mathematical principles to practical ends. Many have researched the notion of an Engineering based curriculum. The concept of such a curriculum lies in the fact that engineering is all around us and is apparent in everyday interactions with the world we live in. The more one can introduce such engineering concepts into the frameworks of the curriculum, the more students become aware of the underlying concepts in such fields as math and science for they can obviously see and demonstrate the applications of such concepts. The fact is that students should not be initially subjected to more rigorous studies of the fundamental concepts, but should be initially engaged in interdisciplinary studies allowing them to further grasp these fundamental concepts.

Given the newly established Science and Technology/Engineering Curriculum Framework for Massachusetts public schools, the lack of a diverse curriculum and the implementation of engineering principles in general mathematics and science courses are the current challenges public schools face. As a result, the number of Minority undergraduates pursuing a degree in one of the STEM related fields is very minimal in comparison to that of their undergraduate counterparts. However, with the introduction of and implementation of a curriculum comprised of Engineering principles of math and science and more realistic examples, such as the recognition of well-known researchers, scientists, and/or engineers with minority decent the amount of minorities pursuing engineering will most likely increase. The additionally project based curriculum should guarantee an increase in rate of enrollment.

The goal is to produce a curriculum that retains the salient technical material but enhances the link between fundamentals and applications, reduces critical path length in the course sequence, introduces team experiences into all courses, and creates an atmosphere of inclusion rather than exclusion (Busch-Vishniac and Jarosz, 2004).

Engineering principles are not coupled with the current curriculum that is presented to the students comprising the Massachusetts Educational System. Unless students are initially and progressively introduced to Engineering and its concepts at an early stage in their education, preferably High School, and if these principles are not related to them in a way that they can relate the material to their surroundings, the number of minority students in Engineering will do nothing but remain and a stagnant increase. “We expect engineering students to be so committed to the engineering endeavor from the time they set foot on a campus that they will pursue courses that offer no insight into engineering as a profession for a minimum of a year, knowing that after this “hazing,” there will be the reward of relevant classes. This sort of approach selectively disadvantages women and minorities, because they are less likely to be exposed to engineering as a profession and to be encouraged to pursue engineering careers” (Wyer, 2003)

Integration and incorporation of engineering principles in the current curriculum is the first and most important step to increase the number of minorities in the domain of engineering. “Integration of engineering in all classes will increase the interest in any student to pursue engineering.” (Wyer, 2003) “John Slaughter, president of the National Action Council for Minorities in Engineering, declined to set up separate African American and Latino study programs at Occidental College but ensured that minority contributions were reflected in the core curriculum. ‘I encouraged the faculty to build stronger cultural studies programs that incorporate those disciplines as central themes.’” (Wyer, 2003)

The total integration and progression of these engineering principles throughout students educational career will only aid in the retention of the minority student in the engineering major of the students choosing but will serve as the prerequisite or foundation for the onslaught of preliminary and basic classes the student will face in the near future at an institution of higher education. “Many students lost before the engineering faculty get to them because they become discourages in the introductory classes—physics, chemistry, and calculus—and discontinue their pursuit of engineering (Tobias, 1994).” (Wyer, 2003)

The introduction of a conceptual hands-on engineering-based multicultural curriculum into the current Mathematics and Science curriculum and the development of an engineering based program to supplement the curriculum addendum could prove to be promising in the diversification of minorities interested in pursuing engineering as an undergrad and the awareness of engineering principles to all students. In order to properly develop a program that would compensate for these theorized educational deficiencies, a survey, administered to local Worcester Public High School 9th and 12th graders. This survey focused on gauging the current student population’s academic status, as well as, the attitudes towards Engineering & STEM related fields as disciplines and as future careers.

This assessment would allow us to draw inference towards whether or not there is a correlation between their decision to pursue a post-secondary education and their academic performance, attitudes towards their academics and perception of Engineering and Engineers. This allowed us to draw inference into whether or not these characteristics played a role in their decision to pursue a degree in a STEM related field if they decided to pursue a post-secondary degree.

Relying on methodologically solid data analysis, a curriculum addendum comprised of project-based engineering principles and multicultural reference proposed. In addition to the proposed curriculum addendum, an engineering design outreach program, Step into Strive, aimed to supplement the current curriculum, as well as, prove to challenge the students with more advanced concepts was developed. To successfully implement this new method of conceptual hands-on learning and to manage the engineering design program, a consortium of private sector entities was proposed to provide the necessary training and resources to the teachers, as well as, to oversee the general administration of the engineering outreach program.

As the paper progresses, we will detail the need for relating Engineering, mathematics and science, socially is crucial to increasing the interest of minority students in Engineering. Correspondingly, detailing how this relation is necessary due to the fact that ethnic minority students are on a continuous mission to discover how courses relate to their individual subcultures; an assessment they then use to select a college and career, leading to the diversification of people in the engineering community.

2. Literature Review

2.1. The Nature of Mathematics, Science and Technology

2.1.1. American Association for the Advancement of Science

The American Association for the Advancement of Science (AAAS) founded in 1848 works towards the advancement of scientific knowledge and scientific innovation worldwide for the betterment of all peoples globally. The AAAS is open to and provides its services to 262 affiliated societies and academies of science, totaling over 10 million people worldwide. The AAAS publishes the acclaimed and widely read journal, Science, as well as many scientific newsletters, books and scientific reports. The AAAS also develops and leads multiple programs that elevate the progress they want and need for science worldwide.

2.1.2. Project 2061

The AAAS founded Project 2061 in 1985 to further the Science and Mathematics and Technology knowledge of all Americans. “Curriculum materials are a critical component of improving science and mathematics education, yet many materials fail to teach the most important concepts in an effective way.” (AAAS) Project 2061 is developing programs, publications and various other materials to assist in the identification and development of curricular amendments and instructional materials towards the guarantee of a fundamental Science and Mathematics education for students. “Project 2061 is developing strategies and tools for evaluating the alignment of K-12 assessments in science and mathematics with national and state standards and benchmarks.” Project 2061 is now leading two scientific research efforts towards the enhancement of our knowledge in science and mathematics teaching and learning. Due to its constant fight for people’s awareness of science and mathematics, Project 2061 has garnered the reputation as the "single most visible attempt at science education reform in American history" (Organization of Economic Cooperation and Development, 1996)

2.1.3. Science for All Americans

"*Science for All Americans* is based on the belief that the science-literate person is one who is aware that science, mathematics, and technology are interdependent human enterprises with strengths and limitations; understands key concepts and principles of science; is familiar with the natural world and recognizes both its diversity and unity; and uses scientific knowledge and scientific ways of thinking for individual and social purposes." (AAAS) The publication, Science for All Americans, is comprised of information and analyses on the nature of Mathematics, Science and Technology, as well as, the impact of science, mathematics, and technology on our human society.

Science for All Americans is founded on the fundamental basis that Mathematics relies on both logic and creativity, two attributes that accentuate the intellectual challenges that mathematics poses to those that comprise its domain. Mathematics is one of the most important disciplines in the realm of knowledge and education and it plays such a vital role in our society as a whole. The

Nature of Mathematics delves deeper into the scope of how mathematical knowledge is the fundamental basis of scientific literacy. The Nature of Mathematics focuses on the comprehension, perception, and familiarity of fundamental mathematical concepts by students. Science for All Americans works on the premise of fundamental relationships between mathematics, science, and engineering/technology, 4 of which are of great significance:

- The alliance between science and mathematics has a long history, dating back many centuries. Science provides mathematics with interesting problems to investigate, and mathematics provides science with powerful tools to use in analyzing data. Often, abstract patterns that have been studied for their own sake by mathematicians have turned out much later to be very useful in science. Science and mathematics are both trying to discover general patterns and relationships, and in this sense they are part of the same endeavor.
- Mathematics is the chief language of science. The symbolic language of mathematics has turned out to be extremely valuable for expressing scientific ideas unambiguously. The statement that $a=F/m$ is not simply a shorthand way of saying that the acceleration of an object depends on the force applied to it and its mass; rather, it is a precise statement of the quantitative relationship among those variables. More important, mathematics provides the grammar of science—the rules for analyzing scientific ideas and data rigorously.
- Mathematics and science have many features in common. These include a belief in understandable order; an interplay of imagination and rigorous logic; ideals of honesty and openness; the critical importance of peer criticism; the value placed on being the first to make a key discovery; being international in scope; and even, with the development of powerful electronic computers, being able to use technology to open up new fields of investigation.

Mathematics and technology have also developed a fruitful relationship with each other. The mathematics of connections and logical chains, for example, has contributed greatly to the design of computer hardware and programming techniques. Mathematics also contributes more generally to engineering, as in describing complex systems whose behavior can then be simulated by computer. In those simulations, design features and operating conditions can be varied as a means of finding optimum designs. For its part, computer technology has opened up whole new areas in mathematics, even in the very nature of proof, and it also continues to help solve previously daunting problems.

2.2. Massachusetts Department of Education

2.2.1. Massachusetts Education Reform Act

The Massachusetts Education Reform Act, written into law in 1993, was the driving force towards the development of the Educational Frameworks present to this day. The Educational Reform Act was the result of the 1978 Webby vs. Dukakis lawsuit filed against then Governor Michael Dukakis's Administration. The lawsuit dealt with the lack of funding in the Massachusetts Public School System. The basis of the lawsuit was that the future of the students that comprise the Massachusetts Educational system, due to the lack of funding, would be that of only inadequacy and mediocrity. The lawsuit claimed that the lack of funding deprived the students of a proper education and future.

The 1978 Webby vs. Dukakis lawsuit lead to a full assessment of the current Massachusetts Educational Standards and System as a whole. The result of this assessment was the Massachusetts Education Reform Act. This Reform Act included within it the need for the development of Frameworks or Statewide Standards for the Massachusetts Educational System. The State Frameworks were just one of many of the proposed changes outlined in the Massachusetts Education Reform Act of 1993, which included equitable funding to schools, accountability for student learning.

2.2.2. Massachusetts Curriculum Frameworks

The Curriculum Frameworks act as guidelines to the teaching of standards in all core academic courses; guidelines designed for Massachusetts School Districts and educators to utilize in the development of district curricula, coursework, and daily lesson plans. The final step towards the development of statewide standards was the approval of the Science and Technology Frameworks and the Mathematics Frameworks by the Board of Education.

2.2.2.1. Mathematics Curriculum Framework

The Mathematics Curriculum Framework was developed to foster and advance the Educational Reform that has been ongoing in the state of Massachusetts. It is comprised of the work and guidance of members of the administration, teachers, and university professors in the field of mathematics.

The Board of Education panel accepted the work and guidance of the aforementioned group of educators and administrators, the National Council of Teachers of Mathematics (NCTM), the Mathematical Association of America, the American Mathematical Society, the American Association for the Advancement of Science, NCTM’s Principles and Standards for School Mathematic, data from the Third International Mathematics and Science Study, the National Research Council’s National Science Education Standards, and drew upon them to develop and approve of what we know now as the Mathematics Curriculum Framework. This framework is one of seven sets of standards developed and approved to progress the educational reform taking place in the Massachusetts Educational System.

The Mathematics Framework was developed in the belief that it would drive all students to attaining a level of mathematical competence through the implementation of the standards that comprise the framework. The Mathematics Frameworks is comprised of the following standards.
Number Sense and Operations

- Analyze relationships among the various subsets of the real numbers (whole numbers, integers, rationals, and irrationals).
- Explore higher powers and roots using technology.
- Explore the system of complex numbers and find complex roots of quadratic equations.
- Investigate special topics in number theory, e.g., the use of prime numbers in cryptography.
- Use polar-coordinate representations of complex numbers (i.e., $a + bi = r(\cos\theta + i\sin\theta)$) and DeMoivre’s theorem to multiply, take roots, and raise numbers to a power.
- Plot complex numbers using both rectangular and polar coordinate systems.

Patterns, Relations, and Algebra

- Explore matrices and their operations. Use matrices to solve systems of linear equations.
- Investigate recursive function notation.
- Prove theorems using mathematical induction.
- Investigate parametrically defined curves and recursively defined functions, including applications to dynamic systems.

Geometry

- Apply properties of chords, tangents, and secants to solve problems.
- Use deduction to establish the validity of geometric conjectures and to prove theorems in Euclidean geometry.
- Investigate and compare the axiomatic structures of Euclidean and non-Euclidean geometries.
- Explore the use of conic sections in engineering, design, and other applications.
- Investigate the notion of a fractal.
- Use graphs (networks) to investigate probabilistic processes and optimization problems.

Measurement

- Explore the scientific use of different systems of measurement, e.g., centimeter-gram-second (CGS), Scientific International (SI).

Data Analysis, Statistics, and Probability

- Explore designs of surveys, polls, and experiments to assess the validity of their results and to identify potential sources of bias; identify the types of conclusions that can be drawn.
- Describe the differences between the theoretical probability of simple events and the experimental outcome from simulations.
- Use technology to perform linear, quadratic, and exponential regression on a set of data.
- Design surveys and apply random sampling techniques to avoid bias in the data collection. (Massachusetts Curriculum Frameworks: Mathematics, 2000)

2.2.2.2. Science and Technology Curriculum Framework

The Science & Technology Framework was developed to foster and advance the Educational Reform that has been ongoing in the state of Massachusetts. It is comprised of the work and guidance of members of the administration, teachers, scientists and university professors in the domain of Science and Technology/Engineering. The Science and Technology Framework promotes and fosters educational environments characterized by curiosity, persistence, respect for evidence, open mindedness balanced with skepticism, and a sense of responsibility. The Science and Technology Framework is comprised of the following standards. (Refer to Appendix A: Science & Technology Curriculum Framework)

2.3. Incorporating Engineering/Technology Principles

2.3.1. Engineering/Technology in the Curriculum

“Investigations in science and technology/engineering involve a range of skills, habits of mind, and subject matter knowledge. The purpose of science and technology/engineering education in Massachusetts is to enable students to draw on these skills, habits, and subject matter knowledge for informed participation in the intellectual and civic life of American society, and for further education in these areas if they seek it." (Massachusetts Department of Education) Implementation of a successful engineering/technology curriculum enhances the students understanding and knowledge of the fundamental principles of each domain of science, mathematics and engineering and their perception, comprehension and understanding of the relations between these domains.

2.3.2. Engineering Outreach Programs

Engineering Outreach Programs are pre-college, pre-engineering programs for students in K-12 schools. The Engineering Outreach Program identifies and assists in the academic and career preparation of students, the majority of them being underrepresented. Outreach programs focus on enhancing and elevating the interest, comprehension and knowledge of engineering and its fundamental principles, as well as, a student's qualifications and eligibility towards the pursuit of an Engineering Degree.

Outreach programs have been developed and implemented for many years now with two-thirds of the United States Engineering Colleges implementing and leading an outreach program. Outreach programs provide other services in addition to introducing students to the realm of engineering. They provide academic advising, introduction and visits to companies, and other institutions in the engineering industry, PSAT and SAT workshops, as well as, leadership opportunities for students. "These programs are designed to employ engineering as a vehicle for making the principles of science and mathematics relevant, exciting, and accessible to students and teachers alike." (ASEE Engineering K12 Center, 2006)

2.3.2.1. Worcester High School Engineering Outreach Programs

There are a variety of programs available to Worcester High School students. These programs help the Students explore the field of mathematics, science, and engineering. In addition to catering to the students' needs, there are also programs available to teachers interested in obtaining an outside perspective and aid when it comes to assessing their current curriculum.

The grant contributed to Worcester from the University of Massachusetts/Raytheon K-16 Engineering Collaborative and the Massachusetts Department of Education has set the grounds for the development of a program that will focus on science and technology in the curriculum, Engineering Pipeline Collaborative (EPiC). The students will have the ability to see how mathematics, science, and technology relate to each other in the world and the contributions engineering provided and their need locally, nationally, and worldwide. As a result, WPI is helping Worcester accomplish the goal of the success of this program. Doherty High School is the first school that will offer new and future engineering courses. The faculty at Doherty is working with WPI faculty to prepare their curriculum for the engineering course. There are also various student team projects that are working to "develop curricular modules for a pre-engineering program at Doherty."

Tufts University, Umass Amherst, and Umass Lowell, with funding from NSF, collaborated to support the implementation of the engineering design into K-12 classrooms. The Pre-College Engineering for Teachers (PCET) program is set up so teachers attend a two week professional development session where they will work with "faculty and engineering graduate students from their affiliate university to apply the concepts leaned in their classes." High school teachers began the program in the 2003-2004 academic school year, middle school teachers will attend the 2004-2005 academic school year, followed by grade 3-5 teachers, and wrapping up with K-2 teachers.

The Frontiers program is a summer program is specially designed for on upcoming high school juniors and seniors. The purpose of Frontiers is to present a challenging research and learning atmosphere created to explore the "outer limits of knowledge in science, mathematics and engineering." The duration of the program is two weeks and the students will have the opportunity to live on campus and assess the facilities available on campus. The students will develop their knowledge while working with prestigious WPI faculty. The students will also have to opportunity to "use state-of-the-art experimental, analytical and computer technology" to enhance their research and learning process throughout the program. The students will also have the advantage of working with WPI students while in the laboratories and study groups.

The GEMS program, Girls in Engineering, Math and Science, is a summer program created to introduce engineering to a maximum of 60 high schools girls from across the country at WPI. The duration of the program is one week. The girls will have the opportunity to enhance their knowledge of engineering while experiencing the college life through living in the dormitories and access the facilities on campus. The week is comprised various hands-on laboratories and sessions geared towards mainly topics that would interest young women, run by WPI faculty or student volunteers. The activities are designed to teach about the different fields available in engineering. The atmosphere is designed so that students will be intrigued by that they are doing and will ask questions to further their understanding of the material. GEMS also explores the importance of mathematics and science during the program. The goal of the program is to enhance the knowledge of engineering in high school girls while also diminishing any preconceived stereotypes of engineers, especially the stereotype that engineering is just a career path for men. Girls are made aware that scientists and engineering are applying what they have learned from mathematics and science courses to better the society, help human population and even make world changing contributions. The program is made possible by the generous grant provided by the Intel Foundation, as a result, the tuition is affordable and scholarship assistance is also available for those in need.

The Strive program is a summer program designed to introduce engineering to a maximum of 60 African-American, Latino, and American Indian high school students from across the country at WPI. The duration of the program is one week. During the week the students will have the opportunity to experience the college life, living in the dormitories on campus and accessing all the facilities, while expanding their knowledge on engineering. The week is comprised of numerous hands-on laboratories and sessions, run by WPI faculty or student volunteers, designated to teach them more about the different fields available in engineering. The atmosphere is designed so that students will be intrigued by that they are doing and will ask questions to further their understanding of the material. Strive also emphasizes the importance of mathematics and science which in turn will hopefully inspire the students to focus on their current and future mathematics and science courses. The goal of the program is help the students to realize that engineers and scientists continuously use mathematics and science concepts to help better the society, lives of the population, and even change the world. The program is made possible by the generous grant provided by the Intel Foundation, as a result, the tuition is affordable and scholarship assistance is also available for those in need.

WPI and the Worcester Higher Education Resource Center have collaborated to create the “Math and Science Technology Education Resource” (MASTERS) Program. The purpose of this program is to reach out to minorities in the Worcester Public High Schools, through various activities that will greatly benefit the students involved in the MASTERS Program. The program occurs during the academic school year. The goal of the program is to provide various activities and sessions that will establish a broader interest in as well as preparation for courses relating to mathematics, science, and engineering. The students meet once a week on the WPI campus where they will have numerous resources at their finger tips such as: WPI students as tutors, enrichment opportunities, and advising session as various topics- college applications, college essays, financial aid information, and SAT preparatory courses. The overall goal of the program is to increase the number of minority students involved in the pipeline of mathematics, science, and engineering areas.

Small Learning Communities (SLC) programs support and aim to enhance the development of a safe and effective learning environment in High Schools with large numbers of students enrolled. The main purpose of the SLC programs is to ensure that all students in High School graduate and move on in life with the knowledge and skills necessary to transition into a setting of higher education and the work force. SLC programs are based on 5 domains:

1. ***Interdisciplinary Teaching and Learning Teams*** are the basic building blocks of SLC’s which may contain one or more teams but never more than a few hundred students. Each interdisciplinary team of teachers shares students in common for multiple years and organizes instruction to gain more instructional time with fewer students.
2. ***Rigorous, Relevant Curriculum and Instruction*** is at the heart of SLC practice. Within large blocks of the instructional day, interdisciplinary teams can organize fieldwork and involve community partners to create a coherent and authentic program of study.
3. ***Inclusive Program and Practices*** ensure that students choose to enter a particular SLC on the basis of their curricular interests and irrespective of their history of achievement. SLC teams include educational specialists, who collaborate with parents, use time and resources flexibly, and tailor instruction to meet all students' learning needs.
4. ***Continuous Program Improvement*** is integral to SLC team work. Teachers engage in disciplined reflection on their practice to ensure that all students are learning. They regularly examine student work and objective indicators of student learning and solicit input from all members of the SLC community to identify needs for improvement.
5. ***Building/District Support*** takes the form of policies and practices that enable SLC teachers to function in the ways described above. A fundamental form of support needed for SLCs to thrive is sufficient autonomy for SLC teams to respond flexibly to the needs of their students. (NW Regional Educational Laboratory)

The Massachusetts Academy of Mathematics and Science at WPI is a program available to 11^{th} and 12^{th} grade high school students. The Mass Academy at WPI is set up to nature the needs of "academically accelerated youths." It is a public high school that focuses there studies on mathematics and science. The junior year class itself follows are very intense curriculum that surpasses the expectations of standard Honors and AP credit courses in ordinary high schools. During the students' senior year, they will have the opportunity to complete one year of college at WPI. The program also offers a balance by including humanities and world languages.

North High offers different programs to fulfill the special interest of students. North High offers Professional Pathways provided for students in grades 11^{th} and 12^{th}. Professional Pathways are two year programs that are comprised of various elective classes related to the students' desired interests. The pathways offered are Advanced Academics, Business, Engineering Technology and Communications, and Health and Human Services. Within the Engineering Technology and Communications pathway students would have to complete the following courses: Computer-Aided Drafting/Design, Graphic Communications, and Electronics. At the end of the program the students will have developed a clear understanding of engineering technology concepts as well as communication concepts. As a result, the students will be able to evaluate their experience and decide whether a degree in engineering technology or communications is the right career path they should pursue in college. Nonetheless, the students will have an established background that will in some way aid in their college experience.

South High offers different academies to the students upon entering their freshman year. Within those academies are predetermined course requirements for every year they are in South High. The areas available for study are Arts and Humanities, Education Service and Government, and Information Technology. Focusing on Information Technology, students enroll in this academy if they express an interest in technology, graphic design, communications, electronics, automotive, or multimedia. This academy is very interactive. The purpose of this program is to create an atmosphere where students succeed while accesses various types of technologies.

Doherty High School also offers an Engineering and Technology Academy. The Academy is comprised of various activities that identify the commonalities within various disciplines as concepts are reinforced in multiple contexts. The program emphasis the advantages of project-based learning and incorporating technology in relating courses. Students will learn the basics such as the engineering design process, scientific method and multimedia programs (i.e. PowerPoint, Excel, Publishing, E-mail). The students will have the opportunity to learn how to use the various tools, programs and materials to enhance their learning process through hands-on activities.

2.3.2.2. Advantages

The majority of students that are currently interested in engineering are only interested because their parents/guardians, family member or friend of the family is an engineer. Engineering outreach programs and Incorporating engineering concepts into the current curriculum will also verify or disprove preconceived beliefs that some students may have already formulated. Outreach programs provided a further explanations and hands-on experiences to students interested in mathematics, science, and/or engineering that they may not experience in their current high school classroom. Outreach programs set a mind nurturing atmosphere, providing students with numerous resources to answer all their questions concerning various concepts.

The incorporation of engineering and engineering principles in the current Worcester Public Schools' mathematics and science courses enhance the student's desire to learn the material because they have made a connection with the material and real-life examples. Introducing the concept that engineering is the application of mathematics and science to solve real-world problems, students will finally realize the importance of the concepts they learn in their basic mathematics and science classes and how they relate to real world situations. Incorporating the concepts that current academies are following regarding engineering in the regular high schools will spark the interest of students. After being exposed to new ideas, concepts and hands-on projects that relate to real world problems--students will begin to ask questions to broaden their understanding of the mathematics, science, and engineering concepts and also seek for additional examples or in-depth explanations.

2.3.2.3. Disadvantages

Although in general there are no disadvantages in outreach programs and academies in the Worcester Public Schools Community, there is one great challenge that must be overcome—lack of interest. Given that the main purpose for outreach programs is to attract those that are not as informed about a topic, it is also used to further educate those that show interest in the topic. However, most of the time only students that are interested in mathematics, science, and/or engineering will consider attending outreach programs or academies on their own. Students that have minimal knowledge of and preconceived views on mathematics, science, and engineering are very unlikely to show any type of interest in outreach programs or academies focusing on the preceding topics. This was seen in a personal experience with Step into Strive, where the majority of the students, although recommended by their teacher or principal, had no plans on attending college for a STEM major. However, in order to overcome the issues many outreach programs deal with in not really reaching out to that student population they initial aim to and hope to reach out to, we made sure to include both the parents and teachers (school administration) into the application process. With the parents aware of the competitive and exclusive nature of the program and seeing that their child had been personally recommended by their teacher and principal of the school, their need for their student to experience this newly available opportunity was overwhelming. A proper selection criteria is one way in which outreach programs can guarantee that they are indeed reaching out to the student population they intend to reach out to.

2.4. Minority Interest In Engineering

2.4.1. Diversity in the Curriculum

The current mathematics and science curriculum is viewed as being white-biased—it only refers to white males that have made discoveries or those that have done extensive work to contribute to mathematics and the sciences. A diverse curriculum is one that incorporates and appreciates the study of multiple ethnic cultures in relevance to the course material. While the curriculum is taught the inclusion of various cultures will subconsciously begin to teach students to appreciate the distinct cultures surrounding them in their studies and their lives, especially in the United States, which is known for being “The Melting Pot” of the world. In addition to the appreciation of multiple cultures, students of distinct ethnic background will be able to finally realize how that course material can be directly related to them, their culture, and their heritage. Minority students will develop a sense of pride while learning the concepts of their course material. The world is full of diversity and there is no escaping it. The best way to deal with it is to accept and learn from it.

2.4.2. Methods

While the courses are being taught, teachers will make reference to well known, yet disregarded people-- whether they be scientists, inventors, or engineers from various ethnic backgrounds and relate them to the course material. Various elementary schools, middle schools, high schools and colleges are beginning to realize that diversity needs to be implemented in the current course curriculums to accommodate the needs and desires of the entire student body at those particular universities.

Due to the diversity at The University of Western Australia, the university implemented a set of guidelines with important points a teacher should review while constructing their course curriculum in 1998. The university felt that the “student population is [characterized] by diversity with regard to, amongst other characteristics, gender, race, age, disability, sexual orientation, cultural background and socio-economic status. Teaching which disregards diversity places students at a disadvantage by reducing their capacity to learn.” The guidelines focus on 5 main points: Curriculum design, Content, Delivery, Assessment, and Duty of Care. Each category is then broken down into various points’ stated in question form, which teachers will refer to and follow while preparing the course material. For example, an excerpt from the list follows:

2. Content
Does the course content:

- acknowledge the diversity of knowledge and experience of your students?
- use examples/case studies which are free of negative stereotypes or assumptions?[*]
- examine the implications of diversity as part of the theory or practice being studied?
- encourage students to [recognize] and understand different ways of knowing?

As a result of the provided guidelines, teachers can be sure that their curriculums appeal to the entire student body’s needs while covering all the course material required.

At the second grade level, Carolyn Brush a New Jersey teacher developed a curriculum that incorporates various cultures into the pre-set curriculum standards for second grade Social Studies. The theme she followed was “Around the World.” The multicultural "Around the World" curriculum expanded the 2nd grade Social Studies curriculum of communities and continents to include world communities and people.” The curriculum is greatly dependant of the class make-up since the material in the class is designed to reflect the diversity of the students in the classroom. In addition to the material taught and learned from the texts, the parents of students are invited in the share different aspects of their culture to the students in relation to the material being taught. The goal of the curriculum is to help “Students from diverse backgrounds develop pride in their heritage” while learning the course material.

2.4.3. Advantages

A diverse curriculum enhances the learning of minority students by providing a common ground between the students and the course material being taught- their individual cultures and heritages. With a diverse curriculum, students become aware of their surrounds and different cultures’ roles in history and in turn show an appreciation and respect towards other cultures as they continue to live their lives.

The University of Western Australia feels that there are many advantages of a diverse curriculum; “An inclusive [curriculum, which] acknowledges, respects and responds appropriately to diversity can contribute to: enhanced learning outcomes for a greater number of students; validation of student experiences and world views; development of international skills, cross-cultural perspectives, respect for different values and learning styles, and other skills useful in a diverse global environment; improvement of academic standards and the quality of university teaching; recruitment and retention of a greater number of students from diverse backgrounds.”

The multicultural curriculum in the New Jersey second grade class is astonishing. There are numerous advantages to this multicultural curriculum. Not only does it make sure to cover all the materials required by the Social Studies requirements but it takes advantage of the diversity in the classroom and applies it to course material to keep the children involved and interested; it also “extends into language arts, science and math.” While discussing all of the ethnic backgrounds, those of ethnic decent will begin to feel proud about their roots. They will feel like they are not losing their culture in the United States, but realizing its value and contributions to history, the building block of the world we live in today. Nevertheless, all the students in the class will be excited to learn more about history and all the difference cultures that contributed to it. The effects of the curriculum in this single second grade class also spread to the neighboring ones. The students had the opportunity of viewing the art the students did in the classroom. The English as Second Language students also had the chance of viewing the art. They “became excited whenever they saw something from their country or even their continent [a]and they felt really good that that their language and their culture were being studied in an American.”

2.4.4. Related Studies

Intending To Stay: Images Of Scientists, Attitudes Toward Women, And Gender As Influences On Persistence Among Science And Engineering Majors, a published work by Mary Wyer from North Carolina State University came to one conclusion that the creation of pipeline programs and outreach programs serves no purpose in the realm of discovering why there is a significantly low retention rate among minority students pursuing an Engineering degree. “Pipeline programs have been created… not the answer to see why under representation of some groups in science and engineering.” (Wyer, 2003)

The goal is to produce a curriculum that retains the salient technical material but enhances the link between fundamentals and applications, reduces critical path length in the course sequence, introduces team experiences into all courses, and creates an atmosphere of inclusion rather than exclusion (Busch-Vishniac and Jarosz).

Minorities make up the smallest portion of the population and on the domain of Engineering with only 23% of the U.S. represented by Black’s, Hispanic’s, and Native American’s. Only 6% of the 23% are in the engineering labor force, and a more alarming statistic is that black women make up 0.4 % and Hispanic women make up 0.6% of the science, engineering and technology workforce.

This is largely due to our current curriculum and the Educational System that employs it. The 2001 retention rate in undergraduate engineering for minority students was 38% of the minority students. “The “lack of hospitality” undermines the academic performance of minority students.” (Wyer, 2003)

The current curricular setup does not appeal to minority students and does not further the interest or even bring about an interest in engineering by minority students. The study by Ilene J. Busch and Jarosz found a lack in the introduction of Engineering at an early stage in a student’s educational career which in turn led to that student undertaking an engineering major only to step into the basic coursework and lose interest, resulting in a change of major.

Once the curriculum holds a sense of social relevance and introduces the Engineering concepts progressively and at an early stage in the students educational career, we will see a major increase in the number of minority students pursuing Engineering degrees, as well as, a large flux in the retention rate of minority students pursuing Engineering. “Our current curriculum structure tends to neglect the importance of social relevance.” “The need for this link is particularly acute for women and ethnic minorities, because they are seeking concrete evidence of social relevance and relevance to their subcultures.” (Wyer, 2003)

Member’s of NSF’s Project for Multicultural and Interdisciplinary Study and Education (PROMISE) at the Univ. Nevada found social relevance was an important aspect of a minority student’s decision to pursue an engineering major. “Evidence suggests that ethnic minority students consider not only social relevance but the extent to which the curriculum is tied to values of their subculture. For this reason, we must consider the role of diversity and multiculturalism if we seek to encourage more diversity in engineering school.” (Wyer, 2003)

The outcome of the majority of the studies was that there was a serious deficit in the realm of multicultural based engineering principles and relevance in the current Educational System. The Massachusetts Public School system is no different and suffers from many if not most of the same symptoms present in institutions of Higher Education. "…a revolutionary change is needed—one that addresses the root cause: an unattractive, unresponsive, and culturally biased curriculum—rather than an easing of symptoms through medical targets achieved by any means possible…addressing social relevance and diversity throughout the curriculum is clearly of great importance in making the curriculum more attractive to underrepresented groups…Even the simple act of discussing the people of both genders and all races who first applied fundamental concepts in particular fields might have the profound effect of humanizing our courses and our profession and making women and underrepresented minorities feel as if they are an integral part of the engineering profession." (Wyer, 2003)

2.5. Surveys

2.5.1. Background

Surveys have a variety of purposes and goals, as well as, means of implementation, which includes telephone surveys, mail surveys, and face to face surveys. In addition to the difference in how surveys can be administered, they also all share the same attributes and characteristics.

Surveys gather information from only a sample of the population being studied. The sample size is usually determined based on the size of the sample population. Thus the sample size would increase as the sample population increased and vice versa. The sample carefully and scientifically determined so that bias is not prevalent and each member of the sample population has the same chance of being selected as part of the sample. This method of statistical random selection allows for statistically inference of the sample population, which is a reliable projection of one's results from the sample to the sample population as a whole.

The ultimate purpose of the survey is to allow for some statistical inference of the sample population. The aim is to describe or obtain a composite perception of the sample population as a whole.

2.5.2. Survey Methods

Mail surveys are usually low in cost. Mail surveys are the most effective when the survey is focused and geared towards particular groups.

Mail surveys are the considered relatively easier to conduct for the person administering the survey, as well as, quite simple to fill out by those that have little or no experience filling out a survey. Mail Surveys also allow one to minimize ones sampling error at a relatively low cost, without increasing the cost of administering the survey. This method also allows for a feeling of privacy, which in turn allows people taking the survey to answer questions more honestly and feel more comfortable filling it out. The most important aspect of a mail survey is its ability to minimize or even eliminate the level of bias that is usually introduced when a person comes in contact with the interviewer.

Mail surveys, however, due lack in some aspects. Mail surveys suffer from non-response error, which stems from the fact that most people just won't fill out the questionnaire that is mailed to them. Another issue that surrounds mail surveys is the lack of control the person administering them has on its completion and return. The idea that someone other than the person intended filled the questionnaire out and returned it is something many researchers who use this method keep in mind.

Telephone surveys are an efficient method of collecting some types of data and are being increasingly used. Telephone surveys are implemented successfully in situations that involve time. When time is a major factor in the successful administering of a survey, this is the preferred method due to the fact that the survey length can be limited and can still be very effective.

The most important and greatest strength of the telephone survey method is its ability to generate results quickly. Adding to the quick turnaround that survey administers experience, the telephone survey allows for the greatest interviewer control. The conductor of the telephone survey controls the implementation of the survey from the beginning to the end.

Like Mail surveys, telephone surveys also have their disadvantages. The first and most common issue with conducting a telephone survey is the fact that not everyone has a telephone in their household. This statement hold true years ago, but in our day and age of technology advancement 93 percent of the United States population has a telephone in their household. In addition to this issue, telephone surveys suffer from the lack of completed and updated telephone directories. It is difficult to continuously and accurately update and complete the telephone directories especially in a timely rate when one in five households in the United States move every year. Lastly telephone surveys introduce a level of bias to the study. Leading questions from the interviewer, the voice of the interviewer, as well as, the knowledge of the subject matter that the interviewer him/herself possesses are all issues that play into the bias brought about by telephone surveys.

Face to Face surveys in a respondent's home or office are much more expensive than mail or telephone surveys. Although face to face surveys tend to be pricey and very difficult to administer, they are found to be necessary when complex information is to be collected.

Face to Face surveys are found to be the most effective manner of interviewing a person or group of people who are less likely or willing to respond to a phone or mail questionnaire. This method eliminates the issue of incomplete directories and phone calls but can also be very inefficient and expensive at times. Price comes into question when money is used to travel to conduct a survey and the participant is not home or not responding.

The negative of conducting a Face to Face survey is the need and requirement of an administrator who is highly trained and well versed on the research topic at hand.

2.5.3. Survey Questionnaire Design

Questionnaire design deals with the reduction of non-response and measurement errors that come from inefficient and difficult to navigate questionnaires. Effectively designed surveys take time and effort to develop. They attract people because people are more inclined to complete and attractive and easily navigable. Due to this non-response error, as well as, measurement error are minimized.

2.5.3.1. Mail Survey Questionnaire

People respond to mail surveys that are attractive and are deemed worth their time. The concept of a good mail survey design lies in the perception of the person that is taking the survey. In order to increase the number of responses for a mail survey, one must make sure that the pages are not cluttered with unnecessary information and that the survey pages have consistent instructions and are easily navigable. The visual aspect of the mail survey is the most important and critical in terms of the response rate that is expected from its participants.

2.5.3.1.1. The First Question

The beginning of a survey questionnaire is not the place for a question that could embarrass a respondent, that is hard to answer, is boring, or smacks of arcane qualities, which only a devoted questionnaire writer could love. (Salant & Dillman, 1994)

The following are some brief points of structure of a survey questionnaire first question:

1. Don’t ask something open-ended
2. Don’t ask something difficult
3. Don’t ask something embarrassing
4. Don’t ask people directly about themselves

2.5.3.1.2. Pre-testing

Pre-testing a questionnaire is time consuming but it is absolutely necessary and at most time essential the effectiveness of the survey and the study. Pre-testing is a researcher’s first line of defense against his/her own survey. Pre-testing is a method use to answer questions such as “Are the questions interpreted the same by all respondents”; “Does the questionnaire create a positive impression that motivates people to respond?; and “Does any part of the questionnaire suggest bias on your part?” (Salant and Dillman, 1994)

Pre-testing is conducted in two phases. The first phase deals with communicating with the potential participants of the survey study, as well as, those individuals that the survey is about if the survey deals with a group of people. This is necessary to gather any feedback from these two groups to further improve on your survey instrument. These people have much more knowledge than you do in the area and could detect and correct and technical errors within the survey instrument.

The second phase of pre-testing deals with the actually administering of the survey instrument to the potential participants. This is the time that the researcher or survey developer should monitor the participants as the fill out the questionnaire. Following the completion of the survey, the researcher should question the participants about taking the survey.

3. Pre-Engineering Mathematics & Science Curriculum Addendum

Ones socioeconomic status in the United States, as well as, in other countries and societies is determined by the income of the family, the education of the parents within the family measuring the highest educational level received, the occupation of the parents within the family and lastly the family’s social status within their community. Those having a higher socioeconomic status usually experience more success in the preparation of their children for the educational system facing them due in part to the numerous resources available to them for the sole purpose of child educational development.

Crnic and Lamberty (1994) discuss the impact of socioeconomic status on children's readiness for school: "The segregating nature of social class, ethnicity, and race may well reduce the variety of enriching experiences thought to be prerequisite for creating readiness to learn among children. Social class, ethnicity, and race entail a set of 'contextual givens' that dictate neighborhood, housing, and access to resources that affect enrichment or deprivation as well as the acquisition of specific value systems."

Research has shown that not only do those having a higher socioeconomic status have access to resources that those beneath them in socioeconomic status do but that they also are more willing to ask and gather the necessary information that they feel is necessary to the development of their children. This is in direct contrast to those have a low socioeconomic status, who are vastly uninformed and do not seek the knowledge and resources necessary for the proper educational development of their children.

Ramey and Ramey (1994) describe the relationship of family socioeconomic status to children's readiness for school: "Across all socioeconomic groups, parents face major challenges when it comes to providing optimal care and education for their children. For families in poverty, these challenges can be formidable. Sometimes, when basic necessities are lacking, parents must place top priority on housing, food, clothing, and health care. Educational toys, games, and books may appear to be luxuries, and parents may not have the time, energy, or knowledge to find innovative and less-expensive ways to foster young children's development.
Even in families with above-average incomes, parents often lack the time and energy to invest fully in their children's preparation for school, and they sometimes face a limited array of options for high-quality child care--both before their children start school and during the early school years. Kindergarten teachers throughout the country report that children are increasingly arriving at school inadequately prepared."

As aforementioned, students of like socioeconomic status perceive the world much differently than those of their counterparts. Pursuing a post-secondary school degree is not something many of these students would say is one of their objectives in life, when they are forced to deal with so much outside of the educational realm. These students are left to venture the world alone and one could only assume that they would quickly come to a realization upon looking at those people that comprise the community that maybe there is no hope for them in furthering themselves.

This mentality is not only developed by students as they progress through the educational system but is also fostered by a lack thereof a continuous effort to acknowledge and deal with the increasing state of failure of the schools that they attend. This lack of a response can only be explained by many researchers with the understanding that America simply is not concerned about the increasing numbers of students coming from such socioeconomic situations that are not being properly educated.

There seems to be a sense of two distinct classes of failure resulting from and proving to be an example of such dismission on the part of the State & Federal Educational Institutions. The first is the issue of high dropout rates and illiteracy of those students who are socioeconomically disparate in comparison to their counterparts. The second is the issue of increasing mass mediocrity throughout the educational system seemingly affecting those falling in a middle class socioeconomic status more than all others. The circumstance of mass mediocrity is addressed by Prof. Pedro A. Noguera, Ph.D:

“And what explains the phenomenon of mass mediocrity? There's some truth to the traditionalists' view that the schools started downhill when we lost faith in the core curriculum and in the pedagogical standbys, like phonics. And yet Americans have always managed to devise substitutes for and distractions from the academic curriculum taken for granted elsewhere in the world - Deweyan "child-centered education," voc ed and football, the "general" track, sex education and character education and drug awareness and conflict resolution and so on. We have never held intellectualism in high esteem, and we became the world's most powerful nation without ever becoming the world's best educated.” (Noguera, 2003)

A good education is often the only method to ending the continuing and increasing cycle of poverty for those students belonging to a low socioeconomic status. This idea of a “good education” is one that is fundamentally grounded in the pursuit of and fostering of high academic standards and expectations. Alignment of such elements with the curriculum must be guaranteed due to the fact that a student’s achievement, personal and academic, is significantly impacted as a result of what occurs in the classroom. The only hope for students is to be continuously challenged in direct contrast to the lowering of standards to compensate for the average students lack of interest in the educational system as seen across the nation. An ever and increasingly challenging curriculum would proportionately prevent decreased opportunity for higher education, as well as, translate into a greater percentage of opportunity available to them as they leave the educational system. “A watered-down curriculum is unacceptable. Teachers should be knowledgeable of the cultures in which their students live so they can plan effective and engaging lessons. Additionally, instructional and classroom management techniques that work well with some students don’t necessarily work well with poor children. The perspective and experiences of the children need to be considered” (Goodwin, 2000).

As educators should be increasingly knowledgeable about the cultures in which their students live, developing a multicultural inclusive curriculum such as that in which we are proposing should be resistant to the documented myths associated with multicultural education. The proposed curriculum addendum must overcome the ideology that the variance seen in other cultures should be represented as different ways of living as compared to the dominant culture, as well as, how there should exist a different set of curriculum for multicultural education. It should also be resistant to the notion that multicultural education proves only relevant to those classrooms in which students representing those cultures reside. (Gomez, 1991)

Educator and content based perspective also plays a large role in the development of a curriculum addendum. Not only must our curriculum addendum establish and foster an educators awareness of a student's cultural identity and the biases it may elicit, it must also through the use of multicultural based content enable a change in student attitudes in that all cultural groups have through history made pertinent and significant contributions in all subject matters. (Gomez, 1991)

A number of programs across the nation have made attempts at implementing a multicultural education. These programs utilize a number of methods including content-oriented, student-oriented and socially-oriented programs. The content-oriented programs add multicultural education into their curriculums by inclusion of excerpts and in-class celebrations of cultural heroes and holidays as the school year progresses. Many of the content-oriented programs also are much more inclusive and representative of an ideal multicultural education by adding a number of multicultural themes and materials to the curriculum allowing for the development and coverage of multicultural content throughout all disciplines incorporating a plethora of ideologies and perspectives in the curriculum. (Burnett, 1994)

Student-oriented programs tend to address the academic needs of students, especially those students representative of an under-represented minority group. These programs tend to exist as a result of research into what teaching methods and curriculum structures show promise towards students of these targeted groups. This leads to bilingual or bicultural programs being offered to students, as well as, special classes and programs of study being implemented for minority students such as special math and science courses. (Burnett, 1994)

Lastly, the socially-oriented programs are aimed towards the increased contact and total inclusion of all races and cultural groups through the desegregation and restructuring of schools. Such aims lead to anti-bias programs, programs to encourage multicultural teachers and teaching, as well as, cooperative learning programs with the sole purpose of increasing cultural and racial tolerance while at the same time decreasing bias. (Burnett, 1994)

All three methods have their advantages and disadvantages. However, we feel that both student-oriented, as well as, socially-oriented programs once again uphold this notion of separation and presenting minority students in a different light. Once you setup a program just for minority students you move further away from inclusion and determent of those students view that they are indeed different and cannot or should not be associated with their counterparts. The content-oriented method seems to be the best method of implementing a multicultural curriculum addendum. One in which, the students are not separated from their counterparts but all students are made knowledgeable of the varying cultures and the significant contributions each has made in all disciplines.

Through the course of our research we have found that the socioeconomic status of students, the lack thereof a multicultural education in the current curriculum, as well as, the low standards that exist in today's education system stemming from the low expectations we have of our students have strong implications on their education and academic performance. As a result, we felt that the ideal curriculum addendum should include the following characteristics:

1. Challenging curriculum for all students

2. Increased standards
3. Provided support for students and their respective families
4. Develop individual educational accountability between students
5. Development of an educational environment fostering team work and respect
6. Establish and emphasize the notion that each students posses unique abilities and brings individual value to the classroom and educational experience
7. Foster diversity acknowledgment and acceptance of diversity within the classroom
8. Proper utilization of constructivist concepts

We feel that the best way to ensure that these elements appear and remain in the course curriculum and to guarantee a challenging and engaging curriculum, one must include a project-based curriculum approach. A project is defined as a supplementary, long-term educational assignment necessitating personal initiative, undertaken by an individual student or a group of students. (American Psychological Association (APA)) It is also viewed as an in depth investigation of a topic. The fundamental aspect of a project based curriculum supplement is that it is a research effort focused on the ascertaining of answers to questions through research and analysis by the student. This approach is advantageous due to the fact that students learn and retain the fundamentals of a problem and reach an answer rather than being told the answer to a problem and simply committing it to memory in order to later regurgitate it if needed never truly understanding how and why one came to said answer. A project based sufficiently accounts for all of the characteristics we aforementioned with special consideration to the proper utilization of constructivist concepts. This approach would allow students to develop their own individual understanding of the concepts they learn in the classroom, allowing for teachers to serve a role consisting less of lecturing and more on developing situations in which all students in their classes can individually process the information and develop the relationship to the concept being taught. Concepts should not be presented as mere facts or notes of knowledge that students just absorb and move on, but should be decomposed and created into a personalized and individualized understanding of the concepts meaning.

As aforementioned we feel the project based approach should supplement the current Worcester Public Schools Curriculum not replace it entirely, as many new methods and models are introduced and replace entirely previous educational model instead of thinking how one could integrate everything. In fact, in line without thinking and application of the project approach to the WPS, advocates of the project based curriculum also do not suggest that the project work constitute or replace the entire curriculum. Instead, they feel that it is best seen as complementary to the more formal and systemic parts of the current curriculum, as well as, the more informal aspects of the current curriculum.“Project work is not a separate subject, like mathematics; it provides a context for applying mathematical concepts and skills. Nor is project work an "add on" to the basics; it should be treated as integral to all the other work included in the curriculum. Systematic instruction: (1) helps children acquire skills; (2) addresses deficiencies in children's learning; (3) stresses extrinsic motivation; and (4) allows teachers to direct the children's work, use their expertise, and specify the tasks that the children perform. Project work, in contrast: (1) provides children with opportunities to apply skills; (2) addresses children's proficiencies; (3) stresses intrinsic motivation; and (4) encourages children to determine what to work on and accepts them as experts about their needs. Both systematic instruction and project work have an important place in the curriculum.” (Katz, 1989)

In addition to not only supplementing the current curriculum with a project based approach, we feel that there exists a real and increasing divergence in the modern students will and personal desire to learn or challenge him/herself. An additional emphasis must be placed on the elimination of this negative image of the world that a student sees and the restoration of a student's personal image. Research has shown that students' image of the world they belong to and his/her image of themselves directly correlates to how they view their potential rewards and the necessities of their education in order to obtain such awards. "Children will work hard, for intrinsic rewards, only if they have a very good reason… The teacher may be the dependable and caring adult, often the only adult of this kind, who is a consistent and reliable figure in their lives of unpredictability and change" (Ciaccio, 2000)

Given the low number of minority students pursuing engineering in comparison to the White and Asian population, it is apparent that something must be added to the current curriculum to increase the awareness of STEM related fields. Currently, the curriculum is white male biased due to the textbooks currently produced. Since STEM related careers, specifically engineering, is the application of both science and mathematics concepts, it is only obvious that engineering concepts should be mentioned in all science and mathematics course. In addition, a connection is necessary to those minority students to increase their awareness and knowledge of STEM related careers. The following sections include an excerpt from the Science and Technology frameworks available on the Massachusetts Department of Education Website in defense of our conceptual curriculum addendum.

This Framework introduces four Scientific Inquiry Skills (SIS) standards that are included in each introductory high school course (except Technology/Engineering, where they are replaced by the steps of the Engineering Design Process):
SIS1. Make observations, raise questions, and formulate hypotheses.
SIS2. Design and conduct scientific investigations.
SIS3. Analyze and interpret results of scientific investigations.
SIS4. Communicate and apply the results of scientific investigations.

4. Step into Strive (Private Sector Engineering Outreach Program)

It is commonly discussed and proven, as aforementioned, that families of low socioeconomic standing do not and could not obtain the same opportunities as their counterparts, primarily due to the lack of a financial, social and educational support system that exists for those of a high socioeconomic standing. As a direct result the community resources that exist to promote and increase a student's educational development and opportunities are limited and inadequate at best. Such community resources include educational outreach programs many of which are funded by private sector partnerships aimed at increasing the number of students in their respective fields and industries that come from low socioeconomic situations. A typical outcome for these outreach programs is the overbearing number of students of higher socioeconomic status applying for the program in comparison to those students the program is aimed towards in part due to the inadequate and limited knowledge those parents of the students the program is attempting to recruit have of the program. "Having inadequate resources and limited access to available resources can negatively affect families' decisions regarding their young children's development and learning. As a result, children from families with low socioeconomic status are at greater risk…from their peers from families with median or high socioeconomic status." (Zill, Collins, West, and Hausken, 1995)

As a result the Step into Strive program was developed to increase the number of students pursuing STEM related fields and guarantee the enrollment of students of a lower socioeconomic standing who excel or have a desire to learn mathematics and the sciences, as well as, those who don't but would under ordinary circumstances be made aware of such a program or opportunity.

4.1. Mission

Step into Strive is a program devoted to the pursuit of an interdisciplinary and challenging Engineering Instructional methodology, as well as, the implementation and promotion of Science, Mathematics, Engineering/Technology and future STEM related opportunities to the parents and students of Worcester, MA through fun, innovative and hands-on design projects that comprise the Step into Strive Program.

The primary objective of the program was to advance the understanding and application of engineering principles and concepts in order to enhance the Science & Mathematics Educational development of the middle school students in the Worcester Public School system while building on and improving the Worcester Polytechnic Institute (WPI) culture of Innovation and Educational leadership. The programs affiliation with the Faculty, Staff and Students of a nearby university (WPI) allowed the program to provide an innovative and challenging STEM based environment to children in Middle School, regardless of gender, ethnicity, culture or socio-economic status, with special outreach for those groups traditionally underrepresented in the Sciences and Mathematics.

4.2. Vision

Step into Strive will be a distinctive and continuously innovative program of national stature, emphasizing and promoting the integration of knowledge across the Mathematics and Sciences to the application of these principles and concepts within the Engineering Discipline and Society. The program will be noted by Departmental and Faculty excellence and innovation in both Education and Support, and by the invaluable Graduate and Undergraduate students trained not only in academic success but also in continuous originality and criticality in reasoning, communication and representation as effective leaders and role-models to those students participating in the program; creating a tangible bridge between their age group and understanding with their higher education mentors and leaders. The program aims to stand as a pinnacle in the movement to attract more students to STEM related fields.

The program has reached almost 100 students and parents not only giving them the opportunity but also providing them the tools and knowledge to begin a lifelong exploration of Engineering, Mathematics and Science.

4.3. Step into Strive Program

Simply put, engineering is solving real-world problems using a combination of mathematics and science principles and concepts. Problems that engineers solve can range from how to build bridges, how to make artificial organs for people, to how to treat waste to keep it from polluting the environment. It's impossible to go through a single day without using something an engineer has helped to create or in the least acting as an engineer yourself by applying your mathematical or science knowledge to a problem no matter what educational level you are at or your age.

The Step into Strive Program is a six month enrichment program to introduce Middle School students in the Worcester, MA area with a special interest to those students in underrepresented groups to fields in Science, Mathematics and Engineering. The program creates an innovative and intuitive environment fostering originality and self-discovery allowing the students to explore the engineering, math and science fields of study through the utilization and application of the Engineering Design Process and Engineering Design Projects to increase their likelihood of pursuing further interest in these areas during their high school and college enrollment.

The ultimate goal is to shatter pre-conceptions of engineering and bridge the gaps between, Mathematics, Science, Fun and Real-World Applications. The Step into Strive program is primarily comprised of a challenging and very in depth Engineering Design Project, that will take the student through each step of the engineering design process, from defining the problem, to conducting in depth research, to designing a solution, to testing the solution, and then to finally fabricating and making their proposed designs.

The design projects fall into one of the three Engineering Majors represented in the program. Biomedical, Mechanical and Electrical & Computer Engineering Professors and their carefully handpicked Graduate students and Undergraduate assistants are at the disposal of the students, with the Professors proposing the problems, many of which are current issues in the field and serving as the client or the Company paying the students to develop this product and come up with a solution and the students overseeing the scope of the project as advisors. Previous projects included an Artificial Leg for a middle school athlete, an innovative powered wheel chair for a paraplegic young man and an integrated and networked security system for the Worcester Courthouse currently being built.

Students were required to learn and display their competence of all of the steps of the engineering design process, as well as, any additional science and mathematical concepts relating to their projects. Students were take on a journey from the most fundamental level of mathematics and science pertaining to their projects to the highest level needed to fundamentally understand each of their individual projects. Examples of such concepts range from the understanding of the biomechanical principles and mathematically equations surrounding prosthetics such as tensile forces, compressive forces, stress and strain to their application and modeling.

All of this is wrapped up in a final presentation, giving the students an opportunity to learn proper presentation and communication skills, as well as, to learn how to create a PowerPoint presentation and a project presentation poster one which follows the format graduating seniors here at WPI utilize. The students are also required to submit a research paper on their design projects.

4.4. Step into Strive Progression

The Step into Strive Program was developed in order to establish a private sector engineering based outreach program that could be used to supplement the classroom curriculum and further foster the mathematical and science principles covered in the classroom. The program operated under the following ideology.

- The Recruitment and retention of middle school students with a special interest in those belonging to under-represented groups and provide an innovative educational environment and experience that prepares them for a future in Mathematics and the Sciences particularly STEM related majors.
- The Recruitment and retention of Dedicated & Interactive Faculty members with interests in increasing the number of youth entering STEM related majors.
- The Establishment of a new model for engineering education that focuses on in depth and challenging project-based interdisciplinary and integrative program facets.
- To increase our relationship with Local Small Business and Large Corporations in the STEM related fields and increase their involvement in the advancement of students in their respective fields.
- To create a continuously innovate environment that fosters and develops a deep conceptual understanding of Mathematics/Science and Engineering principles.
- To be able to translate those engineering principles to design applications leading to a solution.
- To develop within our young participants adequate written and oral communication skills.

4.5. Step into Strive Program Breakdown

The Step into Strive Program is a six month enrichment program to introduce African American, Latino, and American Indian middle school students to fields in science, mathematics and engineering.

4.5.1. Participants

The Engineering Design program targets students from the 6th through 8th grade who are currently attending one of the Worcester Middle Schools. The aim of the program was the acceptance of a diverse group of students with the diversity ranging in grade, ethnicity and more importantly on their academic performance in Mathematics in Science. Primary focus was given towards the acceptance of underrepresented students.

Given the fact that most outreach programs suffer from the lack of a diverse population of participants due to the fact that the only people who apply are already interested in the program being offered, we decided to refine our application and consideration process. Information for the program was sent out to the schools and recommendations for participants were requested. Principals, as well as, teachers were asked to recommend students from their schools from various academic and socioeconomic backgrounds. The program was highly competitive and approximately 25 students are admitted. Thus, acceptance into the program was based on some of the following selection criteria:

i. Student must be representative of one of the ideal socioeconomic groups
ii. Student must be representative of one of the ideal academic groups
iii. Student must show some interest in or must show the potential in succeeding in Mathematics and Science curriculum

A profile of those students who participated in the 2005-2006 program can be seen in Table 3. There is no cost to admitted students for the duration of the 6 month program. All accepted students receive a scholarship to cover their costs in the program including but not limited to course material, lectures, design project budget, field trips and other events, dinner and additional meals on field trips/events. Those participants graduating from the program and who’s Engineering Design Project are judged as the winners will receive a tuition scholarship for the Worcester Polytechnic Institute (WPI) STRIVE Junior Summer Program.

Student	Grade	Race/Ethnicity	Gender	School
1	7	Hispanic	M	Burncoat
2	7	Hispanic	F	Burncoat Middle
3	6	White (non-Hispanic)	M	Burncoat Prep
4	7	African American	M	East Middle
5	7	African American/Hispanic	M	East Middle
6	6	Asian	M	Flagg Street School
7	6	Egyptian	M	Flagg Street School
8	6	Hispanic	M	Gates Lane
9	6	Hispanic	M	Jacob Hiatt
10	6	Hispanic	F	Jacob Hiatt
11	7	African American	M	Jacob Hiatt
12	6	Hispanic	F	Jacob Hiatt
13	6	African American	F	Jacob Hiatt
14	7	African American	M	Jacob Hiatt
15	6	Asian	M	Lake View
16	6	Hispanic	M	Lake View
17	6	African American	F	Rice Square
18	7	Hispanic	M	Sullivan Middle School
19	8	African American	M	Sullivan Middle School
20	7	African American	M	University Park
21	8	Hispanic	F	University Park
22	8	Hispanic	M	University Park

Table 3: Profiles of Step into Strive Student Participants

4.5.2. Program Curriculum

The students participated in the program on a weekly basis with scheduled weekly meetings at the start of the program and then transitioning to 2 meetings on weekly basis the last month to provide sufficient enough time for them to complete their design projects. The weekly meetings were divided accordingly to properly represent one of the steps/stages of the Engineering Design Process.

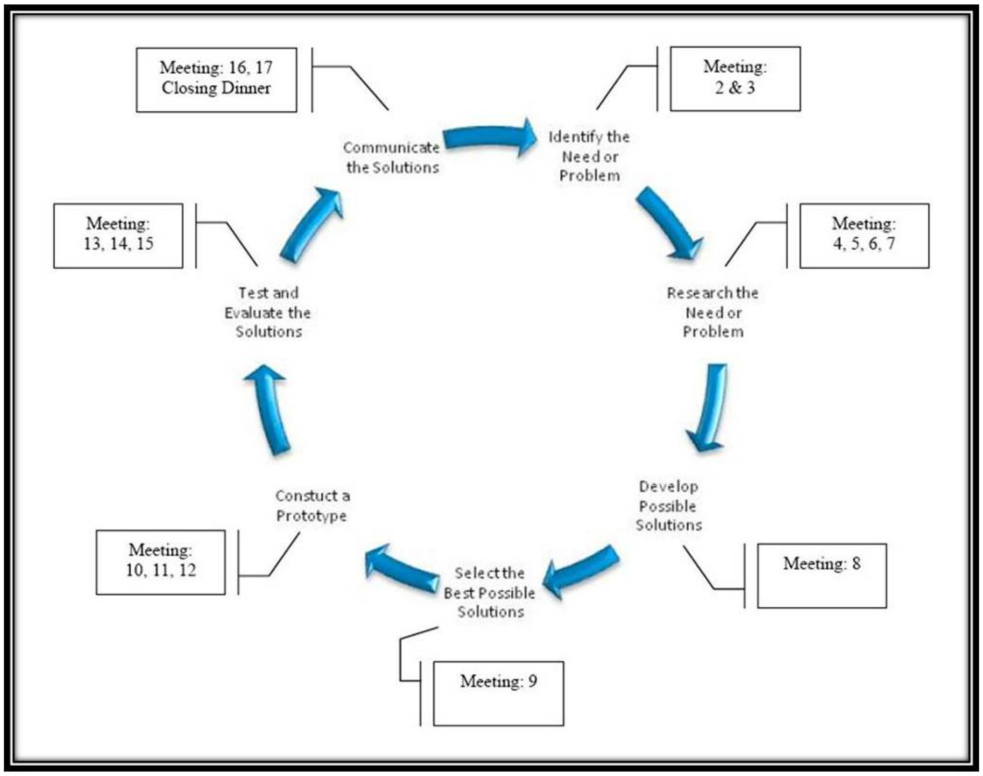

Figure 1: Program Outline & Engineering Design Process

Accepted student participants, their families, teachers and principals were invited to the main WPI campus for the first meeting of the program. The first session of the program served as an informational overview of the program, requirements and schedule. This meeting also served as an overview of the different engineering fields of study the program will examine, with the introduction of the Professors and Department Heads of their respective fields. Each Professor will gave an interactive and informative presentation on their respective engineering major following each one up with a hands-on activity for both the accepted students and all those present. The program and meeting outline, as well as, schedule can be seen in Table 4.

Meeting 2	This meeting began with a recap of Mechanical Engineering and Biomedical Engineering, both parents and participants were present at this meeting. A professor from the Electrical & Computer Engineering (ECE) department was present and gave an overview of ECE. The engineering design process was introduced to the participants before viewing a video created by IDEO which showed the process designers go through when creating/recreating a product. A discussion took place and the participants began thinking of which group they wanted to be a part of.
Meeting 3	The meeting began with a recap of all the majors, the preliminary groups were announced and the students were split into those groups. The focus of this meeting was the first step of the engineering design process, identify the need or problem. The students were given a sample problem statement and we had an open discussion to guide the participants with this step. The participants were then introduced to their clients and took trips to the different labs for an activity related to that major. ME- machine shop; BME-tensile testing; ECE- circuits
Meeting 4	The focus of this meeting was the second step of the engineering design process, research the need or problem. The final groups were announced at this meeting. A recap of how to identify the problem was given at the start of the meeting. The participants moved to the library for a workshop given by two of the librarians on how to research and created a homepage specifically for the participants covering the topics related to their projects.
Meeting 5	The focus of this meeting was step 3 of the engineering design process, develop possible solutions. Prior to this meeting a packet with the following worksheets were sent the participants: Problem statements, Redefine the problem statement, Objectives, Constraints, Research, Interview Questions, and Function-Means Chart. A review of the sample problem was done for each of the worksheets previously mentioned to help the participants understand when each concept means. The participants met with their clients to ask them any questions about their constraints for the project and to work on all the worksheets and based on their functions-means chart, start developing possible solutions.
Meeting 6 & 7	The meeting began with a recap of the engineering design process. The groups then moved to the library to continue research to develop possible solutions.
Meeting 8	The groups were provided with worksheets specific to their groups to guide them in their research. The ME group was given information relating to the different type of wheelchairs that are currently on the market, in addition to a list of vocabulary words such as quadriplegic, joy stick, pressure, stress, and strain to ensure the students understand all the concepts related to their project. The BME group was given more vocabulary words related to material selection such as biocompatible, stress, strain, weight, pressure, hardness, and rigid, since their focus for the project was related more to material selection than the design itself. The group was also given a diagram with the basic parts of prosthesis. The ECE group was given a vocabulary list which included infrared sensors, sensors, current, switch, terminal, series, and parallel. The focus of their design was more understanding the components and how they work than the overall design.
Meeting 9	The meeting began with a recap of the engineering design process. The groups then moved to the library to continue research to develop possible solutions. The students were asked to start thinking of the materials they would need for their prototype.
Meeting 10	The meeting began with a recap of the engineering design process. The groups then moved to the library to continue research to develop possible solutions and develop questions for their clients and a list for their prototype. The sections of the research paper were presented to the participants.

Meeting 11	The focus of this meeting was step 4 of the engineering design process; select the best possible solution, and a lab with a theme of "Talking a walk in my shoes." The meeting began with a client meeting where the participants presented their design idea to the client and the client then gave them feedback. The groups continued developing a list of materials needed for their prototypes. The participants also discussed the parts of the research paper. Each group then completed a lab that related directly to their project. **ME- wheelchair lab:** The group was given two wheelchairs to share and a list of activities to do while on the wheelchair which included, going into a classroom with a closed door, entering a restroom, entering and exiting an elevator, exiting/entering a building, and going up and down an outdoor ramp. The groups also simulated what it would be like to complete these tasks as a quadriplegic. The allowed the group to experience firsthand the challenges people in wheelchairs face on a day to day basis to guide them in their design. **BME- leg prosthesis:** The group was given a set of leg prosthesis that was provided by a local company to let people experience what it is like to have two prosthetic legs. The prosthetic legs were made with a hard strap on cast with a prosthetic ankle and foot attached to the bottom of the cast. At the end of this activity the group discussed the concepts of pressure, tensile stress, strain, and force and how they relate to walking in prosthesis. **ECE- circuits and switches:** The group reviewed all the components of circuits and how switches work. The students reviewed the circuits in sets of two to ensure that they understood the components. At the end of the review session the students were able to see a senior project that was completed by an ECE student that designed a security system. The group was able to see the circuit board used for the project.
Meeting 12 & 13	The focus of this meeting was step 5 of the engineering design process, construct the prototype. The groups met with their clients to begin working on their prototype, research paper, and PowerPoint presentations for the final dinner. The groups also began working on a poster to display at the final dinner.
Meeting 14	The focus of this meeting was step 6 of the engineering design process, test and evaluate the final solution. The groups met with their clients and finished up working on their prototypes and started any testing related to their project. The groups also finished up the research paper, PowerPoint, and poster for the final dinner.
Meeting 15	The first part of the meeting was designated to finish up any parts of the project. The second half of the meeting was designated to celebrate the end f the program and reward the students of all their hard work with a bowling party.
Meeting 16	The focus of this meeting was the final step of the engineering design process, communicate the solution. This was the final meeting where the groups practiced their presentations in preparation for the last meeting.

Table 4: Step into Strive Program Outline and Schedule

5. Worcester Public Schools Private Sector Consortium Pre-Engineering Grant

5.1. Grant Program Description

While implementing the Step into Strive Program we assumed the role of Program Coordinators. During the program it was clear that this position required an extensive amount of work, which is why we feel it is important to create a private-sector consortium to aid in the overall organization of the program to allow for the teachers to focus on the pilot program and concepts associated with it in dealing with the participants. The following sections detail the grant outline used by the Massachusetts Department of Education for our private sector consortium grant concept.

5.1.1. Purpose

The purpose of the privately-funded grant is to aid in the development of a pilot STEM enrichment program during out-of-school hours that will further emphasis the concepts being taught in class through the use of hands-on and in-depth STEM theme design projects. This program will increase the students' knowledge of STEM fields while challenging them to develop a true understanding of the concepts taught in the classroom. Parent/Guardian(s) of the students will have the choice of entering their child into the pilot program. Not only will the program aid in the development of the students intellectually and personally, but should include the awareness of further education to the families of the students.

5.1.2. Priorities

The priorities of the program should include informing the students in the Worcester Public Schools about the different STEM career fields available while also educating the parents about STEM careers and the advantages of pursuing a degree in such an area. The program should place an emphasis on the advancement of underrepresented students due to ethnicity and/or income status.

5.1.3. Eligibility

Only the High Schools in the Worcester Public School System are eligible to apply for this grant.

5.1.4. Funding

A predetermined amount of money will be available to the grantee upon the agreement to submission of:

1. Quarterly progress reports;
2. Attendance and program quality data during the program; and
3. Evidence that the grantee is interested in maintaining the program after the pilot program

The grantee will need to provide information to the grants' Board of Directors regarding the students that are participating in the pilot program and any services the program is providing to the parents of the students involved.

5.1.5. Fund Use

Funding provided must only be used for the *Purpose and Priorities* previously described. This grant is broken into 3 main areas: Teacher training, Classroom curriculum, and the enrichment pilot program. Prior to the launch of the pilot program, a portion of the grant will cover the cost of teacher training to ensure the teachers have an acceptable degree of competence of the STEM careers and potential project topics. The goal of this pilot program is not to replace the current curriculum as mandated by the state, but to add a new model of learning for the students. Another portion of the grant will cover the expenses of adding new materials to the classroom (i.e. updated books, laboratory materials, etc.) to further introduce the concepts to the students. The remaining portion of the grant will fund the pilot program and any services provided to the families of the students that are participating. The activities and services that fall under this grant are included below.

1. Academic enrichment session to emphasis concepts taught in the classroom.
2. STEM theme design projects to further emphasis concepts taught in the classroom.
3. Information sessions on STEM careers.
4. Education field trips relating to STEM careers (i.e. company tours)
5. Activities and workshops to promote parental involvement
6. Tutoring services

In addition, funds may be used to pay for staff and coordinator salaries; contracts with provider agencies; professional development activities; stipends for professionals, students, or family members involved actively in the delivery of services; transportation; and program materials. No more than 22.5% of the total program budget may be used for coordination and administration and no more than 10% may be used for program materials. Districts or agencies including indirect costs in their budget proposals can use their most recently approved indirect cost rates. If the approved rate is higher than 5.0%, the agency can use only a maximum rate of 5.0% for this grant.

5.1.6. Grant Duration

The duration of the grant provided will last for two fiscal school years. The first year of the grant will focus on the development of the pilot program for the grantee school, which includes the teacher training sessions and curriculum changes. The second year the grant will focus of the launch of the program and the fees included with maintaining the program throughout the school year.

6. Assessment Methodology

6.1. Survey

6.1.1. Objective

The Survey was administered to 9th and 12th grade students currently enrolled in the Worcester Public High Schools. The Worcester Public School System, like many that comprise the Massachusetts Education System, takes part in the MCAS Testing that occurs yearly within the Massachusetts Education System. We felt that 9th graders would be the youngest students to survey and include in our assessment due to the fact that they have just begun their High School education. They were the best sample population for us due to the fact that they will have their own preconceptions of what they will expect in the years to come. They also possess an initial vision of their academic and post academic future which is vital data for our assessment. We would like to be able to assess their current status on their education track, as well as, to determine if they have up until this point encountered or been introduced to a diverse and engineering based education.

We decided to conclude our survey and assessment with a sample 12th grade population. They would be the best group of students to alert us to whether or not they completed or will be completing an engineering based and diverse education. They would also be the best group to assess the current curriculum and any necessary changes that should definitely be implemented. By surveying and including the senior population in our assessment we hoped to determine their final level of Engineering competence and whether or not they were introduced to Engineering or Engineering concepts thus far throughout their educational career.

We targeted the four High Schools in the Worcester Public School System. We surveyed 9th and 12th graders in the following High Schools.

North High School
South High School
Doherty High School
Burncoat High School

The survey not only gauged the existing status of seniors graduating for secondary education in Worcester, but also gauged any variance between the 9th and 12th graders in particle and variances with their academic performance and outlook on engineering as a discipline and a career.

6.1.2. 9th Grade Survey Implementation

The Administration and Implementation of the Survey in each of the High Schools differed between the two grades. Our method for implementing the survey to the 9th graders in the four Worcester Public High Schools was to target the Mathematics and Science classes in the grade, and the students that comprise them. In order to get a more accurate and well rounded sample population we decided to develop criteria to what students will be surveyed. In order to keep the survey implementation statistically random these criteria were necessary.

We focused our random sampling of students on the two divisions of Mathematics and Science courses in the High Schools. Those two divisions are that of Honors Science and Mathematics Courses and that of regular Mathematics and Science courses offered by the schools that are open to all students. The factor that determines whether a student is accepted into one over the other is that of academic performance. The majority of students who are in the Honors classes are those that have some level of interest in the Honors class they are enrolled in. For this reason we felt it was necessary to include a class of students that may or may not possess some level of interest in the course material. Thus, allowing us to maintain a statistically random assessment as well as a statistically relevant assessment.

In order to have the surveys administered to the students, we had the Math and Science teachers for the respective classes administer the surveys at the opening of the class. We collected data from two Mathematics and Science classes in each of the high schools. Since we collected data from an advanced mathematics and science class and another from and introductory mathematics course our data should show results from a diverse sample population. The Mathematics courses that we focused on administering the surveys to in all four of the High Schools were Honors Algebra and Foundations of Algebra and Geometry. The Science courses that will be administered surveys in all 4 of the High Schools are Integrated Science 1 Level 1 and Integrated Science 1 Level 2.

6.1.3. 12th grade Survey Implementation

Due to the nature of the Worcester Public School system and the Worcester Public High Schools we found that we were able to administer the surveys in the required homeroom period at the beginning of the School day. This was the best time to administer the survey to the seniors. Homerooms are typically created and split up by the last name of the student. We felt that by surveying the homerooms we would already be presented with a statistically random sample population.

6.2. Statistical Correlation Data Analysis

Microsoft Excel was used to analyze the data gathered from the surveys. Each response from the survey was inputted into an excel spreadsheet. The data was analyzed descriptively to determine the frequency of the answers for each question and a linear correlation was performed to determine the relationships that, if any, exist between the responses from certain questions in comparison to others. The data was then broken down into ninth grade and twelfth grade participants to analyze the results of the participants prior to completing their High School requirements versus those that had completed their educational requirements. The data was then broken down my race to allow for any investigation of the data based on previous research.

The linear correlation was performed on the data to determine the relationships that exists between the questions of the survey. The questions that were most important were compared to one another. The most important questions were determined and the resulting correlations formed were as follows: the participants plans on attending college versus their academic performance; the participants plans on attending college versus their work ethic; their interest of pursuing STEM major versus their academic performance, work ethic, importance of Mathematics to their education, importance of Science to their education, and the importance of English/Language Arts to their education; their consideration of pursuing engineering versus their perception of an engineer based on the perception statements presented in the survey.

The values that were used to perform the correlation using their academic performance and work ethic were the sum of the percentages of the Excellent (Above Expectations) and Good (Above Expectations). For the perceptions of an engineer statement, the values used for the correlations were the sum of the Strongly Agree and Agree percentages for the positive perceptions statements and Strongly Disagree and Disagree for the negative perception statements. The same method was used to determine the values for the likelihood of pursuing engineering and attending college questions. To determine the value of the interest of pursuing a STEM major the sum of each percentage for the majors was divided by the 400, since the absolute total possible amount percentage for each major is 100 percent; this value represents the overall percentage of students that showed an interest in pursuing a STEM major in college.

Once all the values were obtained, the correlation function in Microsoft Excel was used to determine the correlation value between the two questions. The data obtained from the American Indian students was not included in the correlation calculations since there was only 1 in that racial group. Once the correlation was established, the data was inputted into a graph to obtain the best fit trend line equation which can be used to predict different outcomes. This method was obtained a Linear Regression guide from website created by an Associate Professor at Seton Hall University.

7. Results

7.1. Descriptive Data Analysis

Overall 503 students participated in the survey. Of those 503 students, 66.20% (333 students) answered as being in ninth grade and 31.61% (159 students) in twelfth grade. A total of 4 students, 0.60% (3 students) and 0.20% (1 student), answered as being in tenth and eleventh grade, respectively, of which were not used in the data analysis of the survey questions. Therefore, the data analysis following is based off of the 499 ninth and twelfth grade participants. The Worcester Public high schools that participated include North High School and South High School.

The ethnicity categories used for the participants follows the same categories currently used by the public school systems in Massachusetts. The ethnicity breakdown of the participants is as follows, American Indian 0.20% (1); Asian 13.83% (69); Hispanic/White 11.02% (55); Hispanic/Nonwhite 18.44% (92); African American 16.03% (80); and White 39.08% (195). Overall we will be comparing the responses of the participants from the Minority Ethnicity groups, American Indian, both Hispanic groups, and African American, versus the responses from the Asian and White participants. The overall goal of the data analysis is to see whether the current socioeconomic stereotypes correlate with the data obtained in our survey; whether the students exceed the expected responses or if they meet the expected responses.

The gender breakdown is almost a 1:1 ratio consisting of 46.49% (232) Male and 52.10% (260) Female.

Overall, over 50% of the ninth and twelfth grade participants rate their academic performance as Excellent (Exceeds Expectations) and Good (Above Expectations), which corresponds to the A and B range grade point average, respectively. The participants find that Mathematics, Science, and English/Language Arts are all very important parts in their education, where over 80% find that Mathematics and English/Language Arts are important to their education and 65% find that Science is an important part of their education. When it comes to the participants' future, 88.5% of the participants plan on attending college after graduation where 29% consider engineering as a future occupation. The top 4 majors, ranked from highest to lowest, the participants showed the most interest were Health Professions & Allied services, Computer & Information Science & Technology, Business & Commerce, and Engineering & Engineering Technologies. The overall attitude towards the stereotypical perception of an Engineer is positive. The statements that portrayed an engineer in a positive manner had more positive (Strongly Agree and Agree) responses than negative ones (Disagree and Strongly Disagree).

Further looking at the data by ethnicity, it can be seen that with in the ninth grade participants, all the participants have a high academic performance where the Black and Asian participants have the highest percentages, followed by Hispanic/white, Whites, and then Hispanic/Nonwhite. Over 75% of the total participants plan on attending college, where Asians have the highest percentage, followed by the Black participants, and then the two Hispanic groups. The data for American Indian students isn't a very good representation, since it only represents one participant. However, when looking at the amount of participants that selected a STEM major, only 20.41% of the Black participants and 15.79% and 17.65% for the Hispanic/white and nonwhite participants respectively versus the 30.00% of Asian participants. However, more Hispanics and Blacks are thinking of pursuing STEM versus their White classmates.

For the twelfth grade participants, the overall percentage of participants that identified with an Excellent (Exceeds Expectations) and Good (Above Expectations) for their academic performance is over 45.00% with the Black participants having the highest positive performance, followed by Hispanic/nonwhites, White, Hispanic/whites and then the Asians. A different relationship can be seen with the amount of participants that plan on attending college after graduation, the highest percentage can be seen within the Blacks, then Hispanic/Nonwhite, Whites, Asian, and Hispanic/White. The percentage of participants that selected STEM majors as an area they are interested in majoring in, the Blacks 13.41% and Hispanic/Nonwhite 11.46% surpass the amount of Asians 7.50%, followed by Hispanic/White 5.88% and Whites 4.48%. However, the percentage is very low compared to the percentage of the participants interested in STEM for the ninth grade participants. For both the ninth grade and twelfth grade participants, the percentage of student interested in a STEM major is drastically low compared to the percentage of students that are planning on attending college

7.2. Statistical Correlation Analysis

Linear regression was used to determine the correlation between certain questions to determine if there was any relationship between the set of questions, instead of developing conclusions based the descriptive results obtained from the survey for each question. If a strong correlation was established between a set of questions, the equation of the trend line for the graphs based on the set of questions can be used to predict the response for other students that did not participate in the survey. The linear regression of the different set of questions based on the overall responses of each race was done for the ninth grade participants and the twelfth grade participants separately.

The survey is broken into three main categorical themes: academic performance, future educational outlook, and the attitudes towards the stereotypical perception of an engineer. The breakdown of the questions from the survey is as follows:

Academic Performance:

- Question 1- Academic Performance
- Question 2- Work Ethic
- Question3- Importance of Mathematics as a part of their Education
- Question 4- Importance of Science as a part of their Education
- Question 5- Importance of English/Language Arts as a part of their Education

Future Educational Outlook:

- Question 8- Plans on attending college after graduation
- Question 9- Plans on attending a 2 year university or college after graduation
- Question 10-Plans on attending a 4 year university or college after graduation

- Question 11-Fields they considered majoring in after graduation
- Question 19-Consideration of engineering as a future occupation
- Question 20-Where do you see yourself in the future

Attitudes towards the Stereotypical Perception of an Engineer: "When I think about an engineer, I think of a person who:"

- Question 13- Has little or no social life.
- Question 14- Has a lot of friends.
- Question 15- Is very boring.
- Question 16- Is very exciting.
- Question 17- Is an average man/woman doing an average job.
- Question 18- Is nothing like me.

The most important questions from these sections were compared to determine which ones had the strongest correlations. Table 1 Correlation Values of Question Sets below lists the sets of questions that were analyzed and the resulting correlation value based on each of the participants responses. The data was broken down into grade nine and grade twelve for comparison purposes, to compare the difference in responses based on their completion of their high school education requirements. The data used to establish the correlation between the set of questions based on the percentages of the responses is described in the methodology. The tables with the data of the set of questions below are listed in Appendix #.

Questions		Correlation Value	
		9th Grade	12th Grade
Interest in STEM Fields	Importance of Science	0.60	0.62
Interest in STEM Fields	Importance of Mathematics	0.84	0.71
Interest in STEM Fields	Importance of English/Language Arts	0.62	0.37
Plans on attending College After Graduation	Academic Performance	0.83	0.64
Plans on attending College After Graduation	Work Ethic	0.17	0.40
Interest in STEM Fields	Academic Performance	0.66	0.84
Interest in STEM Fields	Work Ethic	0.90	0.51
Future Consideration of Becoming an Engineer	An Engineer has little or no social life.	0.14	0.20
Future Consideration of Becoming an Engineer	An Engineer has a lot of friends.	0.41	-0.53
Future Consideration of Becoming an Engineer	An Engineer is very boring.	0.04	0.62
Future Consideration of Becoming an Engineer	An Engineer is very exciting.	-0.66	0.65
Future Consideration of Becoming an Engineer	An Engineer is an average person doing an average job.	-0.76	-0.23
Future Consideration of Becoming an Engineer	An Engineer is nothing like me.	-0.40	0.33

Table 5: Correlation Values of Question Sets

To determine which correlations are the strongest, the correlations with the highest values closest to one represent the set of questions with the strongest relationships. Some of the correlations from the question sets resulted in a negative value, this means that the relations between the two questions is inverted meaning that as one of the variables increases the value of the other decreases; the relationship still exists, it's just in the opposite direction. The trend line equations that are listed in the graphs can be used predict the outcome for a group of ninth grade students that did not participant in the survey for each of the relationships.

Evaluating the ninth grade responses first, the strongest relationship has a correlation coefficient of 0.84. This relationship can be seen in Table 5 as the correlation between a participant's interest in majoring in a STEM related field and their view on the importance of Mathematics as an important part of their education. For example, a group of students enter high school and at the end of their ninth grade year, the percentage of students that Strongly Agree and Agree that Mathematics is an important part of their education is a total of 72.00%. Utilizing the regression line equation, $y = 1.025x - 50.22$, to forecast the response of the percentage of student participants that view Mathematics as important, we can forecast that 23.58% of those student participants will show interest in STEM majors. Figure 2 is a graphical representation of this relationship.

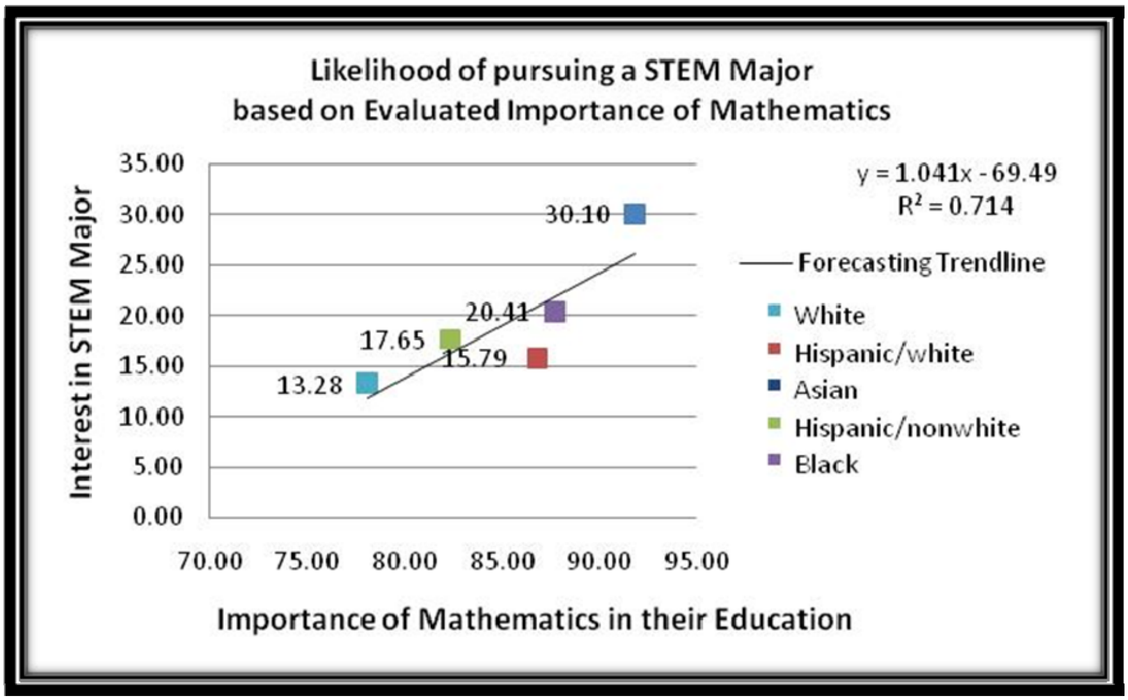

Figure 2- 9th Grade Likelihood of pursuing a STEM Major based on Evaluated Importance of Mathematics

Although the relationship between the importance of Mathematics to one's education and their interest in STEM majors does not directly predict that by increasing a student's evaluation of Mathematics as an important part of their education will increase their interest in pursuing a STEM major in the future. However, it does represent that through different initiatives made on the school's behalf to increase students' evaluation of Mathematics being an important part of their education will play a positive role in their interest of pursuing a STEM major.

The next highest correlation value of 0.83 is between the questions about the participants' plans on attending college based on their academic performance. This relationship allows us to conclude that the better a ninth student performs based on the expectations set for them in their school, the higher their plans are for attending college after graduating high school. For example, a group of students enter high school and at the end of their ninth grade year, the percentage of students that identify as academically performing at either Excellent (Exceeds Expectations) or Good (Above Expectations) is 70.00%. Utilizing the regression line equation, $y = 0.526x + 52.97$, to forecast the response of the percentage of student participants that academically performing above and beyond set expectations, we can forecast that 89.79% of the participants will plan on attending college. Figure 3 is a graphical representation of this relationship.

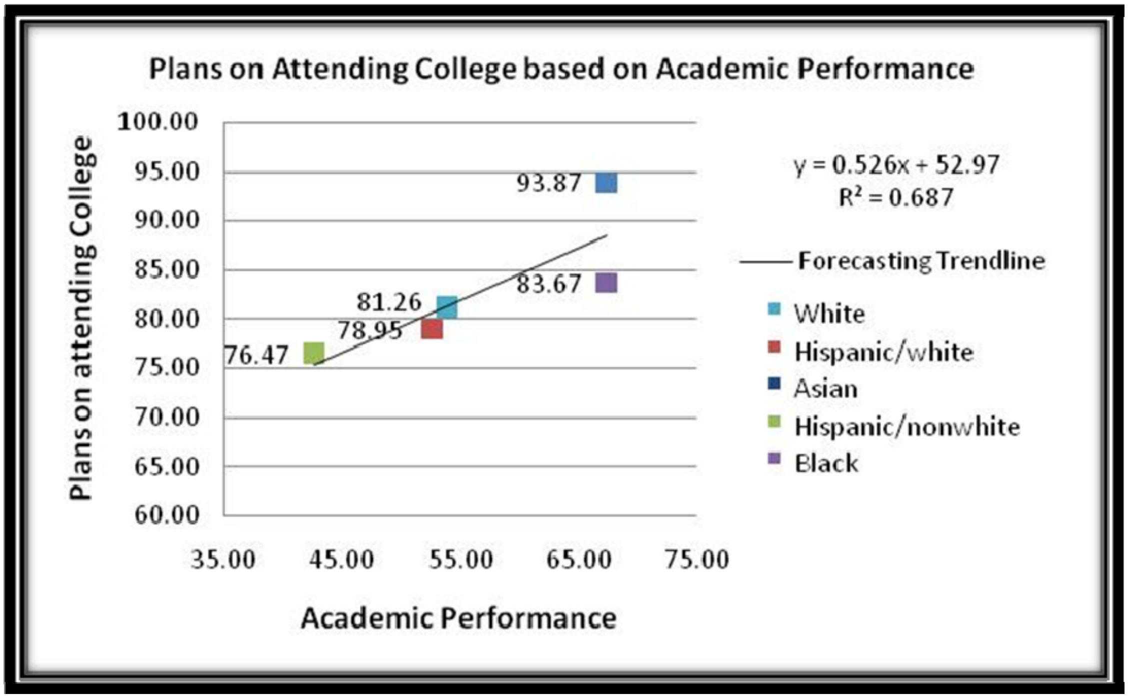

Figure 3- 9th Grade Plans on Attending College based on Academic Performance

This relationship between the academic performance and plans on attending college cannot be used to directly conclude that by increasing students' academic performance level will lead to an increase in the amount of students that plan on attending college. However, it can be concluded that if the schools spearhead an initiative to get students to work to their full potential above the set expectations rather than just meeting them, overtime they will realize that they are capable of attending college and succeeding in that atmosphere due to their dedication and academic performance.

Looking now at the twelfth grade correlations, the strongest correltion with a value of 0.84 is the relationship between the participants' interest in pursuing STEM majors versus their Academic Performance. The relatioship shows that as the students work to exceed the expectations set for them in their highschool courses, the higher the chance that they will express an interest in pursuing a STEM major after graduation. For example, a group of students about to graduate high school that identify as academically performing at either Excellent (Exceeds Expectations) or Good (Above Expectations) is 75.00%. Utilizing the regression line equation, $y = 0.270x – 6.70$, to forecast the response of the percentage of student participants that academically perform above and beyond set expectations, we can forecast that 13.55% of the participants will show interest in STEM majors. Figure 4 is a graphical representation of this relationship.

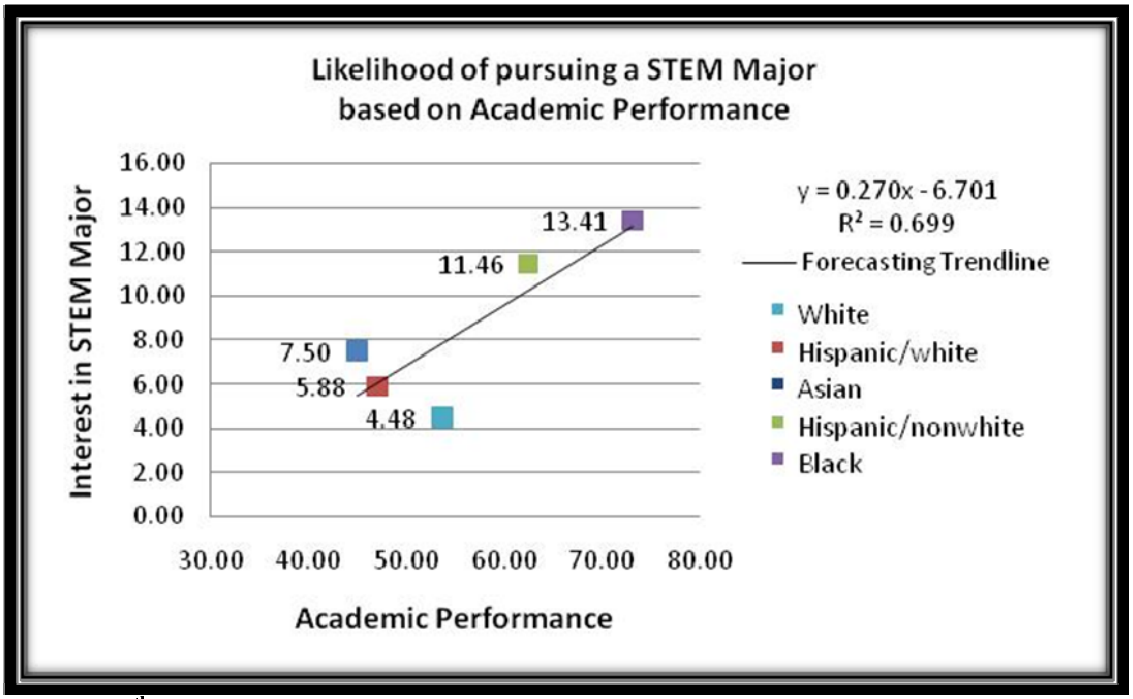

Figure 4- 12th Grade Likelihood of pursuing a STEM Major based on Academic Performance

Although the relationship between a students' academic performance and their interest in STEM majors is related, it cannot e used t not directly predict that by increasing a student's evaluation of academic performance will increase their interest in pursuing a STEM major in the future. However, through different initiatives made on the school's behalf to increase students' academic performance it will play a positive role in their interest of pursuing a STEM major.

The second highest correlation of 0.71 is the relationship beween the participants' interest in pursuing STEM majors versus their evalaution of Mathematics being an important part of their education. The relatioship shows that as the students show an understanding of the imporatnce of Mathematics to their overall education, the higher the chance that they will express an interest in pursuing a STEM major after graduation. For example, a group of students about to graduate high school that Strongly Agree and Agree that Mathematics is an important part of their education is a total of 93.00%. Utilizing the regression line equation, $y = 0.254x – 11.78$, to forecast the response of the percentage of student participants academically performing above and beyond set expectations, we can forecast that 11.84% of the participants will shown an interest in STEM majors. Figure 5 is a graphical representation of this relationship.

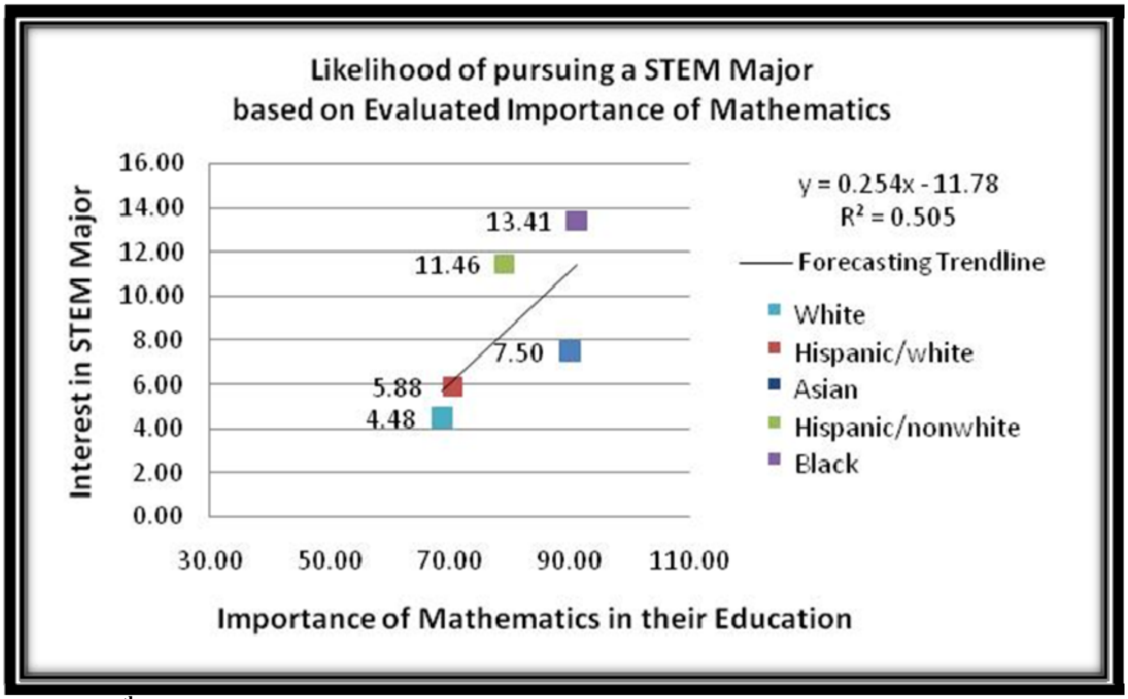

Figure 5- 12th Grade Likelihood of pursuing a STEM Major based on Evaluated Importance of Mathematics

Although the relationship between the importance of Mathematics to one's education and their interest in STEM majors does not directly predict that by increasing a student's evaluation of Mathematics as an important part of their education will increase their interest in pursuing a STEM major in the future. However, as aforementioned, it does represent that through different initiatives made on the school's behalf to increase students' evaluation of Mathematics being an important part of their education will play a positive role in their interest of pursuing a STEM major

8. Discussion

Linear regression was used to analyze the data so that we would be able to find relationships between the responses of certain sets of questions to allow us to make overall conclusions. Based on the data obtained and discussed in the previous sections, it is clear to see that there is a strong correlation between the importance of Mathematics for both the ninth grade and twelfth grade participants in their interest of pursuing a STEM major in the future. In addition, the importance of Science also has a strong correlation in comparison to the other question sets.

Due to the recent increase in the implementation of outreach programs, it explains why the students in the ninth grade showed a stronger relationship between the interests in pursuing a STEM career based on the importance of mathematics to their education than those students in twelfth grade. This shows that students value the concepts that they learn in their Mathematics classes, but since there are very low percentage of students that show interest in pursuing a STEM major, there is obviously a disconnect in the class room along with other classes such as the different science related subjects.

The sole decline among the top five most popular degree fields between 1989-90 and 2003-04 was in engineering and engineering technologies (five percent). (NCES, 2006)

Looking at the descriptive data results we can see that there is a significant relationship between the students interest in STEM majors based on their perception of the importance of Mathematics to their education. Getting students to realize the importance of Mathematics and Science to their education and how it relates to real world situations would increase the student’s interest in STEM fields. Project based learning would be the best tool to address this weakness. Currently, there are initiatives being made to introduce engineering or STEM fields in general to the younger students, but little attention is being paid to those in high school.

"While our younger students are making progress on national assessments and are ahead on some international measures, the same can not be said at the high school level," said Mark Schneider, NCES Commissioner. "U.S. students do relatively well in reading literacy when compared to their international peers, but they are outperformed in mathematics and science and our 15-year-old students trail many of our competitors in math and science literacy." (NCES, 2006)

The more students are exposed to different concepts in real world situations, the more interested they may become in the field, given that they can apply it to the real world instead of just theoretical examples in class. Not only will these projects further explain the concepts to the students, but it will close that gap between concepts they learn in school and the real world; students should be able to see the importance of these concepts and how they affect their daily living.

The descriptive data also shows the differences among the races. For the ninth and twelfth grade participants, both the academic performances the Black participants have the highest percentage overall combining the Excellent (Exceeds Expectations) and Good (Above Expectations) categories with values of 67.35% and 73.17%. In the ninth grade data, the Asians have the same combined percentage as the Black students. The Hispanic/nonwhite and Hispanic/white participants and the White participants come in slightly behind with values of 52.63%, 42.65% and 53.91% respectively. The same type of comparison can be made for the twelfth grade participants where the Blacks have an overall academic percentage exceeding expectations of 73.17% versus 45.00% for Asians, 47.06% for Hispanic/nonwhite, 62.50% for Hispanic/white, and 53.73% for the Whites. From this data we can conclude that although the Black students are improving, the majority of the minorities are still behind when it comes to exceeding the expectations set for them by their educational institution based on their counter parts in the class room.

So what exactly does this tell us you may be asking or better yet how is all of this representative of our current educational culture and the student's outlook on the importance of education? This study proved very telling of the current nature of the outlook on education amongst minority students. Indeed we find a great irony in the results of the data analysis, as well as, the individual responses we received from students as to what was the definition of engineering. These responses included but were not limited to "It is a form of study that deals with both science and math. There are a lot of different types of engineering such as civil, bio, mechanical etc", "I don't like engineering. It's too much work and it's hard to understand", "It is some sort of work and you need to be smart to do it", "Working with machines" and finally "I don't know", with only one minority student responding with the first statement and the majority responding with "I don't know" or with some statement totally irrelevant to what engineering truly is.

With the majority of the minority students lacking a basic understanding of what engineering actually is and how interrelated mathematics and science are in engineering it stands as a stark contrast to the direction in which our society is moving. As the society moves further and further towards a technologically advanced society, as well as, a technologically dependant way of living, one would only assume that with the increase in technology there would also be an increase in the need of the students to pursue STEM related fields. However, how ironic that we find that there is a nonexistent knowledge of how the new technologies many of the kids use today work or what they do. Given the socioeconomic status of many of the minority students and the influence of their environment and their culture, we find that there does not exist a progressive mindset, a notion of personal betterment, which directly corresponds to the lack of students pursuing STEM related fields.

Ray Kurzweil's "Law of Accelerating Returns" states that the history of technology shows that technological change is exponential, contrary to the common-sense "intuitive linear" view. So we won't experience 100 years of progress in the 21st century -- it will be more like 20,000 years of progress (at today's rate). (Kurzweil, 2001) With technology poised to increase exponentially as the years progress, why has there been a decline in STEM related fields as of late, especially engineering. How can we foresee a leap in technological advancement in the coming years when the degree program of those working towards this leap is experiencing a decline. (NCES, 2006)

The problem proves to be much simpler than first thought. In this day and age there seems to be a total paradigm shift in the ideology of valuation amongst students. No longer is a proper education and self-improvement valued. No longer are long-term goals and achievements valued amongst the minority students found in our schools today. Much emphasis is put in short term gain, and ease of advancement. It's no wonder there is a decline in the number of students all together pursuing engineering or a STEM related fields, especially amongst minority students when there exists a recurring theme in our school system that develops a mentality in students to stare clear of anything they find to prove difficult, anything that may serve as a challenge. This is evident in the ever decreasing educational standards we find in our schools today.

One of the members of the research group had the pleasure of being invited to a dinner for young women, mostly minority high school students, aimed at exposing them to women of success and achievement. She attended having had academic success in High School, through College and now heading to work for a large Engineering Company, she was looking forward to speaking to many of the young women about the challenges and rewards of pursuing an Engineering Degree or a STEM related degree. As the speeches progressed through the night and she continued to look throughout the room and read many of the profiles of the other professionals that were also invited, she started to become bothered. Although there were many nurses, surgeons and doctors, many of the women invited to provide guidance to the girls were uneducated and worked in a service industry as some sort of technician or a secretary. What seemed to disturb her the most and even seemed puzzling, was that at her own table she was continuously confronted with women telling girls that they did not need to go to college, that they should pick up some trade in High School and continue it through their life or pursue technician program. Never was she more enraged and disappointed as the night progressed and the common theme seemed to become, "I was nothing, then became something when I pursued a trade field". What was actually going on? Is this what we want our young women of the future introduced to, the idea that they can't or shouldn't even pursue a STEM degree because it might be too difficult. A woman sitting at her table stated to a young girl who told her that she was thinking about going to college because she currently attends a vocational school and is in the carpentry program but does not see it as a future career, "You don't have to go to college, just pick up a trade in school and start a business, it's much easier." She could not believe her eyes.

These students seem to stand no chance with our society and their cultures constantly bombarding them with the idea that college is not necessary and that they can make it in this world without a secondary education degree. The classroom is the only medium in which students can formulate their own ideas and aims in life. It is where many students finally decide that a college education is something they definitely need or want having been exposed to some transformational element in their curriculum. Outside the walls of the school, the students dwell in a different world. The need for the classroom and curriculum to take them outside of this world is extremely important.

9. Conclusion

Based on our research and the data obtained from the survey, it is clear that there is a gap between STEM concepts taught in the classroom and interest in STEM fields for future education. There have been recent implementations of outreach programs geared towards minorities to increase their interest in STEM fields, which explains why there are more ninth grade students interested in pursuing STEM fields than those in twelfth grade. However, an initiative needs to be implemented to focus on educating those students in high school.

There is a need for a multicultural project based curriculum to be implemented in the schools, one which develops and fosters personal constructivism and understanding of concepts being taught. The hands-on group project approach is one way to realize this. Our proposed curriculum addendum proves in theory and when compared to literature that it should be successful. In addition, comparing it to current college project based learning programs, such as the one implemented at WPI, the real challenge would be integrating it into the middle school and high school curriculum.

Development of a supplement program such as Step into Strive has already proven successful with the increasing interest and awareness of the importance of math and science in our middle and high schools, as well as, the increase in academic performance of those students who see the importance of a science and mathematics education. With the formation of a private sector forum, improvements can be made to the current school system in Worcester, which would compensate for the funding that has been recently cut from the school systems throughout Massachusetts. The private sector forum would unite with one goal in mind- the further the education of the Worcester high school students in STEM fields.

With the implementation of a project based curriculum and a program similar to Step into Strive to further emphasis the concepts taught in the classroom, the increase in students' exposure to STEM concepts at earlier stages in their high school career will most likely increase their interest in pursuing a degree in a STEM related field. With the effort and funding provided by the private sector forum, the Worcester Public school system would have enough support to implement a program of this size while maintaining their responsibilities presented to them by the Massachusetts Department of Education. Since the private sector program would ensure the involvement of parents in their child's education, more students of minority decent will understand the benefits of pursuing a career in STEM related fields since the parents would assume a more active role in their education.

10. Future Recommendations

Given the constraints we had in developing this educational proposal, we hope future research would lead to the implementation of a project based curriculum addendum that satisfies the needs we addressed alongside an engineering outreach program. Upon doing so, one must determine if indeed there was an increase in the knowledge of and attitude towards STEM fields by those students who participated. In addition, to properly assess how this course of action affects the students academically one should develop a means of tracking the academic and educational progress of the student participants. Tracking the progress of the students from ninth grade up to twelfth grade will also allow for the proper identification of any other variables that either deter a student from STEM fields, or increase his/her attitude/interest toward STEM fields in addition to the influence of the curriculum addendum and outreach program.

Further research should also lead to an investigation into the schools and the majors the participating students are applying towards, as well as, the majors they actually declare by their sophomore year in college. One might find that other variables or even the continued socioeconomic status of a student has an impact on their future outlook toward STEM fields other than those variables they encounter in High School.

If we were not hindered by the time constraints we experienced through the course of the project, we would have indeed developed and setup the infrastructure for the engineering design outreach program, as well as, the private sector grant consortium.

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V. Appendices

Appendix A: Science & Technology Curriculum Framework

Science and Technology/Engineering Learning Standards, PreK–High School

STRAND 1: EARTH AND SPACE SCIENCE

In earth and space science, students study the origin, structure, and physical phenomena of the earth and the universe. Earth and space science studies include concepts in geology, meteorology, oceanography, and astronomy. These studies integrate previously or simultaneously gained understandings in physical and life science with the physical environment. Through a study of earth and space, students learn about the nature and interactions of oceans and the atmosphere, earth processes including plate tectonics, changes in topography over time, and the place of the earth in the universe.

In grades PreK–2, students are naturally interested in everything around them. This curiosity leads them to observe, collect, and record information about the earth and about objects visible in the sky. Teachers should encourage their students' observations without feeling compelled to offer the precise scientific reasons for these phenomena. Young children bring these experiences to school and learn to extend and focus their explorations. In the process, they learn to work with tools like magnifiers and simple measuring devices. The learning standards at this level fall under the topics of *Earth's Materials, Weather, Sun as a Source of Heat and Light,* and *Periodic Phenomena.*

In grades 3–5, students explore properties of earth materials and how they change. They conduct tests to classify materials by observed properties, make and record sequential observations, note patterns and variations, and look for factors that cause change. Students observe weather phenomena and describe them quantitatively using simple tools. They study the water cycle, including the forms and locations of water. The focus is on having students generate questions, investigate possible solutions, make predictions, and evaluate their conclusions. Learning standards fall under the topics of *Rocks and Their Properties, Soil, Weather, Water Cycle, Earth's History,* and *The Earth in the Solar System.*

In grades 6–8, students gain sophistication and experience in using models, satellite images, and maps to represent processes and features. In the early part of this grade span, students continue to investigate geological materials' properties and methods of origin. As their experiments become more quantitative, students should begin to recognize that many of the earth's natural events occur because of processes such as heat transfer.

At this level, students should recognize the interacting nature of the earth's four major systems: the geosphere, hydrosphere, atmosphere, and biosphere. They should begin to see how the earth's movement affects both the living and nonliving components of the world. Attention shifts from the properties of particular objects toward an understanding of the place of the earth in the solar system and changes in the earth's composition and topography over time. Middle school students grapple with the importance of and methods of obtaining direct and indirect evidence to support current thinking. They recognize that new technologies and observations change our explanations about how things in the natural world behave. Learning standards fall under the topics of *Mapping the Earth, Earth's Structure, Heat Transfer in the Earth System, Earth's History,* and *The Earth in the Solar System.*

The unifying theme of 9th and 10th grade earth and space science is the interaction of the Earth's various spheres and human activities. It falls into the following categories: *Matter and Energy in the Earth System, Earth's Sources of Energy, Earth's Processes and Cycles,* and *The Origin and Evolution of the Universe.* Students continue their studies to include the universe. As they review geological, meteorological, oceanographic, and astronomical data, they learn about direct and indirect evidence and consider how these might be used to test competing theories about the origin of stars and planets, including our own solar system. Through increasingly sophisticated investigations and measurements, students also learn about various geological processes, including plate tectonics, wind formation, the flow of water through the local watershed, and changes in the earth over time.

STRAND 2: LIFE SCIENCE (BIOLOGY)

The life sciences investigate the diversity, complexity, and interconnectedness of life on earth. Students are naturally drawn to examine living things, and as they progress through the grade levels, they become capable of understanding the theories and models that scientists use to explain observations of nature. In this respect, a PreK–12 life science curriculum mirrors the way in which the science of biology has evolved from observation to classification to theory. By high school, students learn the importance of Darwin's theory of evolution as a framework for explaining continuity, diversity, and change over time. Students emerge from an education in the life sciences recognizing that order in natural systems arises in accord with rules that seem to govern the physical world, and can be modeled and predicted through the use of mathematics.

As Piaget noted, young children tend to describe anything that moves as *alive.* For purposes of working with young children, who do not yet understand the continuity of life (e.g., from seed to seedling to tree to log), *living* can be defined as anything that is alive or has ever been alive (e.g., muskrat, flower, roadkill, log) and *nonliving* can be defined as anything that is not now and has never been alive (e.g., rock, mountain, glass, wristwatch). Over time, students refine their intuitive understanding. They begin to include in their definition of *living* such behaviors as eating, growing, and reproducing. Young children learn to use their senses to observe and then describe the natural world. Noticing differences and similarities and grouping organisms based on some common features is fundamental to the life science curriculum at this grade span. For a more in-depth discussion of this issue, please refer to the National Science Education Standards under Content Standard C: Developing Student Understanding (www.nap.edu/readingroom/books/nses/html/6c.html).

As children move through the elementary grades, they expand the range of observations they make of the living world. In particular, children record details of the life cycles of plants and animals, and explore how organisms are adapted to their habitat. In these grades, children move beyond using their senses to gather information. They begin to use measuring devices to gather quantitative data that they record, examine, interpret, and communicate. Children are introduced to the power of empirical evidence as they design ways of exploring questions that arise from their observations. Learning standards in PreK–2 fall under the topics of *Characteristics of Living Things, Life Cycles, Evolution and Biodiversity, Heredity,* and *Living Things and Their Environment.* The standards for grades 3–5 fall under the topics of *Characteristics of Plants and Animals, Plant Structures and Functions, Life Cycles, Heredity, Adaptations of Living Things,* and *Energy and Living Things.*

As students enter the middle school grades, the emphasis changes from observation and description of individual organisms to the development of a more connected view of biological systems. Middle school students begin to study biology at the microscopic level without delving into the biochemistry of cells. They learn that organisms are composed of cells and that some organisms are unicellular and must therefore carry out all of the necessary processes for life within that single cell. Other organisms, including human beings, are multicellular, with cells working together. Students should observe that cells of multicellular organisms can be physically very different from each other and relate that fact to the specific role that each cell has in the organisms (specialization). For example, cells of the eye or the skin or the tongue look different and do different things. Middle school students develop the understanding that the human body has organs, each of which has a specific function of its own, and that these organs together create systems that interact with each other to maintain life. As is outlined in the National Science Education Standards, students should be exposed in a general way to the systems of the human body, but are not expected to develop a detailed understanding at this grade level. Middle school students also examine the hierarchical organization of multicellular organisms and the roles and relationships that organisms occupy in an ecosystem.

At the macroscopic level, students focus on the interactions that occur within ecosystems. They explore the interdependence of living things, specifically the dependence of life on photosynthetic organisms such as plants, which in turn depend upon the sun as their source of energy. Students use mathematics to calculate rates of growth, derive averages and ranges, and represent data graphically to describe and interpret ecological concepts. The standards for grades 6–8 fall under the topics of *Classification of Organisms, Structure and Function of Cells, Systems in Living Things, Reproduction and Heredity, Evolution and Biodiversity, Living Things and Their Environment, Energy and Living Things,* and *Changes in Ecosystems Over Time.*

At the high school level, students study the molecular basis of life by looking at the processes occurring in cells. In particular, these students learn that the DNA molecule dictates all of our physical traits and that we inherit our parents' DNA and therefore their physical traits. They learn that genetic variation is inherited and that the unit of inheritance is the gene. It is the inherited traits that provide the variation on which natural and manipulated selection act. It is changes in the DNA over time (mutations) that lead to diversity and the appearance of new traits that can give an organism a selective advantage, allowing it to become more competitive in a given environment, survive better, or adapt to changes in the environment (basis of natural selection).

The theory of organic evolution is fundamental to understanding modern biology. It provides a framework for explaining why there are so many different kinds of organisms on earth; why organisms of distantly related species share biochemical, anatomical, and functional characteristics; why species become extinct; and how different kinds of organisms are related to one another.

STRAND 3: PHYSICAL SCIENCES (CHEMISTRY AND PHYSICS)

The physical sciences (physics and chemistry) examine the physical world around us. Using the methods of the physical sciences, students learn about the composition, structure, properties, and reactions of matter and the relationships between matter and energy.

Students are best able to build understanding of the physical sciences through hands-on exploration of the physical world. This framework encourages repeated and increasingly sophisticated experiences that help students understand properties of matter, chemical reactions, forces and motion, and energy. The links between these concrete experiences and more abstract knowledge and representations are forged gradually. Over the course of their schooling, students develop more inclusive and generalizable explanations about physical and chemical interactions.

Tools play a key role in the study of the physical world, helping students to detect physical phenomena that are beyond the range of their senses. By using well-designed instruments and computer-based technologies, students can better explore physical phenomena in ways that support greater conceptual understanding.

The physical science learning standards for PreK–2 fall under the topics of *Observable Properties of Objects, States of Matter,* and *Position and Motion of Objects*. Young children's curiosity is engaged when they observe physical processes and sort objects by different criteria. During these activities, children learn basic concepts about how things are alike or different. As they push, pull, and transform objects by acting upon them, children see the results of their actions and begin to understand how part of their world works. They continue to build understanding by telling stories about what they did and what they found out.

The standards for grades 3–5 fall under the topics of *Properties of Objects and Materials, States of Matter,* and *Forms of Energy* (including electrical, magnetic, sound, and light). Students' growth in their understanding of ordinary things allows them to make the intellectual connections necessary for understanding how the physical world works. Students are able to design simple comparative tests, carry out the tests, collect and record data, analyze results, and communicate their findings to others.

The standards for grades 6–8 fall under the topics of *Properties of Matter, Elements, Compounds and Mixtures, Motion of Objects, Forms of Energy,* and *Heat Energy.* While students at the middle school level may be better able to manage and represent ideas through language and mathematics, they still need concrete, physical-world experiences to help them develop concepts associated with motion, mass, volume, and energy. As they learn to make accurate measurements using a variety of instruments, their experiments become more quantitative and their physical models more precise. Students are able to understand relationships and can graph one measurement in relation to another, such as temperature change over time. Students may collect data by using microcomputer- or calculator-based laboratories (MBL or CBL), and learn to make sense immediately of graphical and other abstract representations essential to scientific understanding.

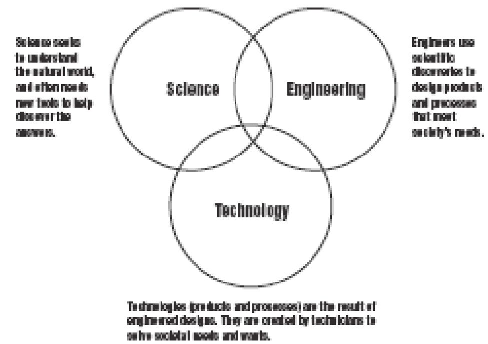
The high school standards for physics include *Motion, Forces, Energy, Waves,* and *Electromagnetism.* At the end of their study based on these standards, students can understand the evidence that underlies more complex concepts of physics, including forces and vectors, and transformations of energy. Graphical representations and the gradual introduction of functions introduce students to well-defined laws and principles of physics.

The high school chemistry standards for a full-year study include *Properties of Matter, Atomic Structure and Bonding, Chemical Reactions and Stoichiometry, Solutions, Acids and Bases,* and *Equilibrium and Kinetics.* Because chemistry is central to our understanding of many other sciences, chemistry instruction should include links to actual applications to enable students to relate chemistry to their everyday lives and current engineering/technology. At the end of their study, students are capable of using sophisticated models and rigorous mathematical computations to make formal statements of principles of chemistry and understand their implications. They are able to apply their understanding in another science course, in a higher level of science or engineering/technology learning, or in the experiences they encounter.

Science tries to understand the natural world. Based on the knowledge that scientists develop, the goal of engineering is to solve practical problems through the development or use of technologies. For example, the planning, designing, and construction of the Central Artery Tunnel project in Boston (commonly referred to as the "Big Dig") is a complex and technologically challenging project that draws on knowledge of earth science, physics, and construction and transportation technologies.

Technology/engineering works in conjunction with science to expand our capacity to understand the world. For example, scientists and engineers apply scientific knowledge of light to develop lasers and fiber optic technologies and other technologies in medical imaging. They also apply this scientific knowledge to develop such modern communications technologies as telephones, fax machines, and electronic mail.

The Relationship Among Science, Engineering, and Technology



Although the term technology is often used by itself to describe the educational application of computers in a classroom, instructional technology is a subset of the much broader field of technology. While important, computers and instructional tools that use computers are only a few of the many technological innovations in use today.

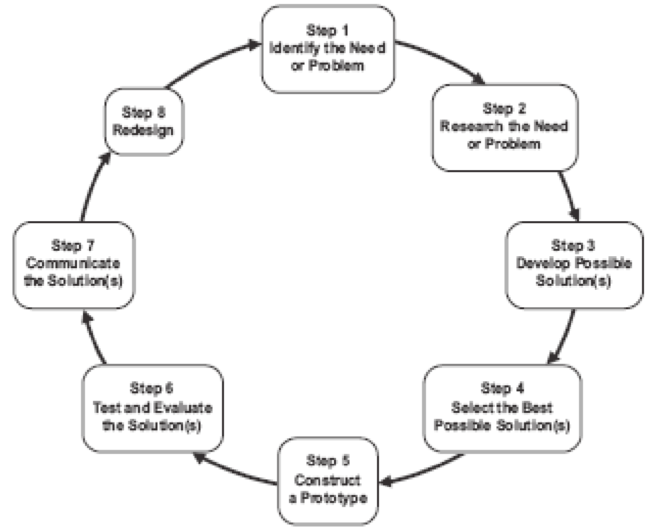
Technologies developed through engineering include the systems that provide our houses with water and heat; roads, bridges, tunnels, and the cars that we drive; airplanes and spacecraft; cellular phones, televisions, and computers; many of today's children's toys; and systems that create special effects in movies. Each of these came about as the result of recognizing a need or problem and creating a technological solution. Figure 1 on page 73 shows the steps of the engineering design process. Beginning in the early grades and continuing through high school, students carry out this design process in ever more sophisticated ways. As they gain more experience and knowledge, they are able to draw on other disciplines, especially mathematics and science, to understand and solve problems.

Students are experienced technology users before they enter school. Their natural curiosity about how things work is clear to any adult who has ever watched a child doggedly work to improve the design of a paper airplane, or to take apart a toy to explore its insides. They are also natural engineers and inventors, builders of sandcastles at the beach and forts under furniture. Most students in grades PreK–2 are fascinated with technology. While learning the safe use of tools and materials that underlie engineering solutions, they are encouraged to manipulate materials that enhance their three-dimensional visualization skills–an essential component of the ability to design. They identify and describe characteristics of natural and manmade materials and their possible uses and identify the use of basic tools and materials, e.g., glue, scissors, tape, ruler, paper, toothpicks, straws, and spools. In addition, students at this level learn to identify tools and simple machines used for a specific purpose (e.g., ramp, wheel, pulley, lever) and describe how human beings use parts of the body as tools.

Students in grades 3–5 learn how appropriate materials, tools, and machines extend our ability to solve problems and invent. They identify materials used to accomplish a design task based on a specific property and explain which materials and tools are appropriate to construct a given prototype. They achieve a higher level of engineering design skill by recognizing a need or problem, learn different ways that the problem can be represented, and work with a variety of materials and tools to create a product or system to address it.

In grades 6–8, students pursue engineering questions and technological solutions that emphasize research and problem solving. They identify and understand the five elements of a technology system (goal, inputs, processes, outputs, and feedback). They acquire basic skills in the safe use of hand tools, power tools, and machines. They explore engineering design; materials, tools, and machines; and communication, manufacturing, construction, transportation, and bioengineering technologies. Starting in these grades and extending through grade 10, the topics of power and energy are incorporated into the study of most areas of technology. Students integrate knowledge they acquired in their mathematics and science curricula to understand the links to engineering. They achieve a more advanced level of skill in engineering design by learning to conceptualize a problem, design prototypes in three dimensions, and use hand and power tools to construct their prototypes, test their prototypes, and make modifications as necessary. The culmination of the engineering design experience is the development and delivery of an engineering presentation.

Figure 1
Steps of the Engineering Design Process



1. Identify the need or problem
2. Research the need or problem
   - Examine current state of the issue and current solutions
   - Explore other options via the internet, library, interviews, etc.
3. Develop possible solution(s)
   - Brainstorm possible solutions
   - Draw on mathematics and science
   - Articulate the possible solutions in two and three dimensions
   - Refine the possible solutions
4. Select the best possible solution(s)
   - Determine which solution(s) best meet(s) the original requirements
5. Construct a prototype
   - Model the selected solution(s) in two and three dimensions
6. Test and evaluate the solution(s)
   - Does it work?
   - Does it meet the original design constraints?
7. Communicate the solution(s)
   - Make an engineering presentation that includes a discussion of how the solution(s) best meet(s) the needs of the initial problem, opportunity, or need
   - Discuss societal impact and tradeoffs of the solution(s)
8. Redesign
   - Overhaul the solution(s) based on information gathered during the tests and presentation

Students in grades 9 and 10 learn to apply scientific and mathematical knowledge in a full-year, comprehensive technology/engineering course. The topics addressed include engineering design; construction technologies; power and energy technologies in fluid, thermal, and electrical systems; communication technologies; and manufacturing technologies. Students engage in experiences that enhance their skills in designing, building, and testing prototypes. The culmination of this level of design experience is also the development and delivery of an engineering presentation.

Technology/engineering curricula in grades 11 and 12 follow the approaches used for the previous two grades but expand in a variety of areas based on available school expertise and student interest. Students may explore advanced technology/engineering curricula such as automation and robotics, multimedia, architecture and planning, biotechnology, and computer information systems. They may continue building on their background in engineering design by working on inventions. Course offerings in the high school grades should engage students who are interested in:

- expanding their studies in the area of engineering and technology because they are interested in a college-level engineering program,
- pursuing career pathways in relevant technology fields, or
- learning about certain areas of technology/engineering to expand their general educational background, but who will not necessarily follow a technical career.

All areas of study should be taught by teachers who are certified in that discipline. Because of the hands-on, active nature of the technology/engineering environment, it is strongly recommended that it be taught in the middle and high school by teachers who are certified in technology education, and who are very familiar with the safe use of tools and machines.

Appendix B: Step into Strive Brochure

Our Mission

Step into Strive is a student-run organization devoted to the pursuit of an interdisciplinary and challenging Engineering Instructional methodology, as well as, the implementation and promotion of Science, Mathematics, Engineering/Technology and future STEM related opportunities to the parents and students of Worcester, MA through fun, innovative and hands-on design projects that comprise the Step into Strive Program.

Our Mission is to advance the understanding and application of engineering principles and concepts in order to enhance the Science & Mathematics Educational development of the middle school students in the Worcester Public School system while building on and improving the Worcester Polytechnic Institute (WPI) culture of Innovation and Educational leadership. Our Affiliation with the Faculty, Staff and Students of WPI allows us to provide an innovative and challenging STEM based environment to children in Middle School, regardless of gender, ethnicity, culture or socio-economic status, with special outreach for those groups traditionally underrepresented in the Sciences and Mathematics.

Step into Strive also provides invaluable work experience and leadership opportunities to all of its student volunteers, as well as, further enriches the University and local Worcester Community.

Our Vision

Step into Strive will be a distinctive and continuously innovative program of national stature, emphasizing and promoting the integration of knowledge across the Mathematics and Sciences to the application of these principles and concepts within the Engineering Discipline and Society. The program will be noted by Departmental and Faculty excellence and innovation in both Education and Support, and by the invaluable Graduate and Undergraduate students trained not only in academic success but also in continuous originality and criticality in reasoning, communication and representation as effective leaders and role-models to those students participating in the program; creating a tangible bridge between their age group and understanding with their higher education mentors and leaders. Our hope is to stand as a pinnacle in the movement to attract more students to STEM related fields.

Over the past 2 years, Step into Strive has not only grown from a small budding program to a recognized and greatly appreciated student run organization, but it has also reached almost 100 students and parents not only giving them the opportunity but also providing them the tools and knowledge to begin a lifelong exploration of Engineering, Mathematics and Science.

"It is about time a program with this depth and scope was created and presented to our community and school system. I am lucky that my son excels in school but there is not that much in our Community or school system to this level that my son can really get involved in and apply himself. It was great to finally see a University taking this up and giving students like my son this opportunity." (Segment of an impromptu speech, one of many, given by a Parent of a 2005-2006 Participant at the 2005-2006 Closing Dinner)

It is our deepest hope that you will extend your support and join us again in the years to come as we continue to refine and develop the program and introduce a growing number of students to what lies within Engineering, Mathematics and Science.

Gina Melendez and Walter C. Uchendu
Co-Directors & Co-Founders, 2005

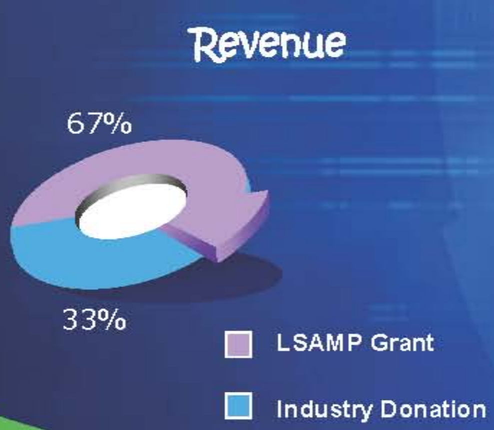
Fiscal Highlights

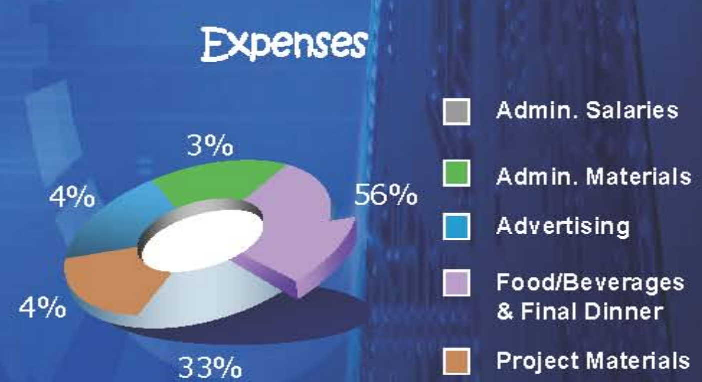
	2004 Actual (estimated)	2005 Budgeted	2006 Projected
Revenue			
Registration	0	0	0
LSAMP Grant	5000.00	6000.00	0
Industry Donation	1615.00	2920.00	15000.00
Total	**6615.00**	**8920.00**	**15000.00**
Expenses			
Administration-Salaries	1615.00	2920.00	4000.00
Administration-Materials	250.00	233.92	600.00
Advertising	-	367.00	500.00
Food and Beverages/Final Dinner	4350.00	5020.00	7500.00
Project Materials	400.00	356.87	2400.00
Total	**5465.00**	**8897.00**	**15000.00**

Fiscal Highlights

The Overall revenue and contributions to the program has increased from 2004, an increase that will continue in 2006 as Step into Strive continues to grow each year. Industry donations have also continued to grow, with many of the Small Businesses, as well as, larger Corporations that contributed to the program in a non-financial form of support now hoping to make a financial contribution to the program. Foundation and University donations are down, but this was predicted due to the large one-time donations we saw in 2004 & 2005, and the subsequent Goals change in direction of the funding source. Administrative expenses will increase in 2006 as we make a move to provide a stipend to our Graduate and Undergraduate student volunteers. Advertising expenses were also up, as a new brochure and interactive CD were created this year for distribution to the schools and our partners and contributors. Travel expenses will also increase in 2006 as we plan to add more trips to Corporate and Small Business locations.

Our budgeted increase for 2006 is accounted for by these additional facets of the Step into Strive program. This corresponds to the budgeted increase in project materials expenses, and many other overall expense increases. We also have included in the administrative budget for the upcoming year an increase to accommodate a training session for both Student volunteers and Faculty & Staff involved. Step into Strive has been and will continue to experience explosive growth. However, this growth would not be sustained without these added facets of the program.



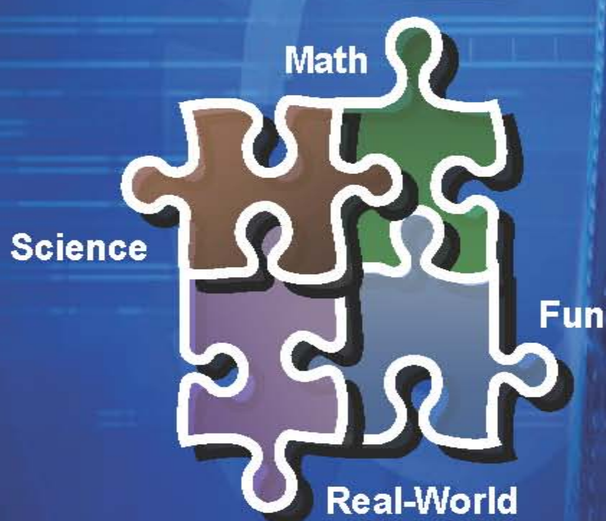


Our Program

Simply put, engineering is solving real-world problems using a combination of mathematics and science principles and concepts. Problems that engineers solve can range from how to build bridges, how to make artificial organs for people, to how to treat waste to keep it from polluting the environment. It's impossible to go through a single day without using something an engineer has helped to create or in the least acting as an engineer yourself by applying your mathematical or science knowledge to a problem no matter what educational level you are at or your age.

The Step into Strive Program is a six month enrichment program to introduce Middle School students in the Worcester, MA area with a special interest to those students in underrepresented groups to fields in Science, Mathematics and Engineering. The program creates an innovative and intuitive environment fostering originality and self-discovery allowing the students to explore the engineering, math and science fields of study through the utilization and application of the Engineering Design Process and Engineering Design Projects to increase their likelihood of pursuing further interest in these areas during their high school and college enrollment.

The ultimate goal is to shatter pre-conceptions of engineering and bridge the gaps between, Mathematics, Science, Fun and Real-World Applications.



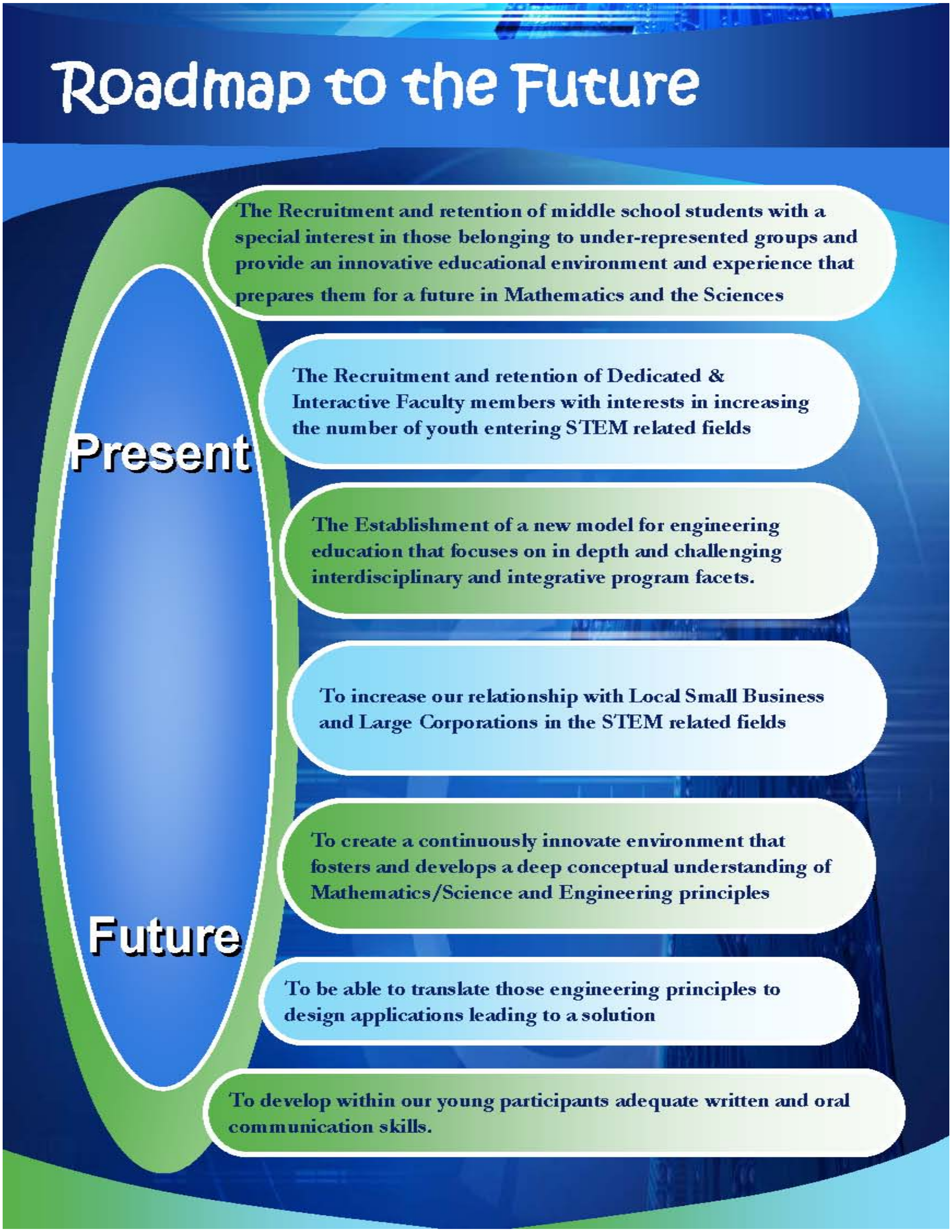
Our Program

Our program is primarily comprised of a challenging and very in depth Engineering Design Project, that will take the student through each step of the engineering design process, from defining the problem, to conducting in depth research, to designing a solution, to testing the solution, and then to finally fabricating and making their proposed designs.

The design projects fall into one of the three Engineering Majors represented in the program. Biomedical, Mechanical and Electrical & Computer Engineering. Professors and their carefully handpicked Graduate students and Undergraduate assistants are at the disposal of the students, with the Professors proposing the problems, many of which are current issues in the field and serving as the client or the Company paying the students to develop this product and come up with a solution and the students overseeing the scope of the project as advisors.

Previous projects included an Artificial Leg for a middle school athlete, an innovative powered wheel chair for a paraplegic young man and an integrated and networked security system for the Worcester Courthouse currently being built.

All of this is wrapped up in a final presentation, giving the students an opportunity to learn proper presentation and communication skills, as well as, to learn how to create a PowerPoint presentation and a project presentation poster one which follows the format graduating seniors here at WPI utilize. The students are also required to submit a research paper on their design projects.


Roadmap to the Future
Present
Future
The Recruitment and retention of middle school students with a special interest in those belonging to under-represented groups and provide an innovative educational environment and experience that prepares them for a future in Mathematics and the Sciences
The Recruitment and retention of Dedicated & Interactive Faculty members with interests in increasing the number of youth entering STEM related fields
The Establishment of a new model for engineering education that focuses on in depth and challenging interdisciplinary and integrative program facets.
To increase our relationship with Local Small Business and Large Corporations in the STEM related fields
To create a continuously innovate environment that fosters and develops a deep conceptual understanding of Mathematics/Science and Engineering principles
To be able to translate those engineering principles to design applications leading to a solution
To develop within our young participants adequate written and oral communication skills.

Sponsors

- Worcester Polytechnic Institute (WPI)
- NE LSAMP
- INTEL

Contributors

- IDEO
- Hanger Orthopedic Group

Step into Strive

Directors

Walter C. Uchendu
Gina Melendez

Faculty

Prof. Kristen Billiar
Prof. Steven Bitar
Prof. Gretar Tryggvasson

Staff

Christine Drew
Laura Robinson

Graduate & Undergraduate Volunteers

Angela Throm
Jacquelyn Youssef
Lauren MacMath
Charly El Khoury
Michael Cretella
Steven Paul Toddes

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Appendix C: Step in Strive Application

Step into Strive

Student Pre-Application Form

Please complete this application form.

STUDENT NAME: ____
First Middle Last

HOME ADDRESS: ____
Street City Zip Code

TELEPHONE: ( ) ______________ DATE OF BIRTH: ____/____/____

EMAIL: ____________________ GRADE ENTERING THIS FALL: __________

SCHOOL: ____
Name City

How did you hear about this program? ______________________________

____

RACE: Please select one

- ❑ African American
- ❑ American Indian/Alaskan Native
- ❑ Hispanic
- ❑ Other (please specify) ______________________

Additional Questions

Why do you want to be in this program?

____

____

____

What is your favorite thing about school?

____

____

____

What is your least favorite thing about school?

____

____

____

If I am accepted into this program I hope to...:

____

____

Please return this form to:
WPI, Office of Diversity Programs, 100 Institute Road, Worcester, MA 01609.

Appendix D: Teacher Recommendation Form

Step into Strive

Teacher Recommendation Form (Only a teacher may complete this form)

Please return this form to WPI, Office of Diversity Programs, 100 Institute Road, Worcester, MA 01609

TEACHER NAME: ______________________________

How do you know this student? ______________________________

Please indicate with a checkmark the characteristics that you have observed regarding this student:

- ❑ Manages routine tasks
- ❑ Is self-directed
- ❑ Displays perseverance
- ❑ Reads at grade level
- ❑ Has curiosity about his environment, posses questions
- ❑ Is observant
- ❑ Originality of ideas
- ❑ Has displayed leadership abilities
- ❑ Good attention span
- ❑ Ability to reason out problems
- ❑ Ability to grasp ideas at a good pace
- ❑ Good vocabulary
- ❑ Has displayed good or better academic performance in:
  - ☐ Reading
  - ☐ Math
  - ☐ Language arts

Please share any additional comments regarding this student below:

____

____

____

____

____

____

____

This student needs to continue improving his abilities in the following academic area(s):

____

____

____

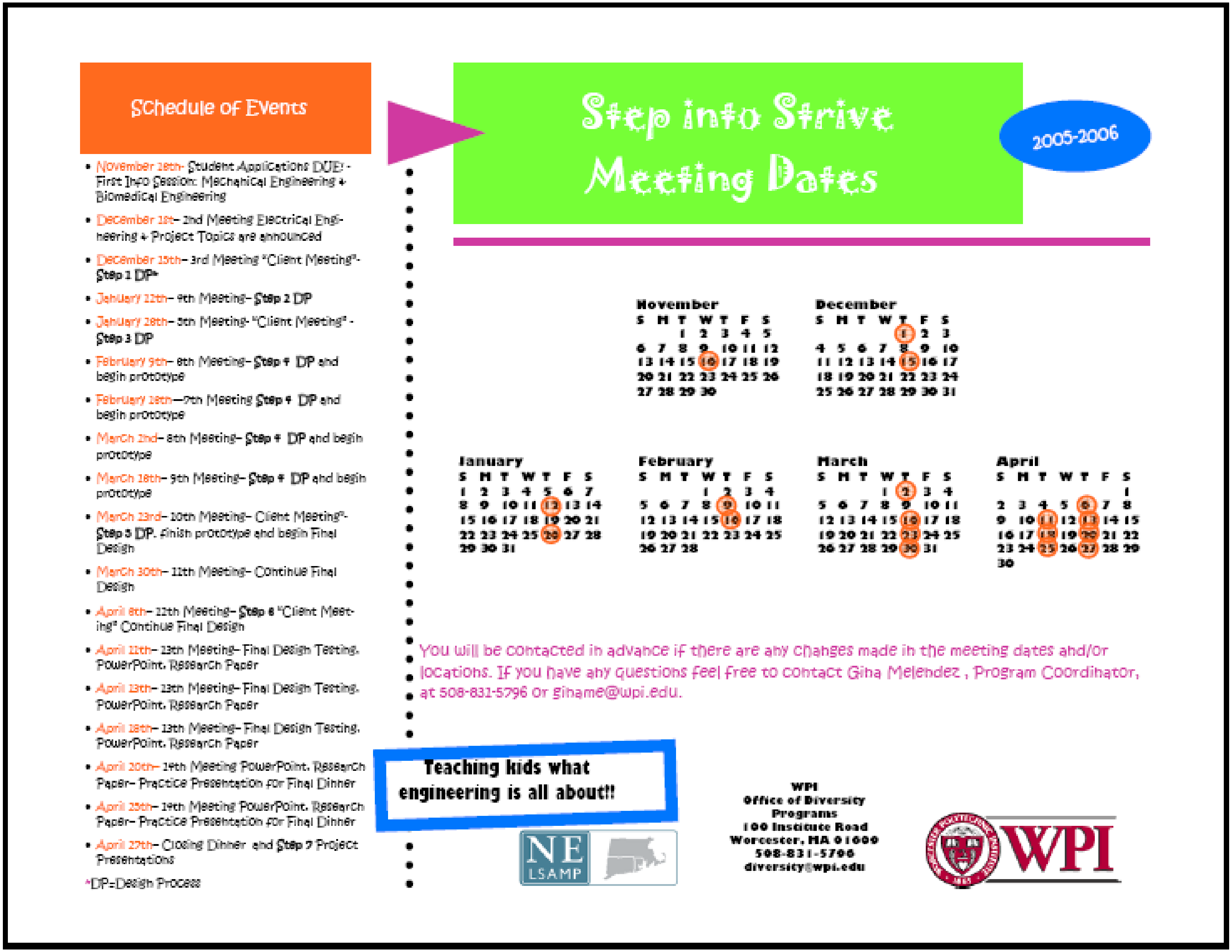
____

____

____

Signature: ______________________________ Date: __________

Appendix E: Step in Strive Calendar



Appendix F: Design Project Problem Statements

Electrical & Computer Engineering Design Problem Statement

The City of Worcester is in the process of building a brand new Courthouse. Due to an oversight, the contracting for an Electrical & Computer Engineering team was overlooked. The Board of Directors is now looking to contract a team to design a Security Alarm System for the new Courthouse. The design must accommodate for every possible situation that can occur in a government building due to natural or intentional causes.
(The students will be given a scaled down model of the Courthouse.)

Biomedical Engineering Group Design Problem Statement

Rafael was the fastest runner for the Windchester Middle School Track Team. After an injury sustained running track, Rafael lost the use of his right leg. His doctor as submitted him into a program offered by UMASS Medical Center that hopes to develop a prosthetic leg substitute for an athlete like Rafael to use so he can continue running track.
UMASS Medical Center is sponsoring the research for the development of a new prosthetic leg design that will accommodate the needs of a student athlete weighing between 100 - 130lbs.

Mechanical Engineering Group Design Problem Statement

Due to low numbers of people pursuing a nursing career, many of the local area hospitals are being overwhelmed with the decreasing nurse to patient ratio. The Worcester County Hospital board of Directors is sponsoring the design and manufacturing contract to the team that offers the best wheelchair design. The wheelchair design must allow for patients to be able to maneuver themselves without the help of a nurse or medical assistant.

Appendix G: Engineering Design Project Report (Electrical & Computer Engineering)

Worcester Courthouse Alarm System

Electrical and Computer Engineering

Group Members
David Marcano
William Rosales
Naveed Rahman
Michael Alache
Emmanuel Acheempong
Diallo
Christopher

Client(s)
Michael Cretella
Lauren MacMath
Charly El Khoury

Table of Contents

Original Problem Statement

The city of Worcester is building a new courthouse, and the board directors have contracted our team to construct an alarm system. The alarm system must accommodate every possible situation that can occur in the government building due to natural or intentional causes. The alarm must have a sensor that detects motion and gives a signal to the police when somebody is inside. We must make an alarm system that will react to anything that will cause harm to the court house such as gases, someone unauthorized trying to get in at a late time, and fires/high temperatures. The alarm system will be camouflaged so that not everybody can see it. We need an alarm system that cost less than $300.

Revised Problem Statement

The city of Worcester assigned us to build an alarm system. This alarm system must be safe and it has to be cheap. Our team thinks that the alarm system has to be small, sensitive, and has to be noisy. Our first problem was the cost of the alarm system. We only have $300 to make the alarm system. We thought that if the alarm is hide from human visibility the alarm will be harder to turn off by a robber.

Objectives

We need to have a small alarm that's not visible to the intruder's eyes so he can't destroy it. We also need a good quality alarm, that is made with good materials and also one that works when it's supposed to. Our alarm has to be inside the cost range, around $300. Another important goal is to get an alarm that covers the whole courthouse so that if any part gets broken into, the authorities will be notified. Another important factor is to have an alarm that works when it's supposed to, that is it only goes off when a burglar breaks in or tries to get out, not when any person walks by the sensor. We would need a battery that will last long so it won't be needed to be changed every month, but in as reasonable period so the owner forgot to replace it. The alarm must send signals to whom it may concern, the police for example. Lastly, the alarm must sound off in daylight for a fire, etc., and has to send a signal to the police so they can catch the burglar unexpected during the night.

Constraints

At the beginning of our project, we came up with a list of constraints, which meant that we came up with a list of obstacles or road blocks that prevent us from achieving our goal.

First of all, one of our constraints at the beginning of the year was how much the total of our project would cost, which is a maximum of $300. In the real world, there are limits to what you can do and buy. For example, you can't just buy anything you want without any limit; therefore since this project would usually be done for real, limits are applied to the amount of money we can spend.

Second of all, each scenario of problems will require different kinds of alarms. For example, in the real world, if you were a manager of the courthouse, you would not want a fire alarm to detect burglary. If it were so, when a thief passes by the fire alarm, the fire alarm would not react to him/her

In addition, a third constraint of this project would be how strong the signal is, such as loud sounds and lights. If you had an alarm in your house and a burglar comes into your house while you and your family are sleeping, you wouldn't want the alarm be so weak that it doesn't even wake anyone.

Furthermore, the materials used for each alarm could also be an obstacle. For example, you would not use a photoelectric sensor (a sensor that detects smoke using a beam that when smoke particles reach it, the light is reflected towards the sensor which will result in the alarm going off) when you are trying to detect motion inside a building.

Additionally, the size of the alarm is a constraint. This would be an obvious constraint because if you were to build a motion detector that is as big as a whole room of the courthouse, it would be pointless because the thief would easily be able to trespass it.

Finally, the last constraint that our group had come up with was when the alarm would be triggered. For example, the alarm cannot trigger during the day time when all the people are walking through the courthouse.

In conclusion, these constraints are obstacles that have gotten in the way of our goal. Cost, type of alarm, the strength of the signal, the material, the size of the alarm, and how it would be triggered are all of our constraints.

Research

The websites that I have visited the most was google.com then when I was in there I look for alarm systems, I found one that said Alarm system, and then I entered there. I found information about how the alarm system work, how can an alarm system save the people from deaths. I also look for information in eBay.com, eBay is a website to find products and buy them. I found some sensors for alarm systems.

To learn more about alarm systems, I went to a couple of sites. One site was howstuffworks.com. There I learned how an alarm works. An alarm is made of a couple of things, most important of them is the battery and sensors. Some sensors are radar-based motion detector, photo-sensor, passive infrared, etc. Another site is edmontsecurity.com. It said an alarm system is made of input devices, control panel, output devices, installed in a way to minimize any loss of security.

User Requirements

We are supposed to deign a security system for the Worcester Courthouse, which must meet these requirements:

We must have a sensor on each location that may be broken into (i.e. doors, windows. etc.). We must have the appropriate sensors in each location.

We must notify in numerous ways that an entry has taken place. That is, if a burglar breaks in we must notify the police (or others) by sound and/or lights.

We have to track the intruder in his whereabouts. The authorities must know which sensor has been triggered, so they know where the burglar is.

We must have a sensor in a very important location inside the courthouse (i.e. where the files of previous trials are kept).

Lastly, have a method for deactivation of the security system both when it has been activated and before it has been activated.

Function-Means Chart

Functions	Means			
Detect Movement	Sonic Sensors	Lasers	Heat Sensors	Cameras
Detecting harmful gasses	Customized gas sensor			
Detect fire	Fire Alarm	Temperature Sensor	Smoke Detector	
Putting out fire	Sprinkler system			
Notify people	Lights	Sounds	Authority	

Using this function-means chart helped us determine what things we could put in our alarm system or make different alarms for different things.

Client Meetings

At the beginning of our program we had met with one of our clients to learn about circuits and electric currents. The clients had wanted an alarm that alerted people of various things, a break-in, fire, etc. The alarm had to be powered by a 12V battery, no more. Our clients were Michael Cretella, Lauren MacMath, and Charly El Khoury. Michael C. had helped us with the basics of electrical circuitry, for example positive and negative ends of a battery, kinds of circuits, etc. Charlie helped us with how to set up the circuits, and Lauren M. had helped us with the prototypes and the presentation/and research paper.

Some questions we had asked our clients were:

1. What is the budget range?
Answer: $300

2. How much time do we have to make it?
Answer: By the end of the program.

3. What tools are we able to use?
Answer: All tools that you need will be provided.

4. How high should the volume be?
Answer: Loud enough to be heard throughout the building, but not damage the people's hearing.

Figure 1: Students Dialo and William working with Clients Charly and Lauren on the Door Circuitry

Possible Solutions

Motion Sensor

One possible motion detector we can use is an Infrared LED. You can think of it as a light bulb, it emits "invisible" light, and when someone gets in the way, the alarm will get triggered. Another type of a motion detector is a radar-based, which detects motion by microwaves. Also, there is a photo-sensor, which rings when a door opens, usually found in a shopping store. A passive infrared sensor is another option; it "detects heat waves that come from the human body. Once it detects these waves, the alarm gets triggered.

Fire Alarm

We look up fire alarms and found that they range from $14-75.

Window/Door Alarm

The magnetic switch was the best possible solution because to secure a window it must be triggered when it opens and the magnetic switches activate when they separate and they separate as soon as the window opens. The magnetic switches makes all possible entries to the windows invalid.

Final Design

Motion Sensor

For our final product, we decided to use a PIR sensor. It uses its frensel lens for the detection of a human body movement, at the limit of five meters. We tested the PIR sensor, whenever you had waved your hand over the sensor—when it is on—it would go off. A couple of features of this is that it uses; a single voltage operator, 12VDC, a three pin terminal, signal output is 0.5sec min, and a small operation power consumption.

Figure 2: Michael and David Testing Motion Sensor

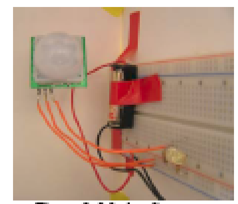


Figure 3: Motion Sensor

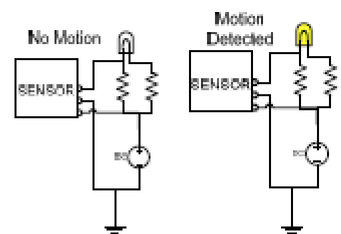


Figure 4: Circuit for Motion Detector

Fire Alarm

We are not able to build a prototype but there will be fire alarms in the courthouse.

Window/Door Alarm

Magnetic window alarms activate when the two pieces of the alarm separate. When separated it will sound an alarm but the alarm will stay quiet if they are together. The alarm are perfect for windows because when the magnetic alarm is attached to the window if the window happens to open the two magnetic pieces will separate and the alarm will be triggered. This way when a person tries to sneak in through the window the alarm will be triggered as soon as it is opened making the windows secured. Some magnetic window sensor cost $9.95 each.

Figure 5: Window Prototype (left), Magnetic Switch Used (center), Window Prototype (right)

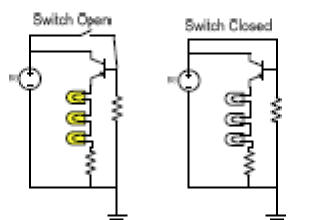
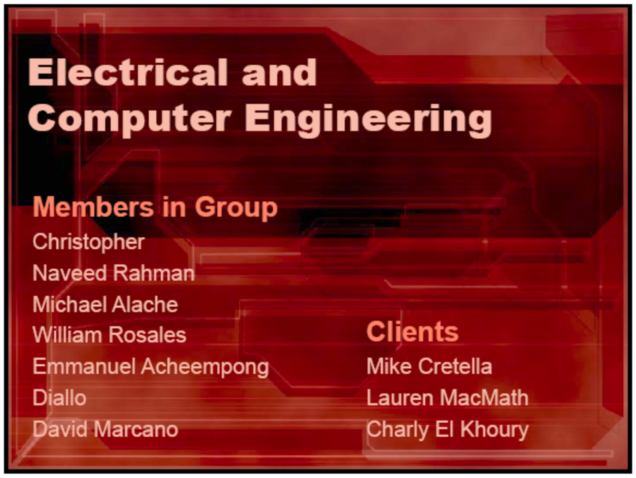


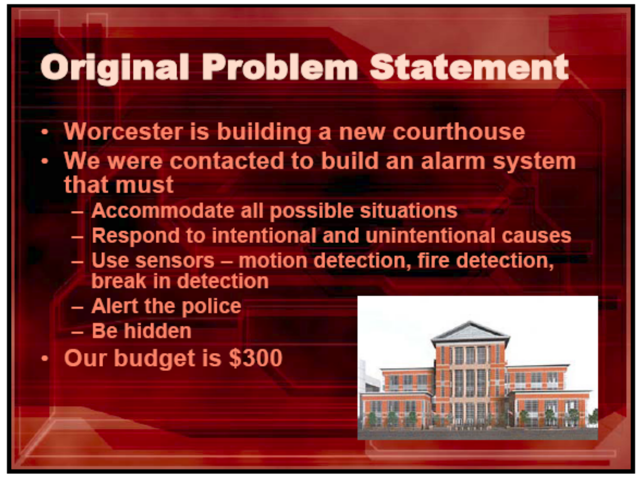
Figure 6: Circuits Used for the Door and Window

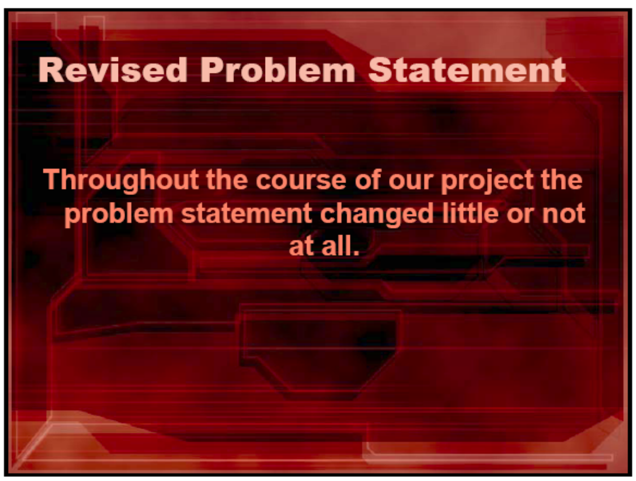
Conclusion

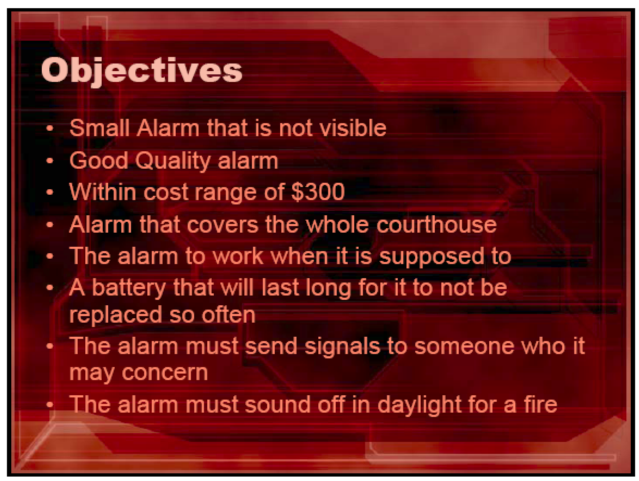
Our group has learned that an alarm system is made up of batteries, sensors, switches, and control panels. To understand more, we learned about circuits, terminals, and open/closed circuits. For the Worcester Courthouse we decided to use simple motion detectors and a magnetic contact alarm for the doors and windows.

Appendix H: Engineering Design Project Presentation (Electrical & Computer Engineering)









Constraints

- The alarm must be small and not too big.
- The cost must be within the budget of $300
- Materials used for each alarm must be appropriate for each
- The strength of the signal must be strong enough to notify the police
- The types of sensors used for each scenario
- When the alarm would be triggered (daytime, or nighttime, or both)

User Requirements

- Have sensors at possible places of entry
- Notify in numerous ways that an entry has taken place.
- There must be a way for the alarm to indicate where the entry has taken place
- Sensor in a very important location inside the courthouse
- A method for deactivation of the security system both when it has been activated and before it has been activated.

Function-Means Chart

Functions	Means			
Detect Movement	Sonic Sensors	Lasers	Heat Sensors	Cameras
Detecting harmful gasses	Customized gas sensor			
Detect fire	Fire Alarm	Temperature Sensor	Smoke Detector	
Putting out fire	Sprinkler system			
Notify people	Lights	Sounds	Authority	

Possible Solutions

- Motion sensor
- Heat sensor
- Laser sensor
- Flashing lights
- Loud sounds radiating
- Radio wave alerting the authority

Final Design/Conclusion

- Motion Sensor- Photoelectric Sensor
- Doors- Magnetic switches
- Windows- Magnetic Switches
- Fire Alarm- No Prototype build

The End

Appendix I: Engineering Design Project Poster (Biomedical Engineering)

DESIGNING A PROSTHETIC LEG

Step into Strive Program

Annette, Josamy, Tevin, Ramon

Client: Angela Throm

Program Goal

- The goal of the "Step into Strive" program is to introduce middle school students to engineering, math, and science. Students picked a project related to the biomedical, electrical, or mechanical engineering field. Each group was given a "real world" engineering problem to solve using the engineering design process.

Original Problem Statement

- Students were given an original problem statement to describe their engineering "problem."

> Rafael was the fastest runner for the Winchester Middle School track Team. After an injury sustained running track, Rafael lost the use of his right leg. His doctor has submitted him to a program offered by UMASS Medical Center that hopes to develop prosthetic leg substitute for an athlete like Rafael to use so he can continue running track. UMASS Medical Center is sponsoring the research for the development of a new prosthetic leg design that will accommodate the needs of a student athlete weighing between 100-130 lbs.

Revised Problem Statement

- Students reviewed the original problem statement and discussed the main objective. From their discussions, the students wrote a revised problem statement that concisely describes the engineering problem.

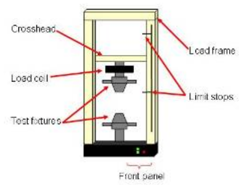
> We need to make a prosthetic leg so Rafael can run in his competitions and walk again.

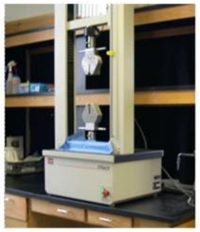
Objectives and Constraints

- The leg must be the right weight for the body
- The leg must be comfortable
- We must choose the right material for the leg
- The prosthetic must function like an actual leg
- The prosthetic must fit for the upper part of the leg
- The leg must be able to stay on
- The prosthetic must be durable
- It should be multi-functional
- It must be non-irritating
- It must be water proof
- Materials that we are limited from
- The cost of the leg itself
- Our time limit
- Leg has to withstand the force of an athlete in the weight of 100-130 pounds

Materials Testing

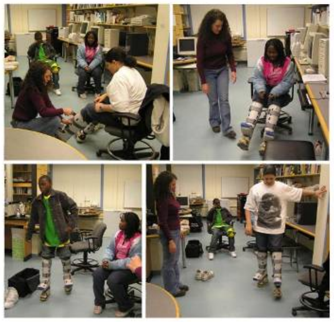
- Students tested various materials using a MTS tensile tester to learn about the strength of different types of materials.





Testing Prosthetic Legs

- Students tried on prosthetic-like devices in order to understand the requirements for the prosthetic design.



- After trying on the prosthetic legs and seeing the different types of prosthetics, the students discussed the important aspects of their design.

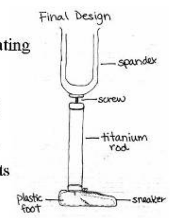
Function-Means Chart

- Using the objectives and constraints the students determined the most important functions for their design and potential materials to achieve the functions.

Function	Means		
Attach to his leg	Adhesive	Straps	Screwed in, or suction
Support his leg	Metals	Polymer	Ceramic
Have to move	Fake Joint	Springs	
Interface with leg	Cotton	Polyester	Velour
Withstand the force of a student athlete	Metals	Plastic	Wood
Withstand temperatures	Aluminum	Polymer gel	Ceramic

Final Design

- After evaluating other designs and materials the students came up with a final design.
  - Spandex – washable, stretches, non-irritating
  - Titanium rod – strong, light
  - Standard foam foot – fits in a shoe, light
  - Screw attachment – leg can be removed
  - Spring – allows for small foot movements
  - Sneaker – good for running



Prototype Design

- Students designed and built a prototype to represent their final design.

References

http://www.endolite.com/
http://www.ossur.com/temptate110.asp?pageid=1
http://www.micacorp.com/
http://www.amputeeresource.org/History%20and%20prosthetics.htm

Appendix J: Survey

Educational Research Survey

WPI The University of Science and Technology. And Life.

Engineering in the Curriculum

- *Please carefully complete the questionnaire*
- *Indicate your answers by filling in the circles on the answer sheet*

YOU MAY USE A BLACK OR BLUE PEN OR PENCIL

INCORRECT MARKS ✓ X • *CORRECT MARK* ●

- You answers are completely confidential.
- Do not write your name on the questionnaire.
- Place your name on the answer sheet.
- Your participation is completely voluntary

Thank you for assisting us in our research study. We hope to see your participation and views make an impact.

SURVEY ID #

Educational Research Survey
(WPI) Worcester Polytechnic Institute

Prepared by: WPI - IQP Research Group

School Code: ☐☐☐☐☐☐☐☐

Student's Grade: ☐ 9th ☐ 12th

Gender: ☐ Male ☐ Female

Race/Ethnicity:

1 ☐ African American/Black 2 ☐ White 3 ☐ American Indian/Alaskan Native
4 ☐ Spanish/Hispanic/Latino 5 ☐ Asian 6 ☐ Other

ID	Question	Selection
1	How would you rate your academic performance? (Academic Performance refers to Final Grades received in your classes)	☐ A Excellent (Exceeds Expectations) ☐ B Good (Above Expectations) ☐ C Fair (Meets Expectations) ☐ D Poor (Below Expectations) ☐ F Very Poor (Unacceptable)
2	How would you rate your Work Ethic?	☐ A Excellent (Exceeds Expectations) ☐ B Good (Above Expectations) ☐ C Fair (Meets Expectations) ☐ D Poor (Below Expectations) ☐ F Very Poor (Unacceptable)
3	Mathematics is an important part of your education.	☐ 1 Strongly Agree ☐ 2 Agree ☐ 3 Neither Agree nor Disagree ☐ 4 Disagree ☐ 5 Strongly Disagree
4	Science is an important part of your education.	☐ 1 Strongly Agree ☐ 2 Agree ☐ 3 Neither Agree nor Disagree ☐ 4 Disagree ☐ 5 Strongly Disagree
5	English/Language Arts is an important part of your education.	☐ 1 Strongly Agree ☐ 2 Agree ☐ 3 Neither Agree nor Disagree ☐ 4 Disagree ☐ 5 Strongly Disagree

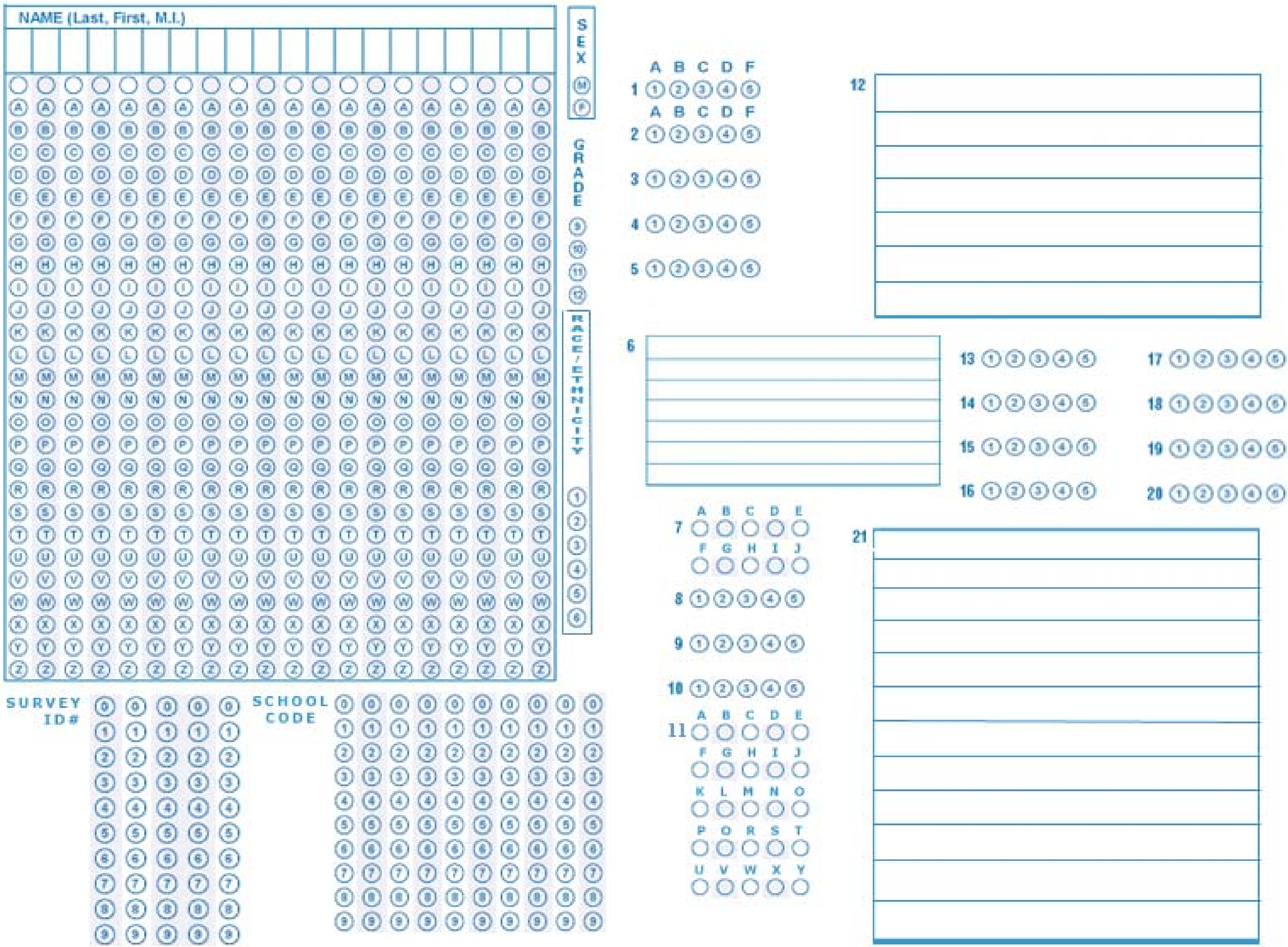
6	What generally interests you? (Hobbies, Interests, etc.)	
7	What courses/subjects in school interest you the most? (Check your top 3 choices)	**A** ☐ Mathematics B ☐ English Language Arts C ☐ History D ☐ Biology E ☐ Anatomy & Physiology F ☐ Physics G ☐ Chemistry H ☐ Psychology I ☐ Foreign Languages J ☐ Other
8	I plan on attending College after graduating High School.	☐ 1 Strongly Agree ☐ 2 Agree ☐ 3 Neither Agree nor Disagree ☐ 4 Disagree ☐ 5 Strongly Disagree
9	I plan on attending a 4 year University or College after graduating High School.	☐ 1 Strongly Agree ☐ 2 Agree ☐ 3 Neither Agree nor Disagree ☐ 4 Disagree ☐ 5 Strongly Disagree
10	I plan on attending a 2 year University or College after graduating High School.	☐ 1 Strongly Agree ☐ 2 Agree ☐ 3 Neither Agree nor Disagree ☐ 4 Disagree ☐ 5 Strongly Disagree

11	What Field do you plan on majoring in? (Check all that apply)	**A** ☐ Architecture & Environmental Design **B** ☐ Agriculture & Natural Resources **C** ☐ Arts: Visual & Performing **D** ☐ Biological Life Sciences **E** ☐ Business & Commerce **F** ☐ Communications **G** ☐ Computer & Information Sciences & Technologies **H** ☐ Education **I** ☐ Public Affairs & Services **J** ☐ Social Sciences & History **K** ☐ Library & Archival Sciences **L** ☐ Engineering & Engineering Technologies **M** ☐ Foreign & Classical Languages **N** ☐ Health Professions & Allied Services **O** ☐ Home Economics **P** ☐ Language & Literature **Q** ☐ Mathematics **R** ☐ Military Science **S** ☐ Philosophy, Religion & Theology **T** ☐ Physical Sciences **U** ☐ Undecided
12	Briefly explain what Engineering is in your own words.	

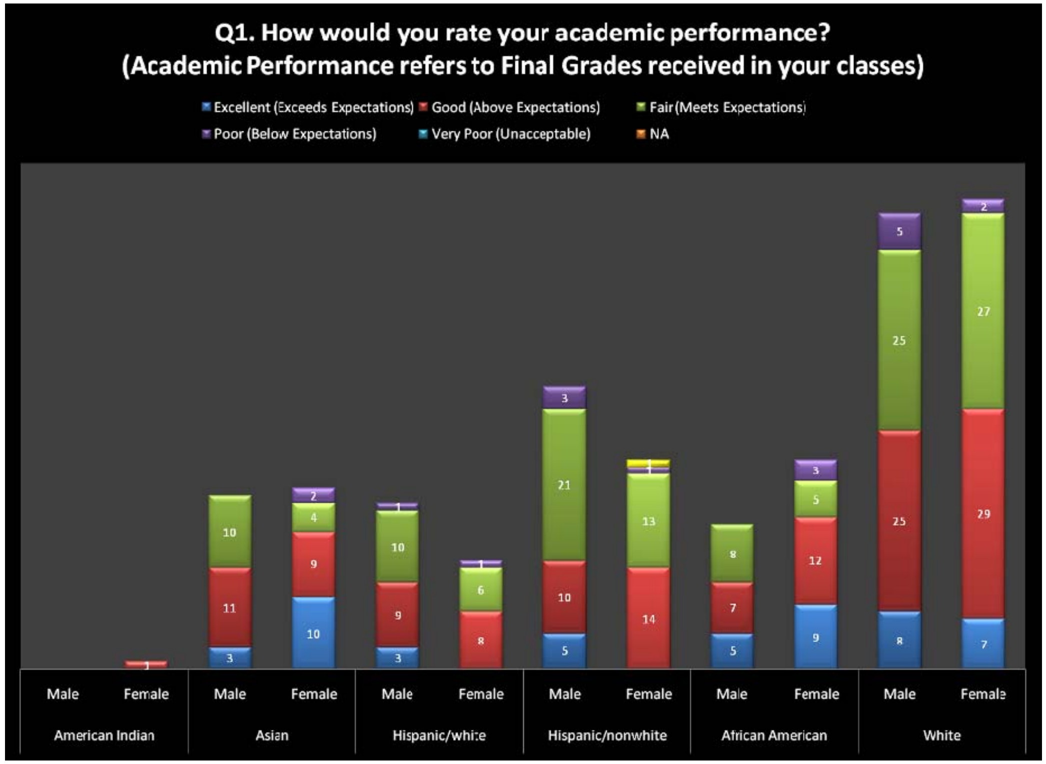
13	When I think about an engineer, I think of a person who: Has little or no social life.	☐ 1 Strongly Agree ☐ 2 Agree ☐ 3 Neither Agree nor Disagree ☐ 4 Disagree ☐ 5 Strongly Disagree
14	When I think about an Engineer, I think of a person who: Has a lot of friends.	☐ 1 Strongly Agree ☐ 2 Agree ☐ 3 Neither Agree nor Disagree ☐ 4 Disagree ☐ 5 Strongly Disagree
15	When I think about an Engineer, I think of a person who: Is very boring.	☐ 1 Strongly Agree ☐ 2 Agree ☐ 3 Neither Agree nor Disagree ☐ 4 Disagree ☐ 5 Strongly Disagree
16	When I think about an Engineer, I think of a person who: Is very exciting.	☐ 1 Strongly Agree ☐ 2 Agree ☐ 3 Neither Agree nor Disagree ☐ 4 Disagree ☐ 5 Strongly Disagree
17	When I think about an Engineer, I think of a person who: Is an average man/woman doing an average job.	☐ 1 Strongly Agree ☐ 2 Agree ☐ 3 Neither Agree nor Disagree ☐ 4 Disagree ☐ 5 Strongly Disagree
18	When I think about an Engineer, I think of a person who: Is nothing like me.	☐ 1 Strongly Agree ☐ 2 Agree ☐ 3 Neither Agree nor Disagree ☐ 4 Disagree ☐ 5 Strongly Disagree
19	Would you consider engineering as a future occupational field?	☐ 1 Strongly Agree ☐ 2 Agree ☐ 3 Neither Agree nor Disagree ☐ 4 Disagree ☐ 5 Strongly Disagree
20	Where do you see yourself in the future? (Future refers to 4 years from now) (Check all that apply)	1 ☐ Undergraduate - College 2 ☐ Part-Time Job 3 ☐ Full-Time Job 4 ☐ Graduate School 5 ☐ Other

21	What concerns or comments, regarding academics and your education, do you have about your school? (Classes Offered, Teaching Methods, Course Materials, etc.)

Appendix K: Survey Answer Sheet

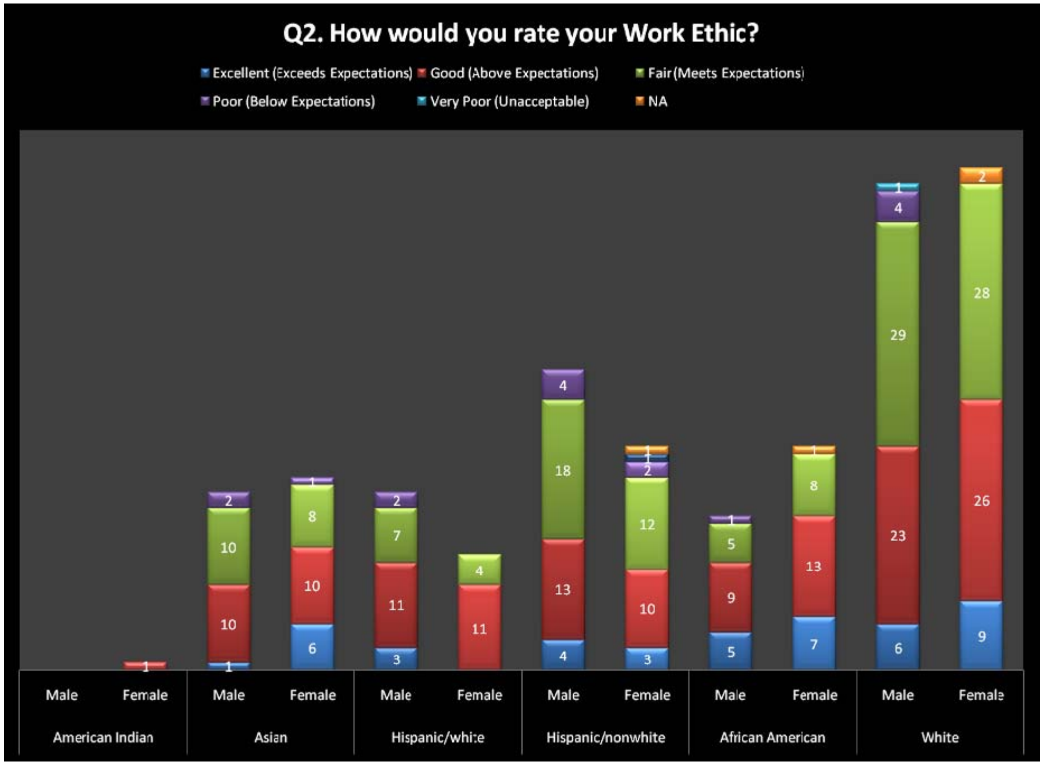


Appendix L: Grade 9 Academic Performance



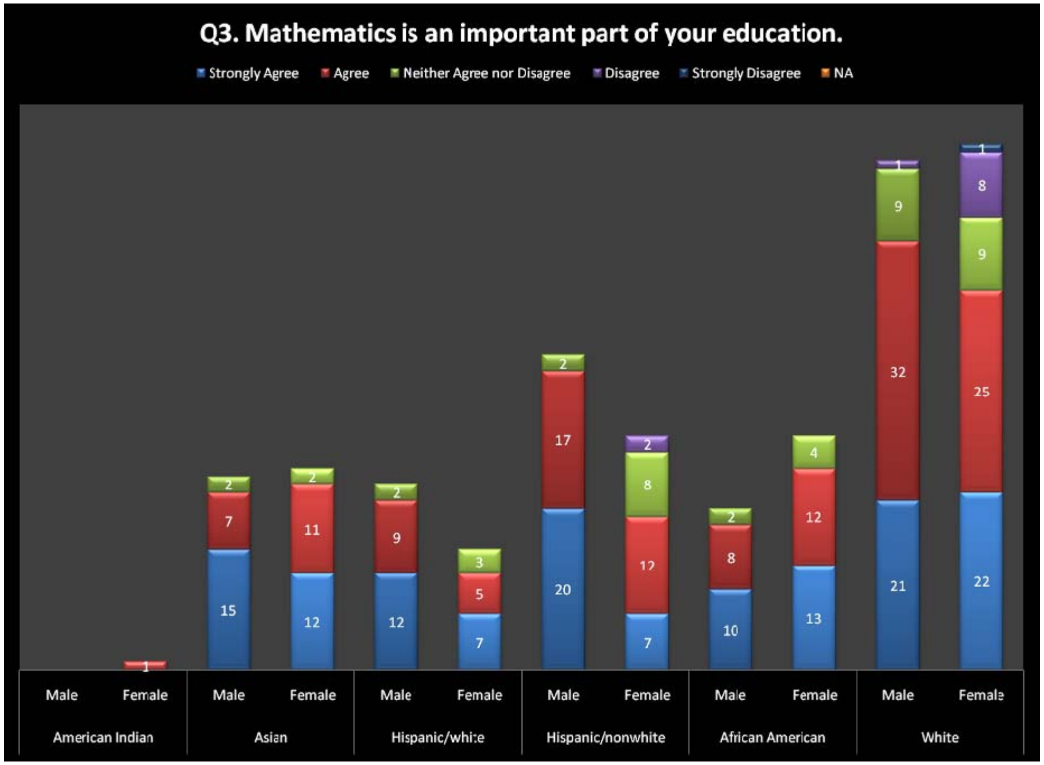
	American Indian	Asian	Hispanic/white	Hispanic/nonwhite	Black	White
	Total	Total	Total	Total	Total	Total
Excellent (Exceeds Expectations)	0.00%	26.53%	7.89%	7.35%	28.57%	11.72%
Good (Above Expectations)	100.00%	40.82%	44.74%	35.29%	38.78%	42.19%
Fair (Meets Expectations)	0.00%	28.57%	42.11%	50.00%	26.53%	40.63%
Poor (Below Expectations)	0.00%	4.08%	5.26%	5.88%	6.12%	5.47%
Very Poor (Unacceptable)	0.00%	0.00%	0.00%	1.47%	0.00%	0.00%
NA	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

	American Indian		Asian		Hispanic/white		Hispanic/nonwhile		Black		White	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Excellent (Exceeds Expectations)	0.00%	0.00%	23.08%	76.92%	100.00%	0.00%	100.00%	0.00%	35.71%	64.29%	53.33%	46.67%
Good (Above Expectations)	0.00%	100.00%	55.00%	45.00%	52.94%	47.06%	41.67%	58.33%	36.84%	63.16%	46.30%	53.70%
Fair (Meets Expectations)	0.00%	0.00%	71.43%	28.57%	62.50%	37.50%	61.76%	38.24%	61.54%	38.46%	48.08%	51.92%
Poor (Below Expectations)	0.00%	0.00%	0.00%	100.00%	50.00%	50.00%	75.00%	25.00%	0.00%	100.00%	71.43%	28.57%
Very Poor (Unacceptable)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%
NA	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%



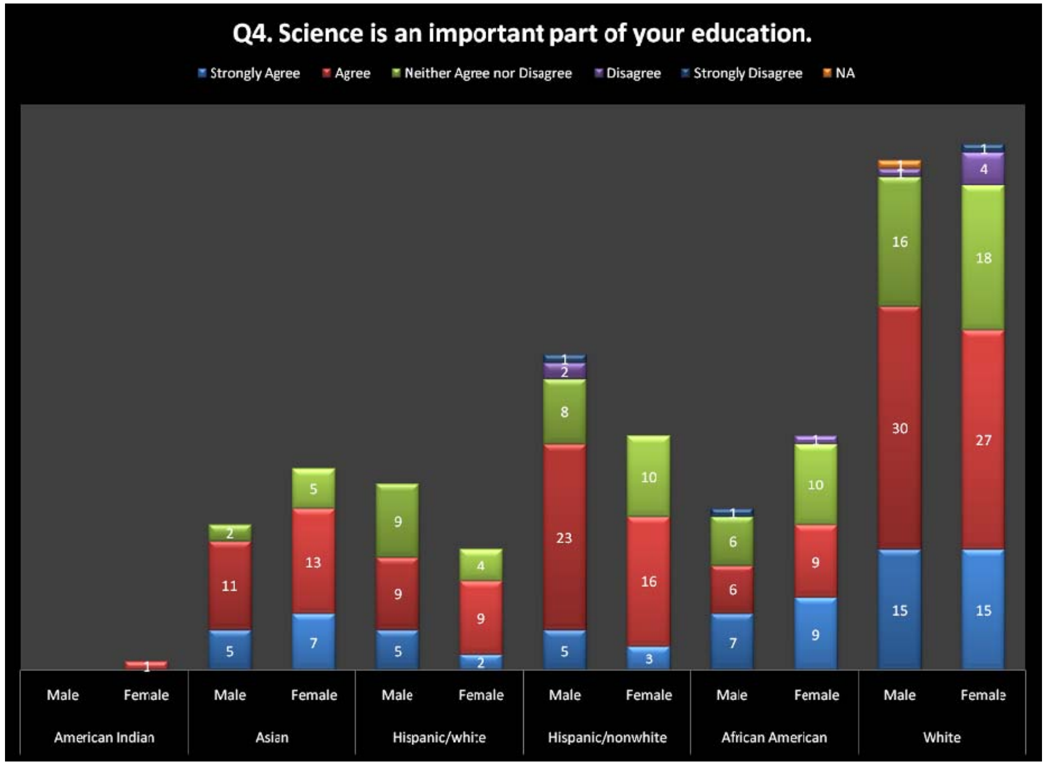
	American Indian	Asian	Hispanic/white	Hispanic/nonwhite	Black	White
	Total	Total	Total	Total	Total	Total
Excellent (Exceeds Expectations)	0.00%	14.29%	7.89%	10.29%	24.49%	11.72%
Good (Above Expectations)	100.00%	40.82%	57.89%	33.82%	44.90%	38.28%
Fair (Meets Expectations)	0.00%	36.73%	28.95%	44.12%	26.53%	44.53%
Poor (Below Expectations)	0.00%	6.12%	5.26%	8.82%	2.04%	3.13%
Very Poor (Unacceptable)	0.00%	0.00%	0.00%	1.47%	0.00%	0.78%
NA	0.00%	0.00%	0.00%	1.47%	2.04%	1.56%

	American Indian		Asian		Hispanic/white		Hispanic/nonwhile		Black		White	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Excellent (Exceeds Expectations)	0.00%	0.00%	14.29%	85.71%	100.00%	0.00%	57.14%	42.86%	41.67%	58.33%	40.00%	60.00%
Good (Above Expectations)	0.00%	100.00%	50.00%	50.00%	50.00%	50.00%	56.52%	43.48%	40.91%	59.09%	46.94%	53.06%
Fair (Meets Expectations)	0.00%	0.00%	55.56%	44.44%	63.64%	36.36%	60.00%	40.00%	38.46%	61.54%	50.88%	49.12%
Poor (Below Expectations)	0.00%	0.00%	66.67%	33.33%	100.00%	0.00%	66.67%	33.33%	100.00%	0.00%	100.00%	0.00%
Very Poor (Unacceptable)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	100.00%	0.00%
NA	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	100.00%	0.00%	100.00%



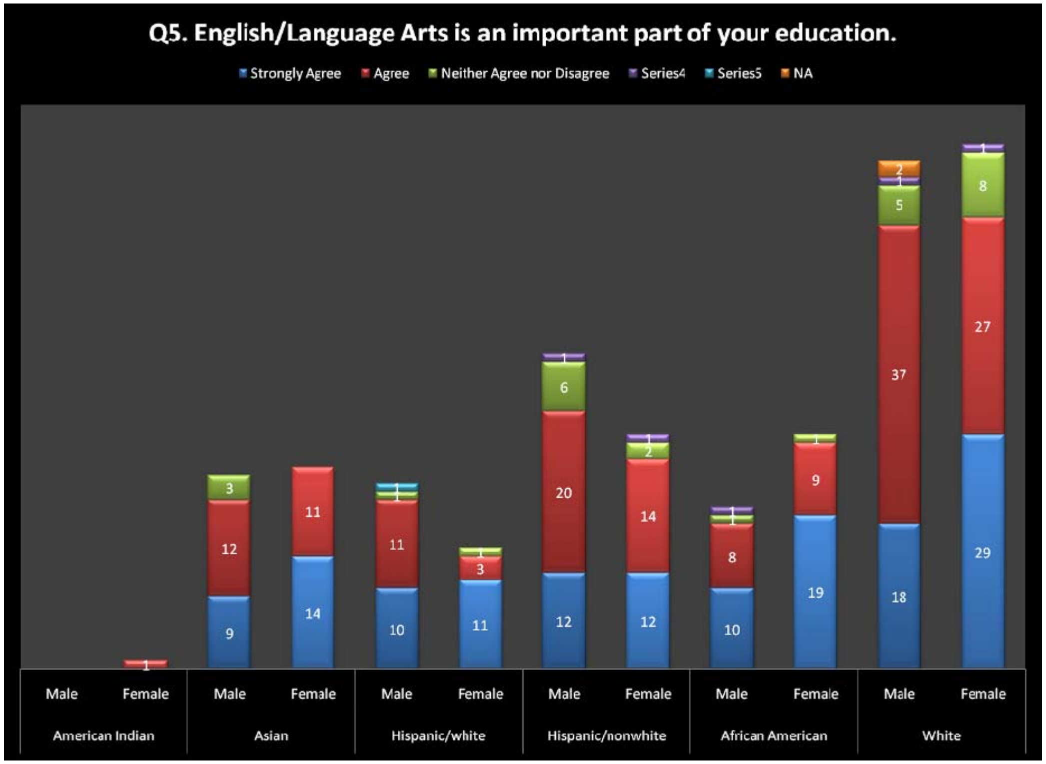
	American Indian	Asian	Hispanic/white	Hispanic/nonwhite	Black	White
	Total	Total	Total	Total	Total	Total
Strongly Agree	0.00%	55.10%	50.00%	39.71%	46.94%	33.59%
Agree	100.00%	36.73%	36.84%	42.65%	40.82%	44.53%
Neither Agree nor Disagree	0.00%	8.16%	13.16%	14.71%	12.24%	14.06%
Disagree	0.00%	0.00%	0.00%	2.94%	0.00%	7.03%
Strongly Disagree	0.00%	0.00%	0.00%	0.00%	0.00%	0.78%
NA	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

	American Indian		Asian		Hispanic/white		Hispanic/nonwhile		Black		White	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Strongly Agree	0.00%	0.00%	55.56%	44.44%	63.16%	36.84%	74.07%	25.93%	43.48%	56.52%	48.84%	51.16%
Agree	0.00%	100.00%	38.89%	61.11%	64.29%	35.71%	58.62%	41.38%	40.00%	60.00%	56.14%	43.86%
Neither Agree nor Disagree	0.00%	0.00%	50.00%	50.00%	40.00%	60.00%	20.00%	80.00%	33.33%	66.67%	50.00%	50.00%
Disagree	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	11.11%	88.89%
Strongly Disagree	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
NA	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%



	American Indian	Asian	Hispanic/white	Hispanic/nonwhite	Black	White
	Total	Total	Total	Total	Total	Total
Strongly Agree	0.00%	24.49%	18.42%	11.76%	32.65%	23.44%
Agree	100.00%	48.98%	47.37%	57.35%	30.61%	44.53%
Neither Agree nor Disagree	0.00%	14.29%	34.21%	26.47%	32.65%	26.56%
Disagree	0.00%	0.00%	0.00%	2.94%	2.04%	3.91%
Strongly Disagree	0.00%	0.00%	0.00%	1.47%	2.04%	0.78%
NA	0.00%	0.00%	0.00%	0.00%	0.00%	0.78%

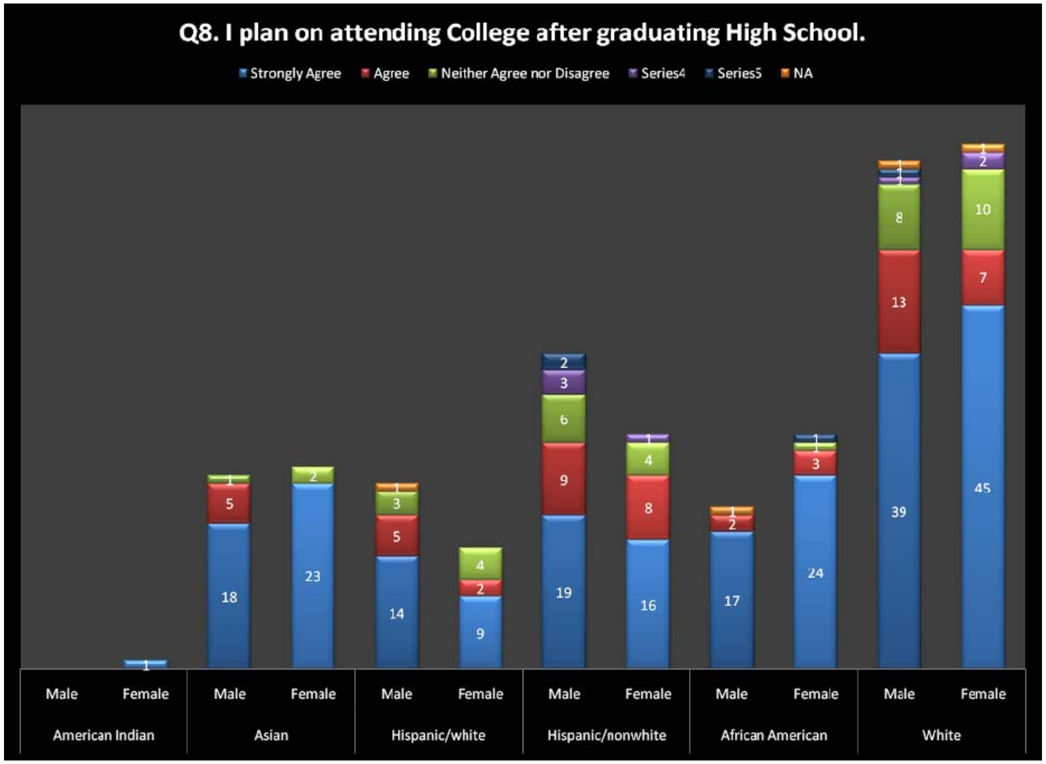
	American Indian		Asian		Hispanic/white		Hispanic/nonwhile		Black		White	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Strongly Agree	0.00%	0.00%	41.67%	58.33%	71.43%	28.57%	62.50%	37.50%	43.75%	56.25%	50.00%	50.00%
Agree	0.00%	100.00%	45.83%	54.17%	50.00%	50.00%	58.97%	41.03%	40.00%	60.00%	52.63%	47.37%
Neither Agree nor Disagree	0.00%	0.00%	28.57%	71.43%	69.23%	30.77%	44.44%	55.56%	37.50%	62.50%	47.06%	52.94%
Disagree	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	100.00%	20.00%	80.00%
Strongly Disagree	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	100.00%	0.00%	0.00%	100.00%
NA	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%



	American Indian	Asian	Hispanic/white	Hispanic/nonwhite	Black	White
	Total	Total	Total	Total	Total	Total
Strongly Agree	0.00%	46.94%	55.26%	35.29%	59.18%	36.72%
Agree	100.00%	46.94%	36.84%	50.00%	34.69%	50.00%
Neither Agree nor Disagree	0.00%	6.12%	5.26%	11.76%	4.08%	10.16%
Disagree	0.00%	0.00%	0.00%	2.94%	2.04%	1.56%
Strongly Disagree	0.00%	0.00%	2.63%	0.00%	0.00%	0.00%
NA	0.00%	0.00%	0.00%	0.00%	0.00%	1.56%

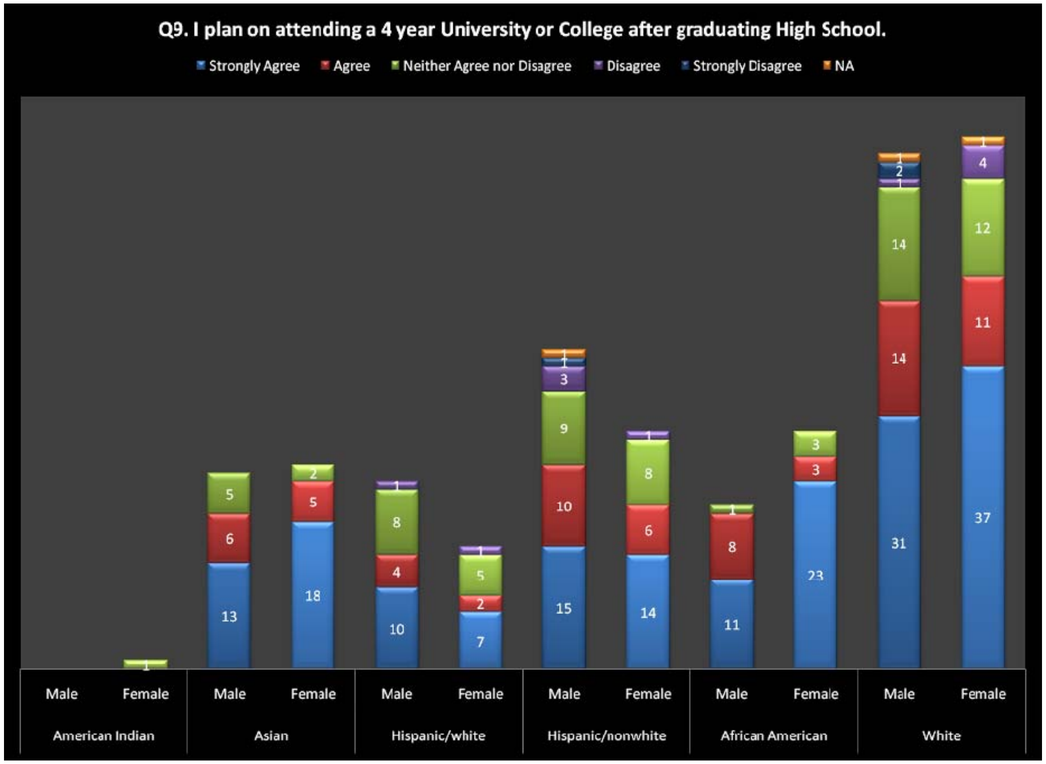
	American Indian		Asian		Hispanic/white		Hispanic/nonwhile		Black		White	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Strongly Agree	0.00%	0.00%	39.13%	60.87%	47.62%	52.38%	50.00%	50.00%	34.48%	65.52%	38.30%	61.70%
Agree	0.00%	100.00%	52.17%	47.83%	78.57%	21.43%	58.82%	41.18%	47.06%	52.94%	57.81%	42.19%
Neither Agree nor Disagree	0.00%	0.00%	100.00%	0.00%	50.00%	50.00%	75.00%	25.00%	50.00%	50.00%	38.46%	61.54%
Disagree	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	50.00%	50.00%	100.00%	0.00%	50.00%	50.00%
Strongly Disagree	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
NA	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%

Appendix M: Grade 9 Future Educational Outlook



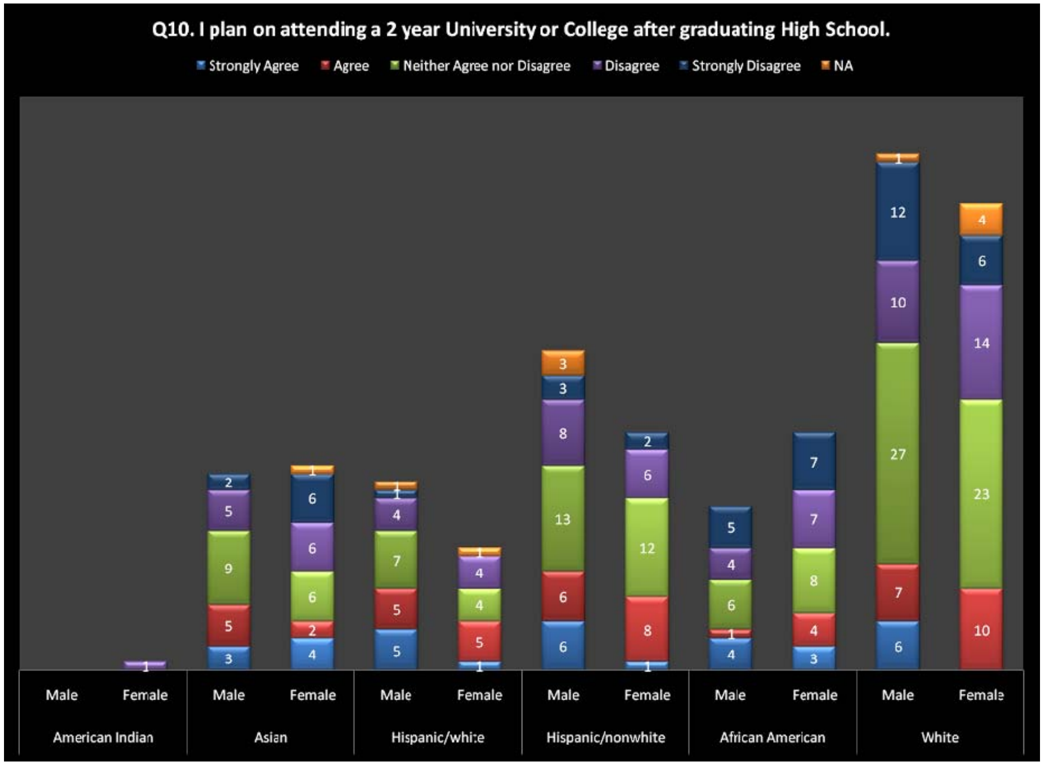
	American Indian	Asian	Hispanic/white	Hispanic/nonwhite	Black	White
	Total	Total	Total	Total	Total	Total
Strongly Agree	100.00%	83.67%	60.53%	51.47%	83.67%	65.63%
Agree	0.00%	10.20%	18.42%	25.00%	10.20%	15.63%
Neither Agree nor Disagree	0.00%	6.12%	18.42%	14.71%	2.04%	14.06%
Disagree	0.00%	0.00%	0.00%	5.88%	0.00%	2.34%
Strongly Disagree	0.00%	0.00%	0.00%	2.94%	2.04%	0.78%
NA	0.00%	0.00%	2.63%	0.00%	2.04%	1.56%

	American Indian		Asian		Hispanic/white		Hispanic/nonwhile		Black		White	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Strongly Agree	0.00%	100.00%	43.90%	56.10%	60.87%	39.13%	54.29%	45.71%	41.46%	58.54%	46.43%	53.57%
Agree	0.00%	0.00%	100.00%	0.00%	71.43%	28.57%	52.94%	47.06%	40.00%	60.00%	65.00%	35.00%
Neither Agree nor Disagree	0.00%	0.00%	33.33%	66.67%	42.86%	57.14%	60.00%	40.00%	0.00%	100.00%	44.44%	55.56%
Disagree	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	75.00%	25.00%	0.00%	0.00%	33.33%	66.67%
Strongly Disagree	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	100.00%	100.00%	0.00%
NA	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	100.00%	0.00%	50.00%	50.00%



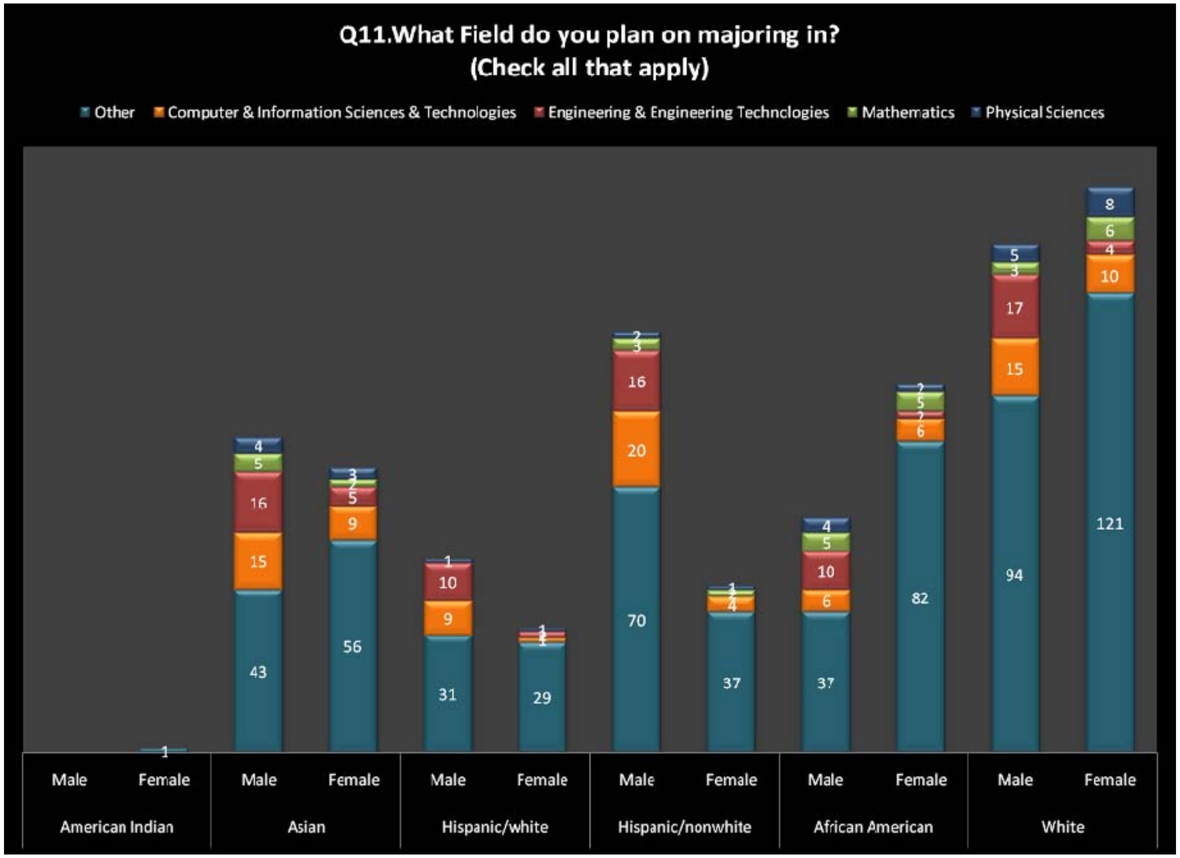
	American Indian	Asian	Hispanic/white	Hispanic/nonwhite	Black	White
	Total	Total	Total	Total	Total	Total
Strongly Agree	0.00%	63.27%	44.74%	42.65%	69.39%	53.13%
Agree	0.00%	22.45%	15.79%	23.53%	22.45%	19.53%
Neither Agree nor Disagree	100.00%	14.29%	34.21%	25.00%	8.16%	20.31%
Disagree	0.00%	0.00%	5.26%	5.88%	0.00%	3.91%
Strongly Disagree	0.00%	0.00%	0.00%	1.47%	0.00%	1.56%
NA	0.00%	0.00%	0.00%	1.47%	0.00%	1.56%

	American Indian		Asian		Hispanic/white		Hispanic/nonwhile		Black		White	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Strongly Agree	0.00%	0.00%	41.94%	58.06%	58.82%	41.18%	51.72%	48.28%	32.35%	67.65%	45.59%	54.41%
Agree	0.00%	0.00%	54.55%	45.45%	66.67%	33.33%	62.50%	37.50%	72.73%	27.27%	56.00%	44.00%
Neither Agree nor Disagree	0.00%	100.00%	71.43%	28.57%	61.54%	38.46%	52.94%	47.06%	25.00%	75.00%	53.85%	46.15%
Disagree	0.00%	0.00%	0.00%	0.00%	50.00%	50.00%	75.00%	25.00%	0.00%	0.00%	20.00%	80.00%
Strongly Disagree	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	100.00%	0.00%
NA	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	50.00%	50.00%



	American Indian	Asian	Hispanic/white	Hispanic/nonwhite	Black	White
	Total	Total	Total	Total	Total	Total
Strongly Agree	0.00%	14.29%	15.79%	10.29%	14.29%	10.94%
Agree	0.00%	14.29%	26.32%	20.59%	10.20%	13.28%
Neither Agree nor Disagree	0.00%	30.61%	28.95%	36.76%	28.57%	39.06%
Disagree	100.00%	22.45%	21.05%	20.59%	22.45%	18.75%
Strongly Disagree	0.00%	16.33%	2.63%	7.35%	24.49%	14.06%
NA	0.00%	2.04%	5.26%	4.41%	0.00%	3.91%

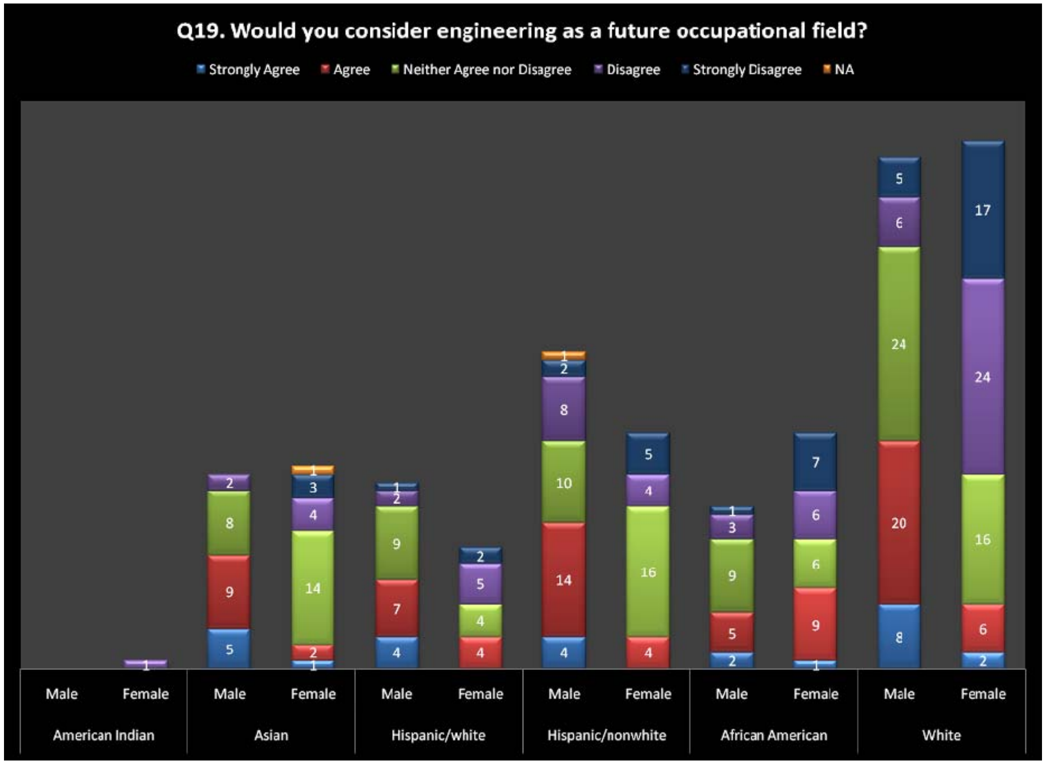
	American Indian		Asian		Hispanic/white		Hispanic/nonwhile		Black		White	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Strongly Agree	0.00%	0.00%	42.86%	57.14%	83.33%	16.67%	85.71%	14.29%	57.14%	42.86%	42.86%	57.14%
Agree	0.00%	0.00%	71.43%	28.57%	50.00%	50.00%	42.86%	57.14%	20.00%	80.00%	41.18%	58.82%
Neither Agree nor Disagree	0.00%	0.00%	60.00%	40.00%	63.64%	36.36%	52.00%	48.00%	42.86%	57.14%	54.00%	46.00%
Disagree	0.00%	100.00%	45.45%	54.55%	50.00%	50.00%	57.14%	42.86%	36.36%	63.64%	41.67%	58.33%
Strongly Disagree	0.00%	0.00%	25.00%	75.00%	100.00%	0.00%	60.00%	40.00%	41.67%	58.33%	66.67%	33.33%
NA	0.00%	0.00%	0.00%	100.00%	50.00%	50.00%	100.00%	0.00%	0.00%	0.00%	20.00%	80.00%



Q11.What Field do you plan on majoring in?
(Check all that apply)
Other
Computer & Information Sciences & Technologies
Engineering & Engineering Technologies
Mathematics
Physical Sciences
Male
Female
American Indian
Asian
Hispanic/white
Hispanic/nonwhite
African American
White

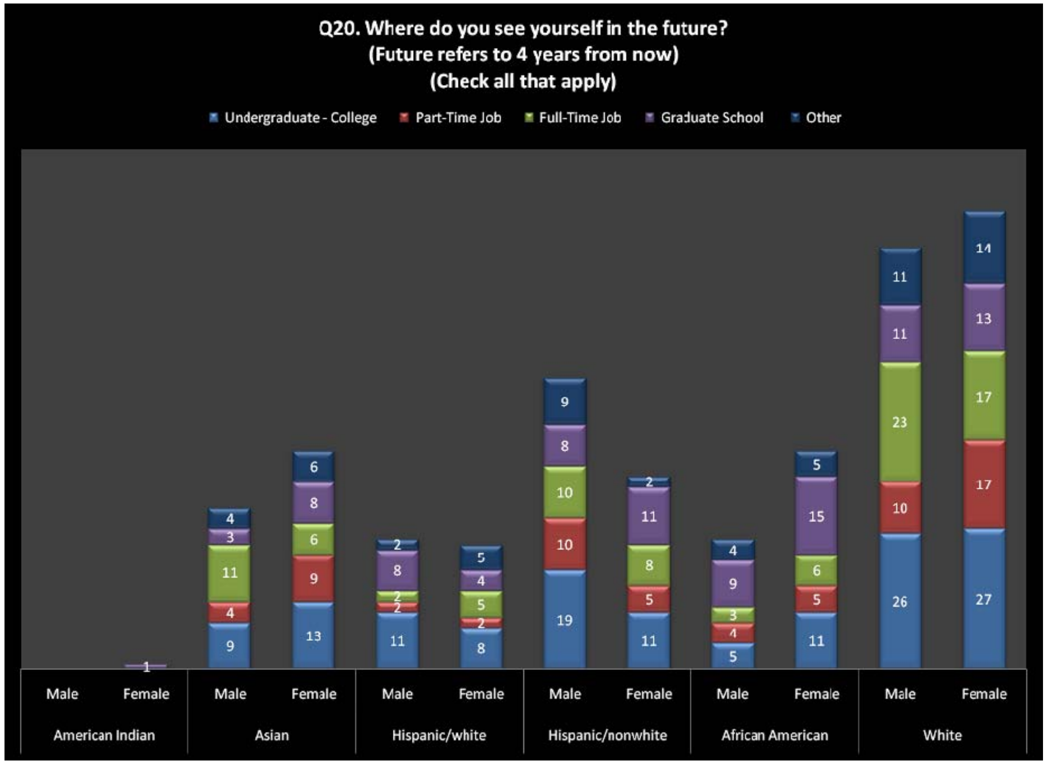
	American Indian	Asian	Hispanic/white	Hispanic/nonwhite	Black	White
	Total	Total	Total	Total	Total	Total
Architecture & Environmental Design	0.00%	16.33%	10.53%	11.76%	10.20%	10.16%
Agriculture & Natural Resources	0.00%	2.04%	0.00%	4.41%	4.08%	0.78%
Arts: Visual & Performing	100.00%	22.45%	26.32%	14.71%	24.49%	19.53%
Biological Life Sciences	0.00%	26.53%	7.89%	10.29%	16.33%	16.41%
Business & Commerce	0.00%	22.45%	18.42%	22.06%	32.65%	17.19%
Communications	0.00%	8.16%	0.00%	7.35%	20.41%	7.03%
Computer & Information Sciences & Technologies	0.00%	48.98%	26.32%	35.29%	24.49%	19.53%
Education	0.00%	12.24%	5.26%	7.35%	16.33%	5.47%
Public Affairs & Services	0.00%	6.12%	2.63%	2.94%	18.37%	3.91%
Social Sciences & History	0.00%	2.04%	7.89%	7.35%	10.20%	6.25%
Library & Archival Sciences	0.00%	2.04%	2.63%	1.47%	2.04%	0.78%
Engineering & Engineering Technologies	0.00%	42.86%	31.58%	23.53%	24.49%	16.41%
Foreign & Classical Languages	0.00%	2.04%	10.53%	23.53%	14.29%	7.03%
Health Professions & Allied Services	0.00%	24.49%	26.32%	16.18%	34.69%	20.31%
Home Economics	0.00%	4.08%	7.89%	4.41%	8.16%	7.81%
Language & Literature	0.00%	6.12%	2.63%	2.94%	6.12%	7.03%
Mathematics	0.00%	14.29%	0.00%	7.35%	20.41%	7.03%
Military Science	0.00%	12.24%	15.79%	7.35%	4.08%	7.81%
Philosophy, Religion & Theology	0.00%	12.24%	0.00%	0.00%	6.12%	2.34%
Physical Sciences	0.00%	14.29%	5.26%	4.41%	12.24%	10.16%
Undecided	0.00%	20.41%	13.16%	13.24%	14.29%	28.13%

	American Indian		Asian		Hispanic/white		Hispanic/nonwhile		Black		White	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Architecture & Environmental Design	0.00%	0.00%	87.50%	12.50%	50.00%	50.00%	87.50%	12.50%	20.00%	80.00%	53.85%	46.15%
Agriculture & Natural Resources	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	66.67%	33.33%	100.00%	0.00%	100.00%	0.00%
Arts: Visual & Performing	0.00%	100.00%	54.55%	45.45%	40.00%	60.00%	40.00%	60.00%	8.33%	91.67%	24.00%	76.00%
Biological Life Sciences	0.00%	0.00%	23.08%	76.92%	100.00%	0.00%	57.14%	42.86%	25.00%	75.00%	42.86%	57.14%
Business & Commerce	0.00%	0.00%	63.64%	36.36%	71.43%	28.57%	86.67%	13.33%	31.25%	68.75%	40.91%	59.09%
Communications	0.00%	0.00%	50.00%	50.00%	0.00%	0.00%	80.00%	20.00%	40.00%	60.00%	66.67%	33.33%
Computer & Information Sciences & Technologies	0.00%	0.00%	62.50%	37.50%	90.00%	10.00%	83.33%	16.67%	50.00%	50.00%	60.00%	40.00%
Education	0.00%	0.00%	16.67%	83.33%	50.00%	50.00%	40.00%	60.00%	37.50%	62.50%	57.14%	42.86%
Public Affairs & Services	0.00%	0.00%	66.67%	33.33%	0.00%	100.00%	50.00%	50.00%	22.22%	77.78%	60.00%	40.00%
Social Sciences & History	0.00%	0.00%	100.00%	0.00%	66.67%	33.33%	60.00%	40.00%	60.00%	40.00%	50.00%	50.00%
Library & Archival Sciences	0.00%	0.00%	0.00%	100.00%	100.00%	0.00%	100.00%	0.00%	100.00%	0.00%	0.00%	100.00%
Engineering & Engineering Technologies	0.00%	0.00%	76.19%	23.81%	83.33%	16.67%	100.00%	0.00%	83.33%	16.67%	80.95%	19.05%
Foreign & Classical Languages	0.00%	0.00%	100.00%	0.00%	50.00%	50.00%	100.00%	0.00%	14.29%	85.71%	33.33%	66.67%
Health Professions & Allied Services	0.00%	0.00%	16.67%	83.33%	30.00%	70.00%	36.36%	63.64%	23.53%	76.47%	19.23%	80.77%
Home Economics	0.00%	0.00%	50.00%	50.00%	33.33%	66.67%	100.00%	0.00%	50.00%	50.00%	60.00%	40.00%
Language & Literature	0.00%	0.00%	0.00%	100.00%	0.00%	100.00%	0.00%	100.00%	33.33%	66.67%	22.22%	77.78%
Mathematics	0.00%	0.00%	71.43%	28.57%	0.00%	0.00%	60.00%	40.00%	50.00%	50.00%	33.33%	66.67%
Military Science	0.00%	0.00%	83.33%	16.67%	50.00%	50.00%	60.00%	40.00%	50.00%	50.00%	90.00%	10.00%
Philosophy, Religion & Theology	0.00%	0.00%	66.67%	33.33%	0.00%	0.00%	0.00%	0.00%	33.33%	66.67%	0.00%	100.00%
Physical Sciences	0.00%	0.00%	57.14%	42.86%	50.00%	50.00%	66.67%	33.33%	66.67%	33.33%	38.46%	61.54%
Undecided	0.00%	0.00%	10.00%	90.00%	80.00%	20.00%	33.33%	66.67%	42.86%	57.14%	55.56%	44.44%



	American Indian	Asian	Hispanic/white	Hispanic/nonwhite	Black	White
	Total	Total	Total	Total	Total	Total
Strongly Agree	0.00%	12.24%	10.53%	5.88%	6.12%	7.81%
Agree	0.00%	22.45%	28.95%	26.47%	28.57%	20.31%
Neither Agree nor Disagree	0.00%	44.90%	34.21%	38.24%	30.61%	31.25%
Disagree	100.00%	12.24%	18.42%	17.65%	18.37%	23.44%
Strongly Disagree	0.00%	6.12%	7.89%	10.29%	16.33%	17.19%
NA	0.00%	2.04%	0.00%	1.47%	0.00%	0.00%

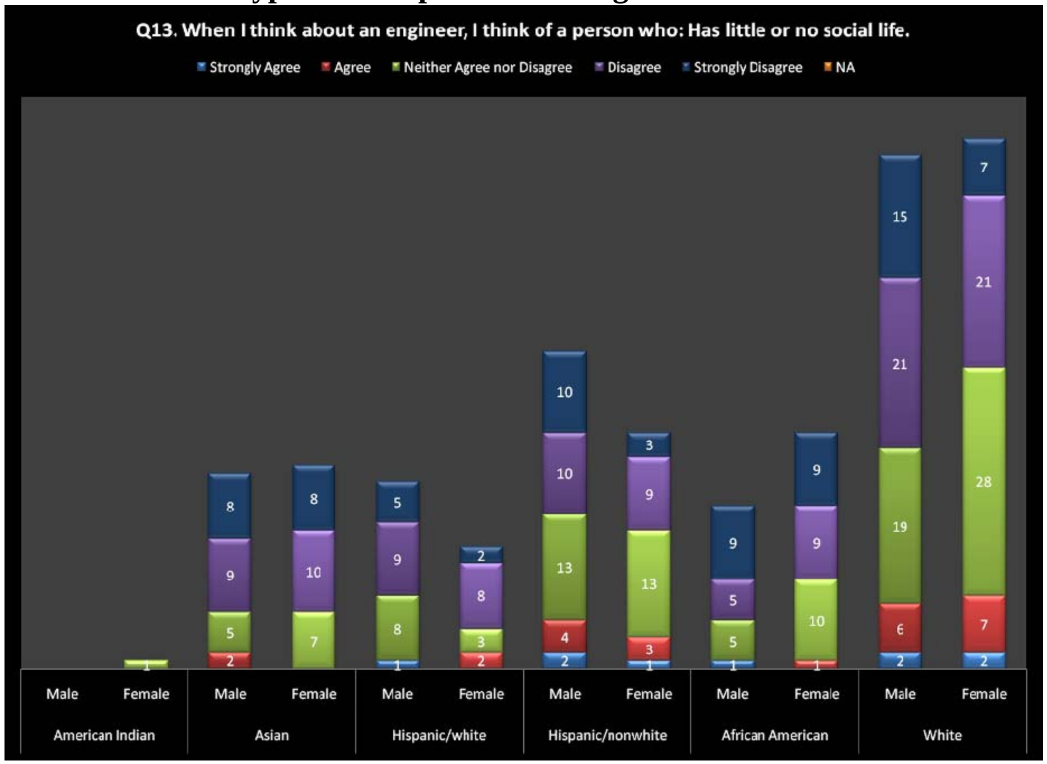
	American Indian		Asian		Hispanic/white		Hispanic/nonwhile		Black		White	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Strongly Agree	0.00%	0.00%	83.33%	16.67%	100.00%	0.00%	100.00%	0.00%	66.67%	33.33%	80.00%	20.00%
Agree	0.00%	0.00%	81.82%	18.18%	63.64%	36.36%	77.78%	22.22%	35.71%	64.29%	76.92%	23.08%
Neither Agree nor Disagree	0.00%	0.00%	36.36%	63.64%	69.23%	30.77%	38.46%	61.54%	60.00%	40.00%	60.00%	40.00%
Disagree	0.00%	100.00%	33.33%	66.67%	28.57%	71.43%	66.67%	33.33%	33.33%	66.67%	20.00%	80.00%
Strongly Disagree	0.00%	0.00%	0.00%	100.00%	33.33%	66.67%	28.57%	71.43%	12.50%	87.50%	22.73%	77.27%
NA	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%



	American Indian	Asian	Hispanic/white	Hispanic/nonwhite	Black	White
	Total	Total	Total	Total	Total	Total
Undergraduate - College	0.00%	44.90%	50.00%	44.12%	32.65%	41.41%
Part-Time Job	0.00%	26.53%	10.53%	22.06%	18.37%	21.09%
Full-Time Job	0.00%	34.69%	18.42%	26.47%	18.37%	31.25%
Graduate School	100.00%	22.45%	31.58%	27.94%	48.98%	18.75%
Other	0.00%	20.41%	18.42%	16.18%	18.37%	19.53%

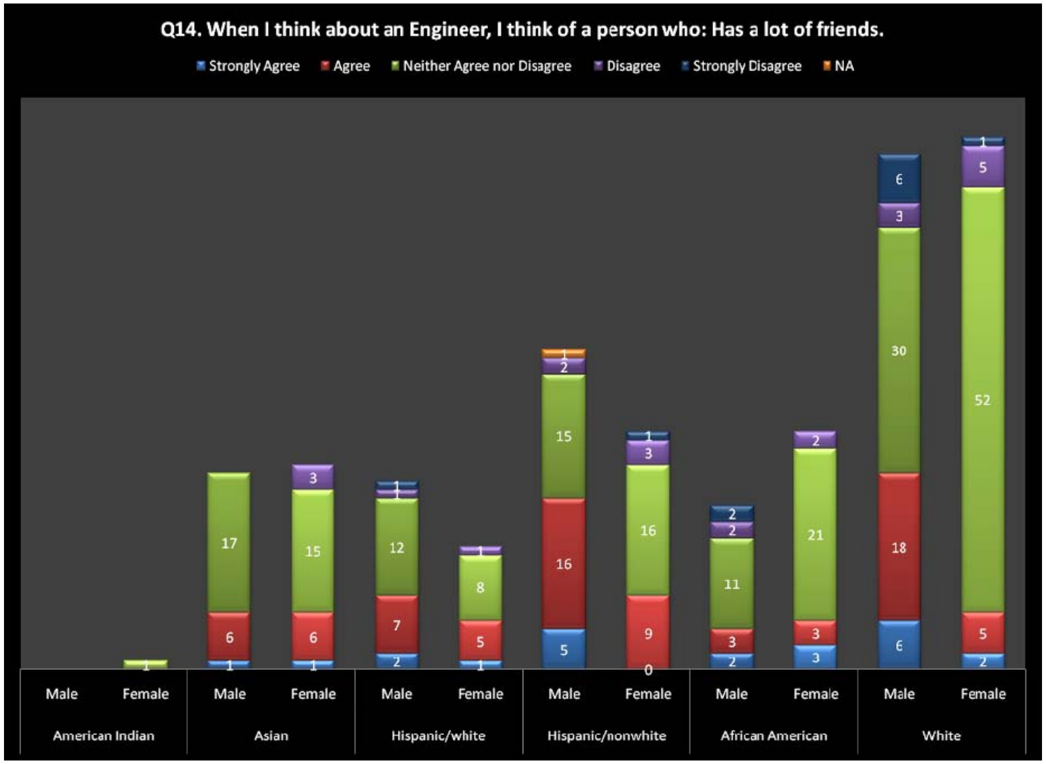
	American Indian		Asian		Hispanic/white		Hispanic/nonwhile		Black		White	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Undergraduate - College	0.00%	0.00%	40.91%	59.09%	57.89%	42.11%	63.33%	36.67%	31.25%	68.75%	49.06%	50.94%
Part-Time Job	0.00%	0.00%	30.77%	69.23%	50.00%	50.00%	66.67%	33.33%	44.44%	55.56%	37.04%	62.96%
Full-Time Job	0.00%	0.00%	64.71%	35.29%	28.57%	71.43%	55.56%	44.44%	33.33%	66.67%	57.50%	42.50%
Graduate School	0.00%	100.00%	27.27%	72.73%	66.67%	33.33%	42.11%	57.89%	37.50%	62.50%	45.83%	54.17%
Other	0.00%	0.00%	40.00%	60.00%	28.57%	71.43%	81.82%	18.18%	44.44%	55.56%	44.00%	56.00%

Appendix N: Grade 9 Attitude Toward the Stereotypical Perception of an Engineer



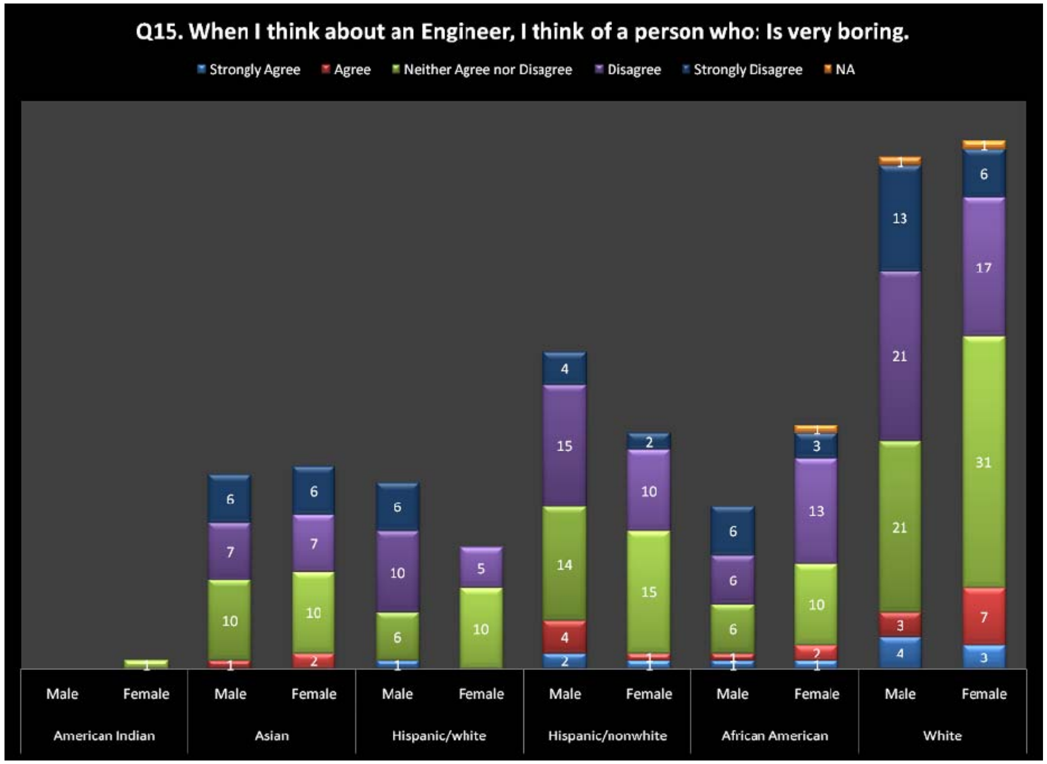
	American Indian	Asian	Hispanic/white	Hispanic/nonwhite	Black	White
	Total	Total	Total	Total	Total	Total
Strongly Agree	0.00%	0.00%	2.63%	4.41%	2.04%	3.13%
Agree	0.00%	4.08%	5.26%	10.29%	2.04%	10.16%
Neither Agree nor Disagree	100.00%	24.49%	28.95%	38.24%	30.61%	36.72%
Disagree	0.00%	38.78%	44.74%	27.94%	28.57%	32.81%
Strongly Disagree	0.00%	32.65%	18.42%	19.12%	36.73%	17.19%
NA	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

	American Indian		Asian		Hispanic/white		Hispanic/nonwhile		Black		White	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Strongly Agree	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	66.67%	33.33%	100.00%	0.00%	50.00%	50.00%
Agree	0.00%	0.00%	100.00%	0.00%	0.00%	100.00%	57.14%	42.86%	0.00%	100.00%	46.15%	53.85%
Neither Agree nor Disagree	0.00%	100.00%	41.67%	58.33%	72.73%	27.27%	50.00%	50.00%	33.33%	66.67%	40.43%	59.57%
Disagree	0.00%	0.00%	47.37%	52.63%	52.94%	47.06%	52.63%	47.37%	35.71%	64.29%	50.00%	50.00%
Strongly Disagree	0.00%	0.00%	50.00%	50.00%	71.43%	28.57%	76.92%	23.08%	50.00%	50.00%	68.18%	31.82%
NA	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%



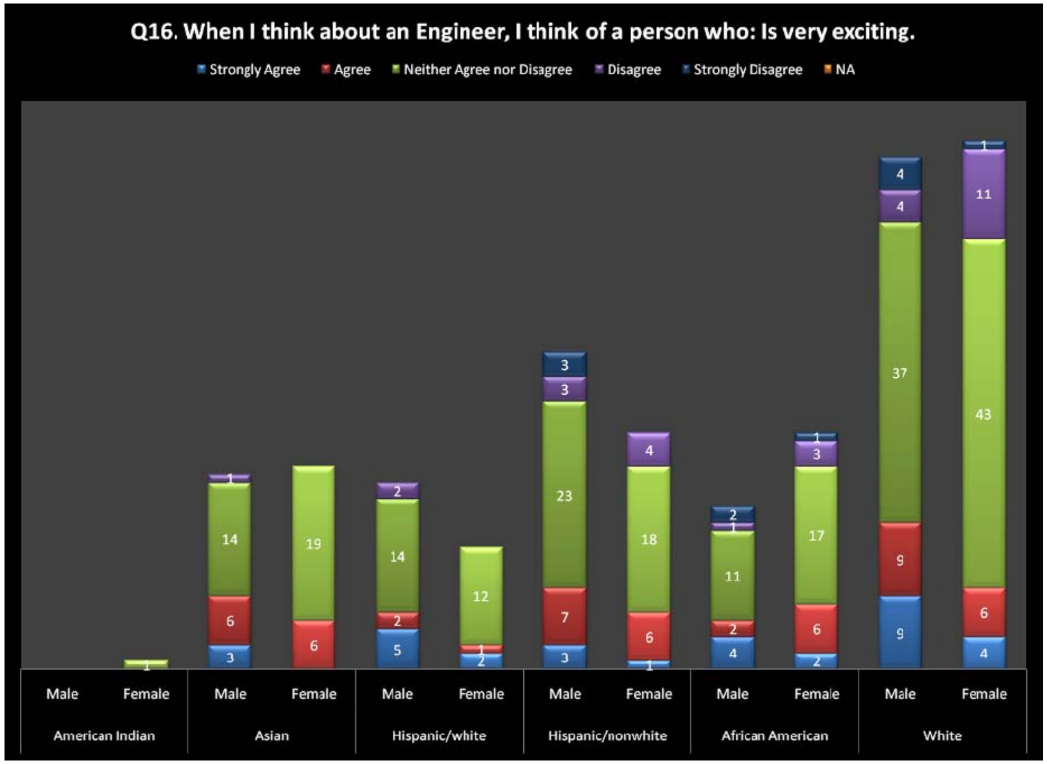
	American Indian	Asian	Hispanic/white	Hispanic/nonwhite	Black	White
	Total	Total	Total	Total	Total	Total
Strongly Agree	0.00%	4.08%	7.89%	7.35%	10.20%	6.25%
Agree	0.00%	24.49%	31.58%	36.76%	12.24%	17.97%
Neither Agree nor Disagree	100.00%	65.31%	52.63%	45.59%	65.31%	64.06%
Disagree	0.00%	6.12%	5.26%	7.35%	8.16%	6.25%
Strongly Disagree	0.00%	0.00%	2.63%	1.47%	4.08%	5.47%
NA	0.00%	0.00%	0.00%	1.47%	0.00%	0.00%

	American Indian		Asian		Hispanic/white		Hispanic/nonwhile		Black		White	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Strongly Agree	0.00%	0.00%	50.00%	50.00%	66.67%	33.33%	100.00%	0.00%	40.00%	60.00%	75.00%	25.00%
Agree	0.00%	0.00%	50.00%	50.00%	58.33%	41.67%	64.00%	36.00%	50.00%	50.00%	78.26%	21.74%
Neither Agree nor Disagree	0.00%	100.00%	53.13%	46.88%	60.00%	40.00%	48.39%	51.61%	34.38%	65.63%	36.59%	63.41%
Disagree	0.00%	0.00%	0.00%	100.00%	50.00%	50.00%	40.00%	60.00%	50.00%	50.00%	37.50%	62.50%
Strongly Disagree	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	100.00%	100.00%	0.00%	85.71%	14.29%
NA	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%



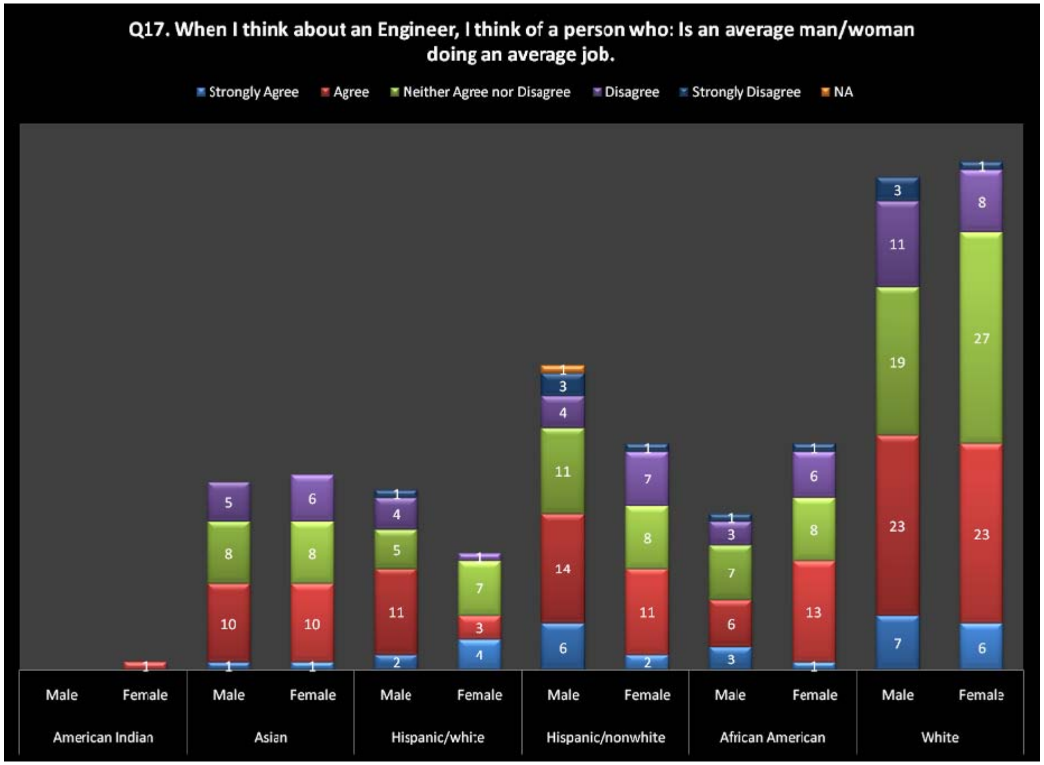
	American Indian	Asian	Hispanic/white	Hispanic/nonwhite	Black	White
	Total	Total	Total	Total	Total	Total
Strongly Agree	0.00%	0.00%	2.63%	4.41%	4.08%	5.47%
Agree	0.00%	6.12%	0.00%	7.35%	6.12%	7.81%
Neither Agree nor Disagree	100.00%	40.82%	42.11%	42.65%	32.65%	40.63%
Disagree	0.00%	28.57%	39.47%	36.76%	38.78%	29.69%
Strongly Disagree	0.00%	24.49%	15.79%	8.82%	18.37%	14.84%
NA	0.00%	0.00%	0.00%	0.00%	2.04%	1.56%

	American Indian		Asian		Hispanic/white		Hispanic/nonwhile		Black		White	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Strongly Agree	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	66.67%	33.33%	50.00%	50.00%	57.14%	42.86%
Agree	0.00%	0.00%	33.33%	66.67%	0.00%	0.00%	80.00%	20.00%	33.33%	66.67%	30.00%	70.00%
Neither Agree nor Disagree	0.00%	100.00%	50.00%	50.00%	37.50%	62.50%	48.28%	51.72%	37.50%	62.50%	40.38%	59.62%
Disagree	0.00%	0.00%	50.00%	50.00%	66.67%	33.33%	60.00%	40.00%	31.58%	68.42%	55.26%	44.74%
Strongly Disagree	0.00%	0.00%	50.00%	50.00%	100.00%	0.00%	66.67%	33.33%	66.67%	33.33%	68.42%	31.58%
NA	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	50.00%	50.00%



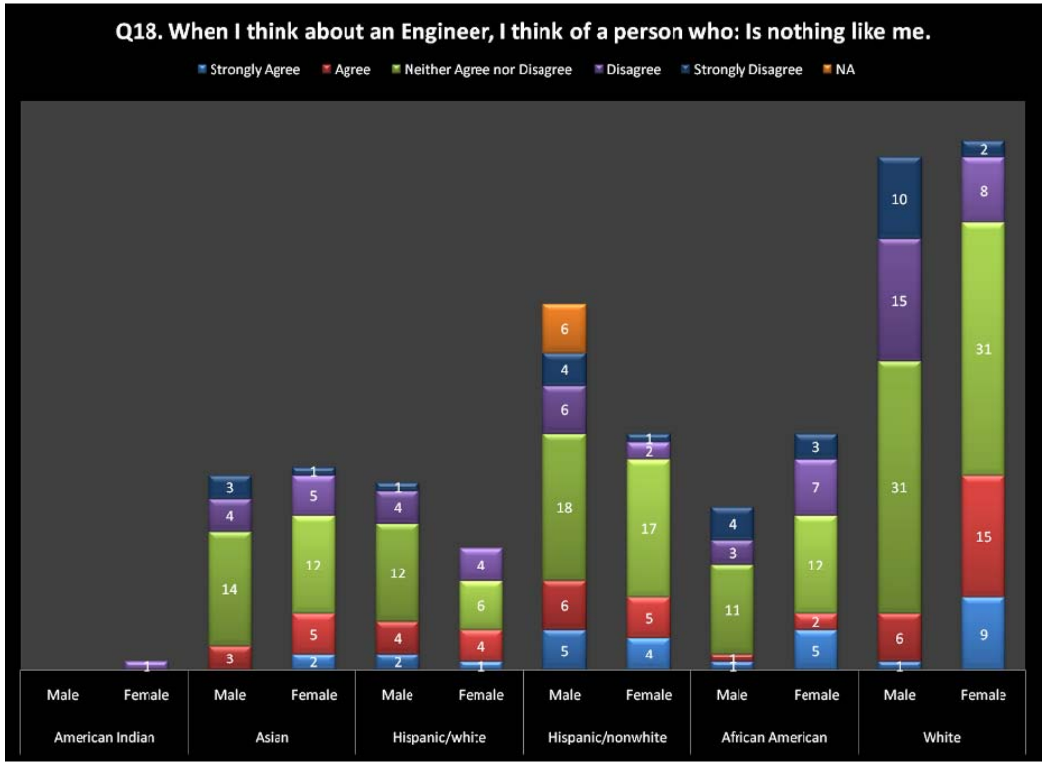
	American Indian	Asian	Hispanic/white	Hispanic/nonwhite	Black	White
	Total	Total	Total	Total	Total	Total
Strongly Agree	0.00%	6.12%	18.42%	5.88%	12.24%	10.16%
Agree	0.00%	24.49%	7.89%	19.12%	16.33%	11.72%
Neither Agree nor Disagree	100.00%	67.35%	68.42%	60.29%	57.14%	62.50%
Disagree	0.00%	2.04%	5.26%	10.29%	8.16%	11.72%
Strongly Disagree	0.00%	0.00%	0.00%	4.41%	6.12%	3.91%
NA	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

	American Indian		Asian		Hispanic/white		Hispanic/nonwhile		Black		White	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Strongly Agree	0.00%	0.00%	100.00%	0.00%	71.43%	28.57%	75.00%	25.00%	66.67%	33.33%	69.23%	30.77%
Agree	0.00%	0.00%	50.00%	50.00%	66.67%	33.33%	53.85%	46.15%	25.00%	75.00%	60.00%	40.00%
Neither Agree nor Disagree	0.00%	100.00%	42.42%	57.58%	53.85%	46.15%	56.10%	43.90%	39.29%	60.71%	46.25%	53.75%
Disagree	0.00%	0.00%	100.00%	0.00%	100.00%	0.00%	42.86%	57.14%	25.00%	75.00%	26.67%	73.33%
Strongly Disagree	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	66.67%	33.33%	80.00%	20.00%
NA	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%



	American Indian	Asian	Hispanic/white	Hispanic/nonwhite	Black	White
	Total	Total	Total	Total	Total	Total
Strongly Agree	0.00%	4.08%	15.79%	11.76%	8.16%	10.16%
Agree	100.00%	40.82%	36.84%	36.76%	38.78%	35.94%
Neither Agree nor Disagree	0.00%	32.65%	31.58%	27.94%	30.61%	35.94%
Disagree	0.00%	22.45%	13.16%	16.18%	18.37%	14.84%
Strongly Disagree	0.00%	0.00%	2.63%	5.88%	4.08%	3.13%
NA	0.00%	0.00%	0.00%	1.47%	0.00%	0.00%

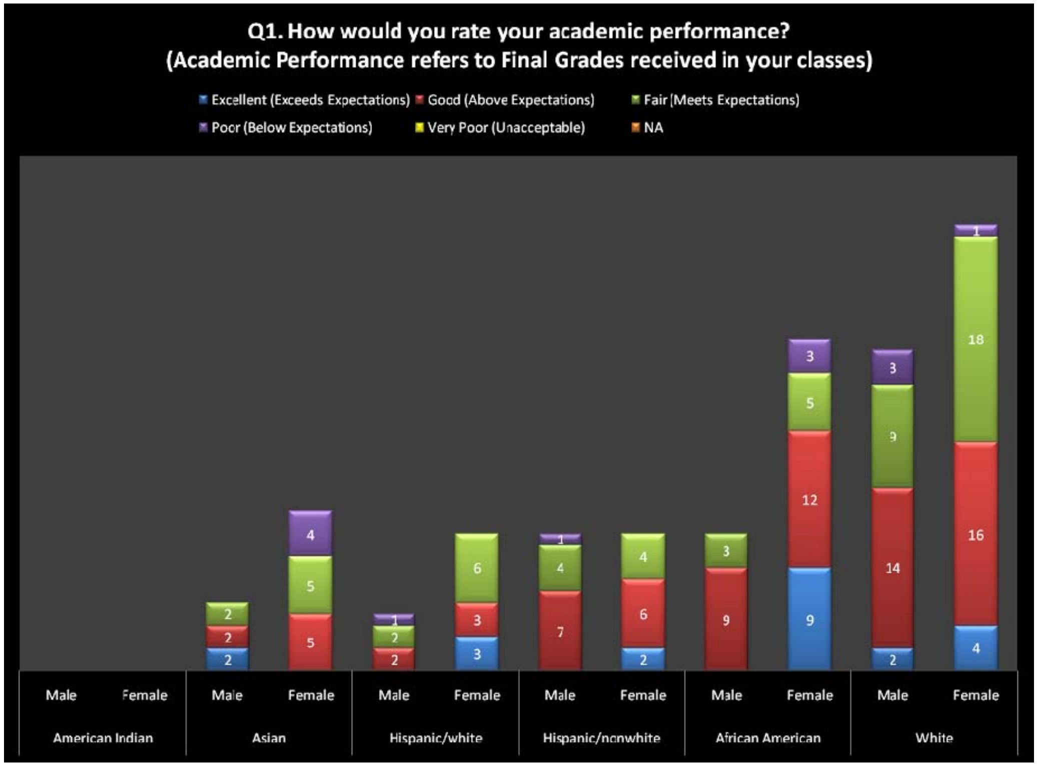
	American Indian		Asian		Hispanic/white		Hispanic/nonwhile		Black		White	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Strongly Agree	0.00%	0.00%	50.00%	50.00%	33.33%	66.67%	75.00%	25.00%	75.00%	25.00%	53.85%	46.15%
Agree	0.00%	100.00%	50.00%	50.00%	78.57%	21.43%	56.00%	44.00%	31.58%	68.42%	50.00%	50.00%
Neither Agree nor Disagree	0.00%	0.00%	50.00%	50.00%	41.67%	58.33%	57.89%	42.11%	46.67%	53.33%	41.30%	58.70%
Disagree	0.00%	0.00%	45.45%	54.55%	80.00%	20.00%	36.36%	63.64%	33.33%	66.67%	57.89%	42.11%
Strongly Disagree	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	75.00%	25.00%	50.00%	50.00%	75.00%	25.00%
NA	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%



	American Indian	Asian	Hispanic/white	Hispanic/nonwhite	Black	White
	Total	Total	Total	Total	Total	Total
Strongly Agree	0.00%	4.08%	7.89%	13.24%	12.24%	7.81%
Agree	0.00%	16.33%	21.05%	16.18%	6.12%	16.41%
Neither Agree nor Disagree	0.00%	53.06%	47.37%	51.47%	46.94%	48.44%
Disagree	100.00%	18.37%	21.05%	11.76%	20.41%	17.97%
Strongly Disagree	0.00%	8.16%	2.63%	7.35%	14.29%	9.38%
NA	0.00%	0.00%	0.00%	8.82%	0.00%	0.00%

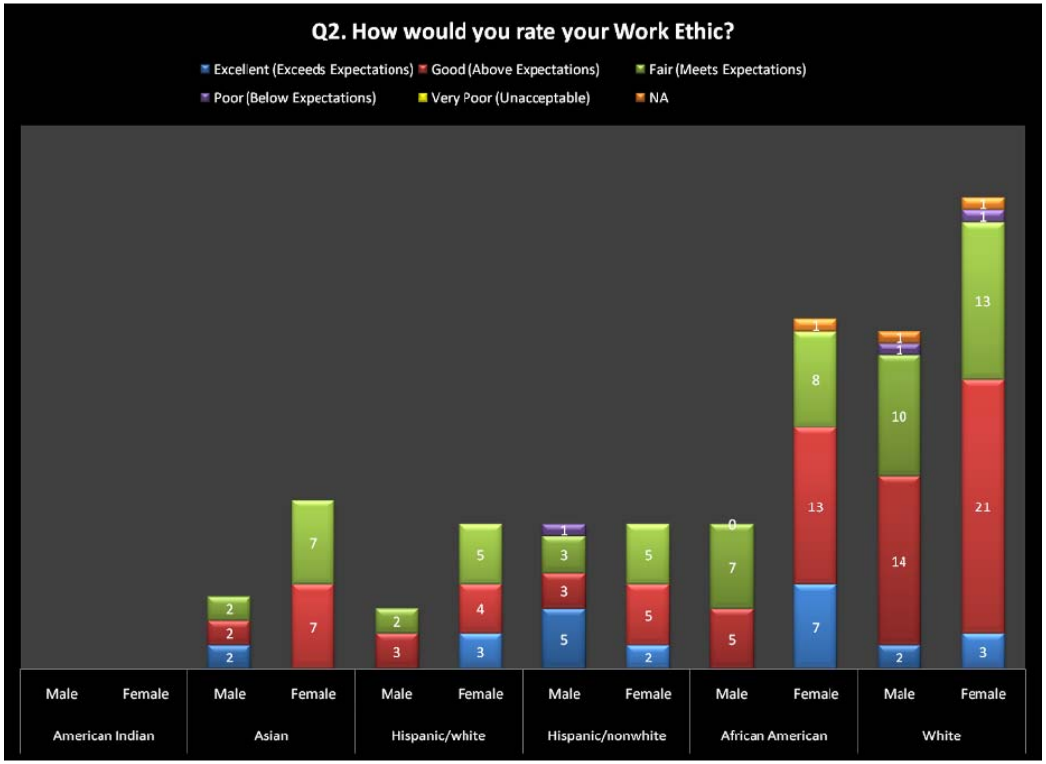
	American Indian		Asian		Hispanic/white		Hispanic/nonwhile		Black		White	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Strongly Agree	0.00%	0.00%	0.00%	100.00%	66.67%	33.33%	55.56%	44.44%	16.67%	83.33%	10.00%	90.00%
Agree	0.00%	0.00%	37.50%	62.50%	50.00%	50.00%	54.55%	45.45%	33.33%	66.67%	28.57%	71.43%
Neither Agree nor Disagree	0.00%	0.00%	53.85%	46.15%	66.67%	33.33%	51.43%	48.57%	47.83%	52.17%	50.00%	50.00%
Disagree	0.00%	100.00%	44.44%	55.56%	50.00%	50.00%	75.00%	25.00%	30.00%	70.00%	65.22%	34.78%
Strongly Disagree	0.00%	0.00%	75.00%	25.00%	100.00%	0.00%	80.00%	20.00%	57.14%	42.86%	83.33%	16.67%
NA	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Appendix O: Grade 12 Academic Performance



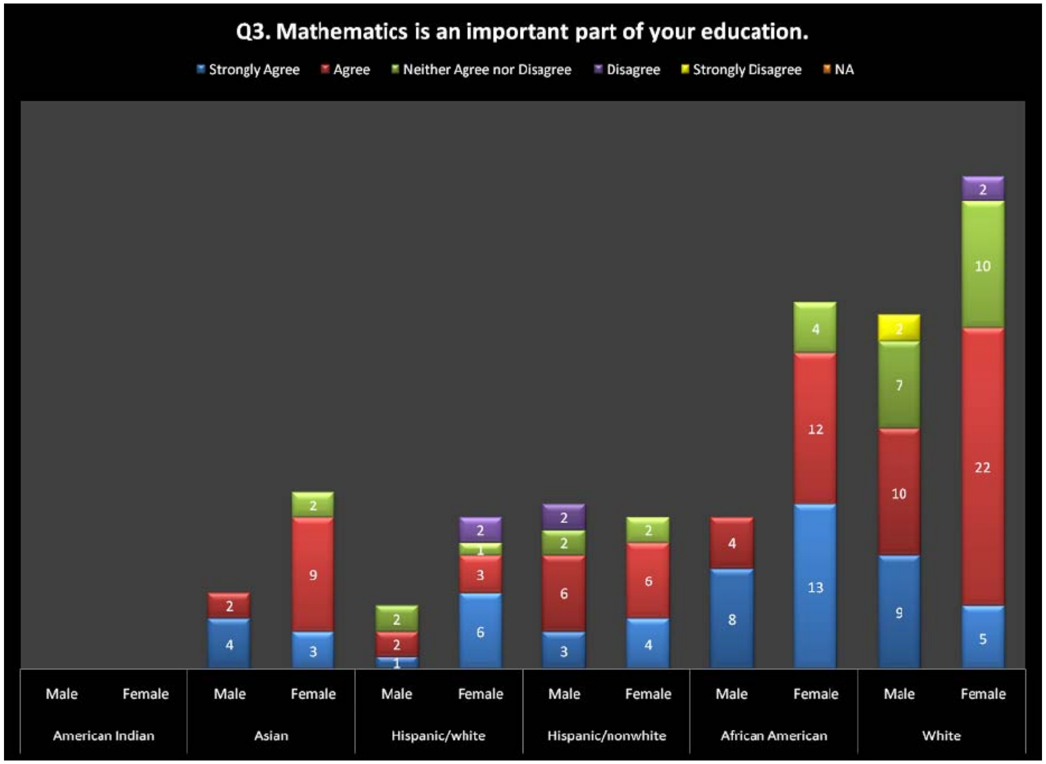
	American Indian	Asian	Hispanic/white	Hispanic/nonwhite	Black	White
	Total	Total	Total	Total	Total	Total
Excellent (Exceeds Expectations)	0.00%	10.00%	17.65%	8.33%	21.95%	8.96%
Good (Above Expectations)	0.00%	35.00%	29.41%	54.17%	51.22%	44.78%
Fair (Meets Expectations)	0.00%	35.00%	47.06%	33.33%	19.51%	40.30%
Poor (Below Expectations)	0.00%	20.00%	5.88%	4.17%	7.32%	5.97%
Very Poor (Unacceptable)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
NA	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

	American Indian		Asian		Hispanic/white		Hispanic/nonwhile		Black		White	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Excellent (Exceeds Expectations)	0.00%	0.00%	100.00%	0.00%	0.00%	100.00%	0.00%	100.00%	0.00%	100.00%	33.33%	66.67%
Good (Above Expectations)	0.00%	0.00%	28.57%	71.43%	40.00%	60.00%	53.85%	46.15%	42.86%	57.14%	46.67%	53.33%
Fair (Meets Expectations)	0.00%	0.00%	28.57%	71.43%	25.00%	75.00%	50.00%	50.00%	37.50%	62.50%	33.33%	66.67%
Poor (Below Expectations)	0.00%	0.00%	0.00%	100.00%	100.00%	0.00%	100.00%	0.00%	0.00%	100.00%	75.00%	25.00%
Very Poor (Unacceptable)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
NA	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%



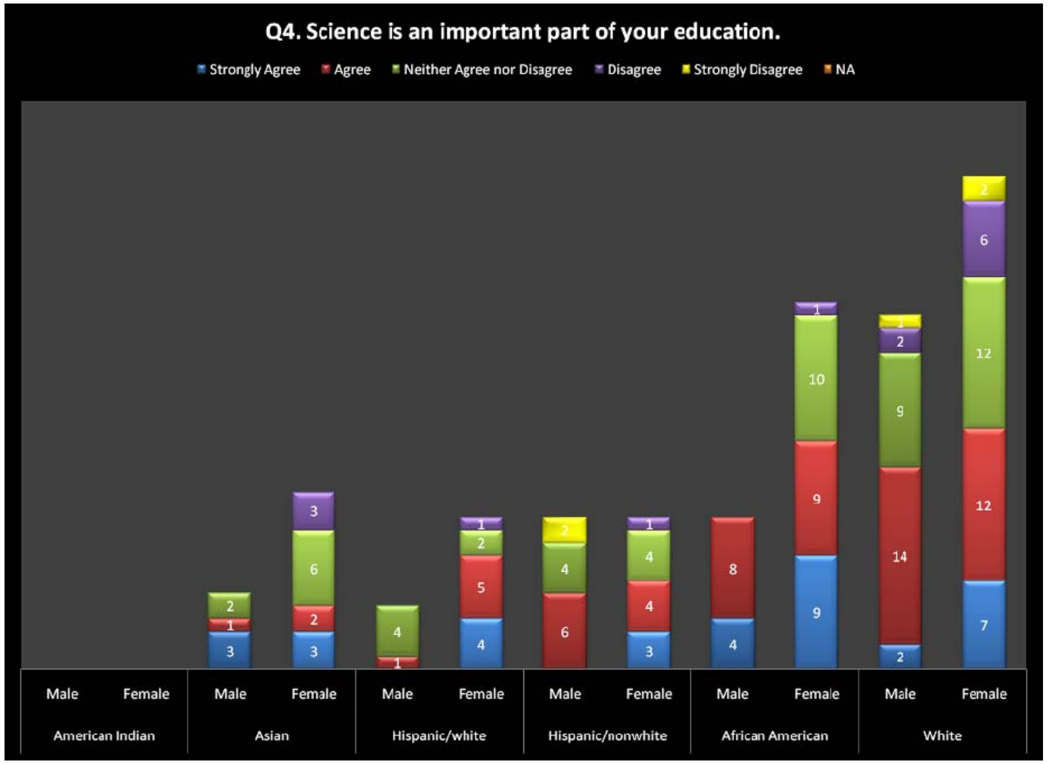
	American Indian	Asian	Hispanic/white	Hispanic/nonwhite	Black	White
	Total	Total	Total	Total	Total	Total
Excellent (Exceeds Expectations)	0.00%	10.00%	17.65%	29.17%	17.07%	7.46%
Good (Above Expectations)	0.00%	45.00%	41.18%	33.33%	43.90%	52.24%
Fair (Meets Expectations)	0.00%	45.00%	41.18%	33.33%	36.59%	34.33%
Poor (Below Expectations)	0.00%	0.00%	0.00%	4.17%	0.00%	2.99%
Very Poor (Unacceptable)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
NA	0.00%	0.00%	0.00%	0.00%	2.44%	2.99%

	American Indian		Asian		Hispanic/white		Hispanic/nonwhile		Black		White	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Excellent (Exceeds Expectations)	0.00%	0.00%	100.00%	0.00%	0.00%	100.00%	71.43%	28.57%	0.00%	100.00%	40.00%	60.00%
Good (Above Expectations)	0.00%	0.00%	22.22%	77.78%	42.86%	57.14%	37.50%	62.50%	27.78%	72.22%	40.00%	60.00%
Fair (Meets Expectations)	0.00%	0.00%	22.22%	77.78%	28.57%	71.43%	37.50%	62.50%	46.67%	53.33%	43.48%	56.52%
Poor (Below Expectations)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	50.00%	50.00%
Very Poor (Unacceptable)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
NA	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	50.00%	50.00%



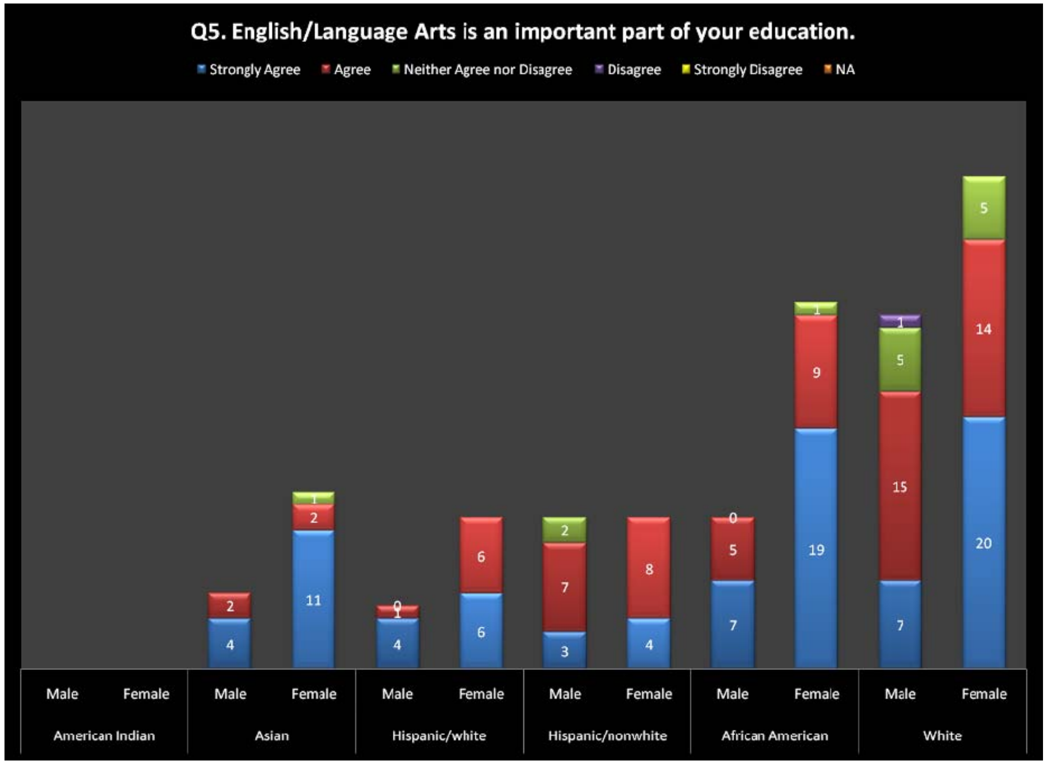
	American Indian	Asian	Hispanic/white	Hispanic/nonwhite	Black	White
	Total	Total	Total	Total	Total	Total
Strongly Agree	0.00%	35.00%	41.18%	29.17%	51.22%	20.90%
Agree	0.00%	55.00%	29.41%	50.00%	39.02%	47.76%
Neither Agree nor Disagree	0.00%	10.00%	17.65%	16.67%	9.76%	25.37%
Disagree	0.00%	0.00%	11.76%	8.33%	0.00%	2.99%
Strongly Disagree	0.00%	0.00%	0.00%	0.00%	0.00%	2.99%
NA	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

	American Indian		Asian		Hispanic/white		Hispanic/nonwhile		Black		White	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Strongly Agree	0.00%	0.00%	57.14%	42.86%	14.29%	85.71%	42.86%	57.14%	38.10%	61.90%	64.29%	35.71%
Agree	0.00%	0.00%	18.18%	81.82%	40.00%	60.00%	50.00%	50.00%	25.00%	75.00%	31.25%	68.75%
Neither Agree nor Disagree	0.00%	0.00%	0.00%	100.00%	66.67%	33.33%	50.00%	50.00%	0.00%	100.00%	41.18%	58.82%
Disagree	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	100.00%	0.00%	0.00%	0.00%	0.00%	100.00%
Strongly Disagree	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%
NA	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%



	American Indian	Asian	Hispanic/white	Hispanic/nonwhite	Black	White
	Total	Total	Total	Total	Total	Total
Strongly Agree	0.00%	30.00%	23.53%	12.50%	31.71%	13.43%
Agree	0.00%	15.00%	35.29%	41.67%	41.46%	38.81%
Neither Agree nor Disagree	0.00%	40.00%	35.29%	33.33%	24.39%	31.34%
Disagree	0.00%	15.00%	5.88%	4.17%	2.44%	11.94%
Strongly Disagree	0.00%	0.00%	0.00%	8.33%	0.00%	4.48%
NA	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

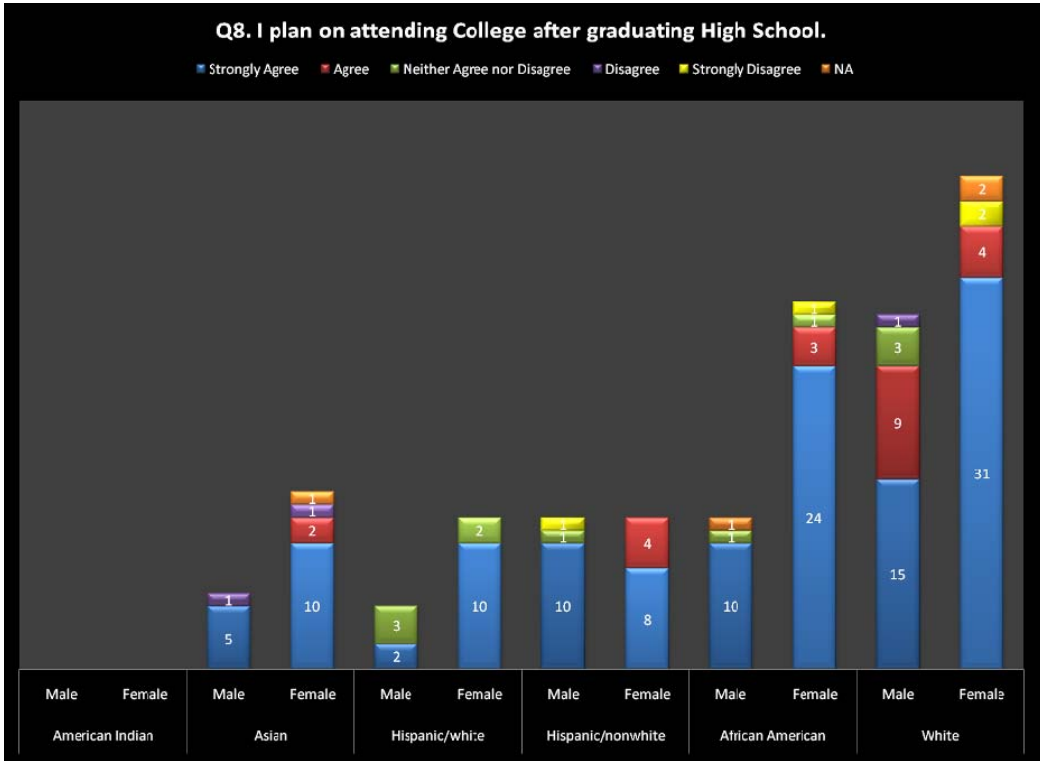
	American Indian		Asian		Hispanic/white		Hispanic/nonwhile		Black		White	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Strongly Agree	0.00%	0.00%	50.00%	50.00%	0.00%	100.00%	0.00%	100.00%	30.77%	69.23%	22.22%	77.78%
Agree	0.00%	0.00%	33.33%	66.67%	16.67%	83.33%	60.00%	40.00%	47.06%	52.94%	53.85%	46.15%
Neither Agree nor Disagree	0.00%	0.00%	25.00%	75.00%	66.67%	33.33%	50.00%	50.00%	0.00%	100.00%	42.86%	57.14%
Disagree	0.00%	0.00%	0.00%	100.00%	0.00%	100.00%	0.00%	100.00%	0.00%	100.00%	25.00%	75.00%
Strongly Disagree	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	33.33%	66.67%
NA	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%



	American Indian	Asian	Hispanic/white	Hispanic/nonwhite	Black	White
	Total	Total	Total	Total	Total	Total
Strongly Agree	0.00%	75.00%	58.82%	29.17%	63.41%	40.30%
Agree	0.00%	20.00%	41.18%	62.50%	34.15%	43.28%
Neither Agree nor Disagree	0.00%	5.00%	0.00%	8.33%	2.44%	14.93%
Disagree	0.00%	0.00%	0.00%	0.00%	0.00%	1.49%
Strongly Disagree	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
NA	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

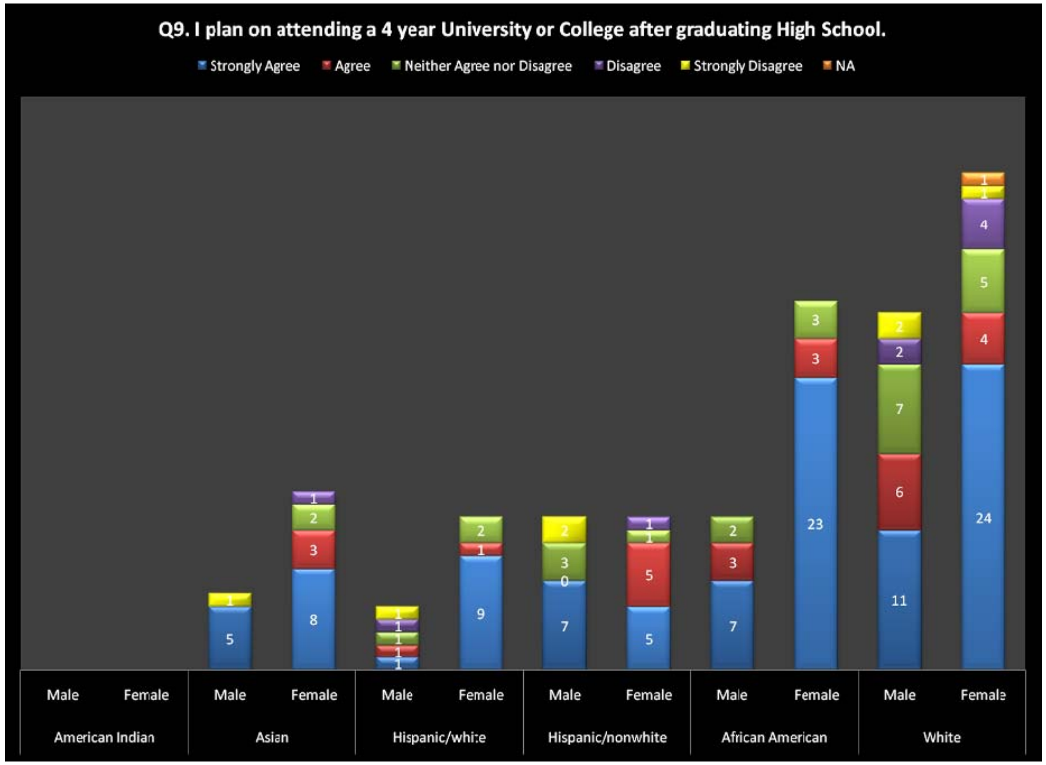
	American Indian		Asian		Hispanic/white		Hispanic/nonwhile		Black		White	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Strongly Agree	0.00%	0.00%	26.67%	73.33%	40.00%	60.00%	42.86%	57.14%	26.92%	73.08%	25.93%	74.07%
Agree	0.00%	0.00%	50.00%	50.00%	14.29%	85.71%	46.67%	53.33%	35.71%	64.29%	51.72%	48.28%
Neither Agree nor Disagree	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	100.00%	0.00%	0.00%	100.00%	50.00%	50.00%
Disagree	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%
Strongly Disagree	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
NA	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Appendix P: Grade 12 Future Educational Outlook



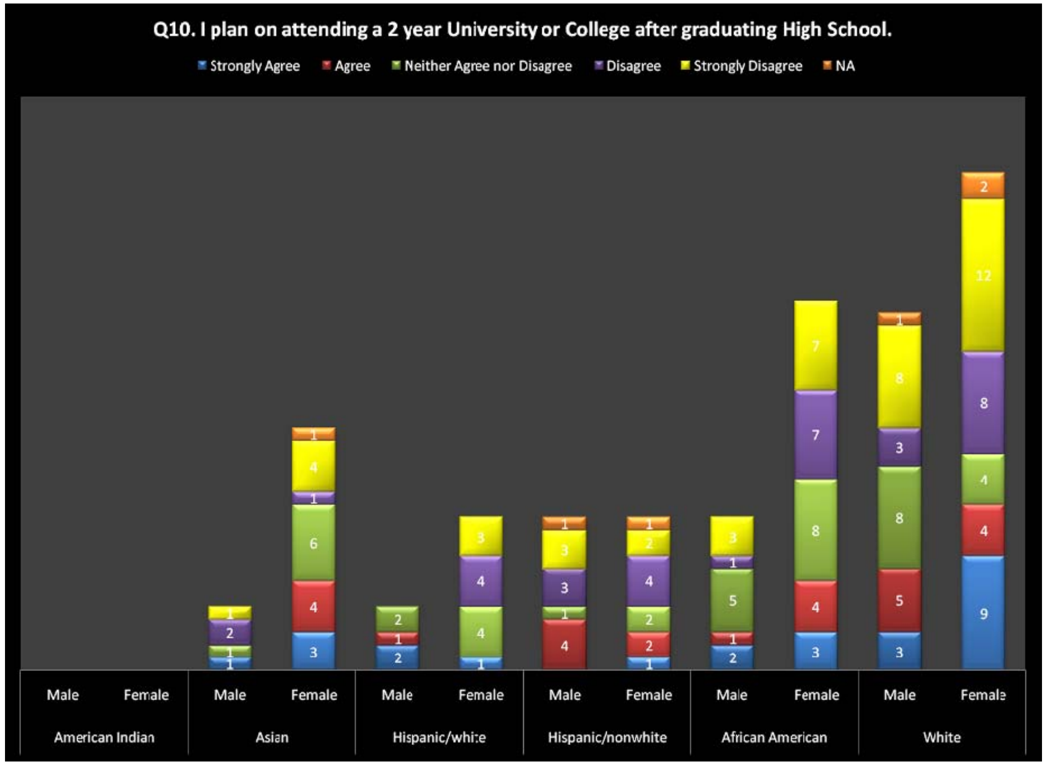
	American Indian	Asian	Hispanic/white	Hispanic/nonwhite	Black	White
	Total	Total	Total	Total	Total	Total
Strongly Agree	0.00%	75.00%	70.59%	75.00%	82.93%	68.66%
Agree	0.00%	10.00%	0.00%	16.67%	7.32%	19.40%
Neither Agree nor Disagree	0.00%	0.00%	29.41%	4.17%	4.88%	4.48%
Disagree	0.00%	10.00%	0.00%	0.00%	0.00%	1.49%
Strongly Disagree	0.00%	0.00%	0.00%	4.17%	2.44%	2.99%
NA	0.00%	5.00%	0.00%	0.00%	2.44%	2.99%

	American Indian		Asian		Hispanic/white		Hispanic/nonwhile		Black		White	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Strongly Agree	0.00%	0.00%	33.33%	66.67%	16.67%	83.33%	55.56%	44.44%	29.41%	70.59%	32.61%	67.39%
Agree	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	100.00%	0.00%	100.00%	69.23%	30.77%
Neither Agree nor Disagree	0.00%	0.00%	0.00%	0.00%	60.00%	40.00%	100.00%	0.00%	50.00%	50.00%	100.00%	0.00%
Disagree	0.00%	0.00%	50.00%	50.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%
Strongly Disagree	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	100.00%	0.00%	100.00%
NA	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	100.00%



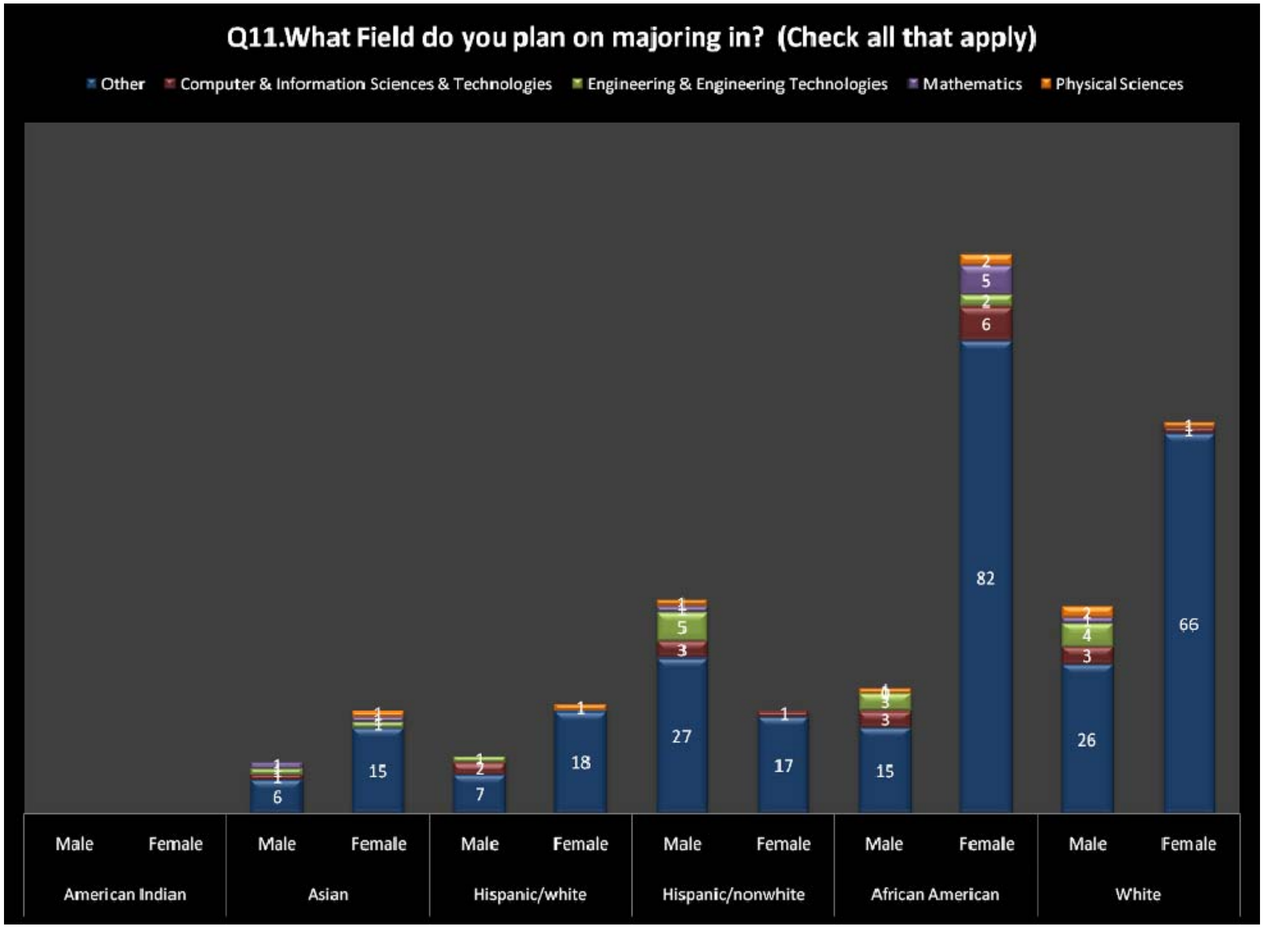
	American Indian	Asian	Hispanic/white	Hispanic/nonwhite	Black	White
	Total	Total	Total	Total	Total	Total
Strongly Agree	0.00%	65.00%	58.82%	50.00%	73.17%	52.24%
Agree	0.00%	15.00%	11.76%	20.83%	14.63%	14.93%
Neither Agree nor Disagree	0.00%	10.00%	17.65%	16.67%	12.20%	17.91%
Disagree	0.00%	5.00%	5.88%	4.17%	0.00%	8.96%
Strongly Disagree	0.00%	5.00%	5.88%	8.33%	0.00%	4.48%
NA	0.00%	0.00%	0.00%	0.00%	0.00%	1.49%

	American Indian		Asian		Hispanic/white		Hispanic/nonwhile		Black		White	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Strongly Agree	0.00%	0.00%	38.46%	61.54%	10.00%	90.00%	58.33%	41.67%	23.33%	76.67%	31.43%	68.57%
Agree	0.00%	0.00%	0.00%	100.00%	50.00%	50.00%	0.00%	100.00%	50.00%	50.00%	60.00%	40.00%
Neither Agree nor Disagree	0.00%	0.00%	0.00%	100.00%	33.33%	66.67%	75.00%	25.00%	40.00%	60.00%	58.33%	41.67%
Disagree	0.00%	0.00%	0.00%	100.00%	100.00%	0.00%	0.00%	100.00%	0.00%	0.00%	33.33%	66.67%
Strongly Disagree	0.00%	0.00%	100.00%	0.00%	100.00%	0.00%	100.00%	0.00%	0.00%	0.00%	66.67%	33.33%
NA	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%



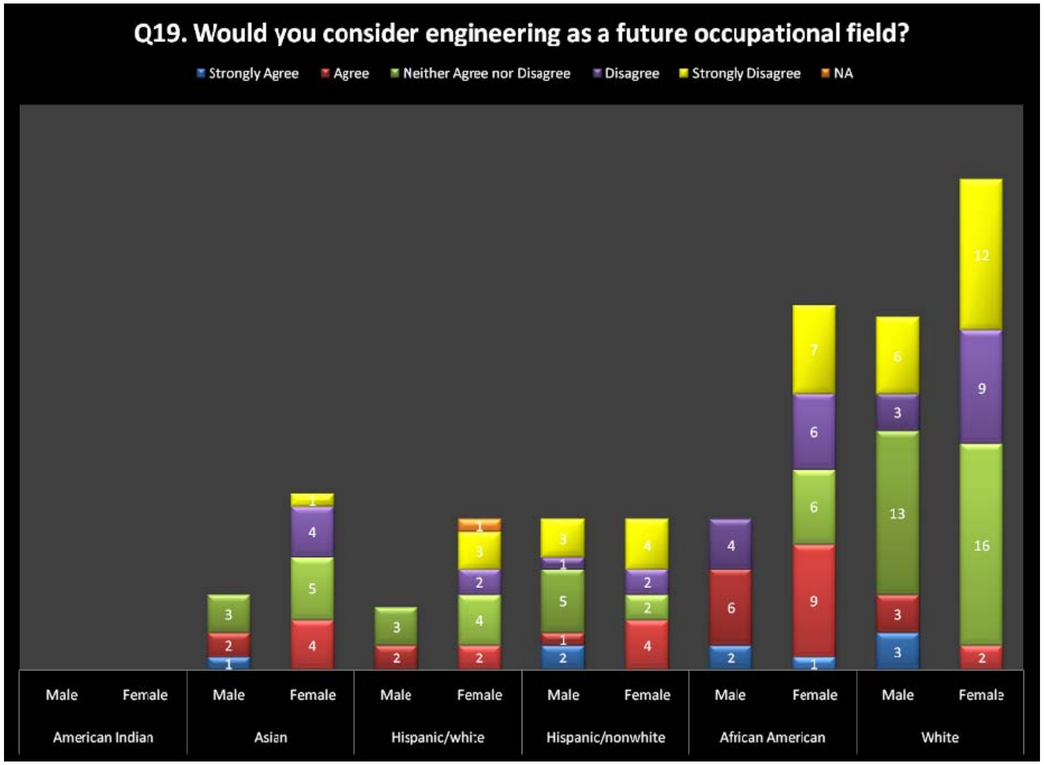
	American Indian	Asian	Hispanic/white	Hispanic/nonwhite	Black	White
	Total	Total	Total	Total	Total	Total
Strongly Agree	0.00%	20.00%	17.65%	4.17%	12.20%	17.91%
Agree	0.00%	20.00%	5.88%	25.00%	12.20%	13.43%
Neither Agree nor Disagree	0.00%	30.00%	35.29%	12.50%	31.71%	17.91%
Disagree	0.00%	5.00%	23.53%	29.17%	19.51%	16.42%
Strongly Disagree	0.00%	25.00%	17.65%	20.83%	24.39%	29.85%
NA	0.00%	5.00%	0.00%	8.33%	0.00%	4.48%

	American Indian		Asian		Hispanic/white		Hispanic/nonwhile		Black		White	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Strongly Agree	0.00%	0.00%	25.00%	75.00%	66.67%	33.33%	0.00%	100.00%	40.00%	60.00%	25.00%	75.00%
Agree	0.00%	0.00%	0.00%	100.00%	100.00%	0.00%	66.67%	33.33%	20.00%	80.00%	55.56%	44.44%
Neither Agree nor Disagree	0.00%	0.00%	0.00%	100.00%	33.33%	66.67%	33.33%	66.67%	38.46%	61.54%	66.67%	33.33%
Disagree	0.00%	0.00%	0.00%	100.00%	0.00%	100.00%	42.86%	57.14%	12.50%	87.50%	27.27%	72.73%
Strongly Disagree	0.00%	0.00%	20.00%	80.00%	0.00%	100.00%	60.00%	40.00%	30.00%	70.00%	40.00%	60.00%
NA	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	50.00%	50.00%	0.00%	0.00%	33.33%	66.67%


Q11.What Field do you plan on majoring in? (Check all that apply)
Other
Computer & Information Sciences & Technologies
Engineering & Engineering Technologies
Mathematics
Physical Sciences
Male
Female
American Indian
Asian
Hispanic/white
Hispanic/nonwhite
African American
White
6
15
7
18
27
3
5
17
15
3
82
6
5
26
3
4
66

	American Indian	Asian	Hispanic/white	Hispanic/nonwhite	Black	White
	Total	Total	Total	Total	Total	Total
Architecture & Environmental Design	0.00%	5.00%	0.00%	12.50%	14.63%	4.48%
Agriculture & Natural Resources	0.00%	0.00%	5.88%	4.17%	0.00%	1.49%
Arts: Visual & Performing	0.00%	5.00%	11.76%	4.17%	29.27%	16.42%
Biological Life Sciences	0.00%	5.00%	5.88%	4.17%	24.39%	5.97%
Business & Commerce	0.00%	35.00%	11.76%	20.83%	31.71%	14.93%
Communications	0.00%	5.00%	5.88%	12.50%	17.07%	16.42%
Computer & Information Sciences & Technologies	0.00%	5.00%	11.76%	16.67%	21.95%	5.97%
Education	0.00%	0.00%	5.88%	16.67%	12.20%	14.93%
Public Affairs & Services	0.00%	0.00%	11.76%	12.50%	19.51%	8.96%
Social Sciences & History	0.00%	0.00%	11.76%	25.00%	4.88%	4.48%
Library & Archival Sciences	0.00%	0.00%	5.88%	4.17%	0.00%	1.49%
Engineering & Engineering Technologies	0.00%	10.00%	5.88%	20.83%	12.20%	5.97%
Foreign & Classical Languages	0.00%	0.00%	11.76%	8.33%	17.07%	1.49%
Health Professions & Allied Services	0.00%	15.00%	23.53%	20.83%	39.02%	16.42%
Home Economics	0.00%	0.00%	0.00%	4.17%	4.88%	1.49%
Language & Literature	0.00%	0.00%	0.00%	4.17%	4.88%	1.49%
Mathematics	0.00%	10.00%	0.00%	4.17%	12.20%	1.49%
Military Science	0.00%	0.00%	11.76%	4.17%	2.44%	4.48%
Philosophy, Religion & Theology	0.00%	0.00%	0.00%	4.17%	4.88%	0.00%
Physical Sciences	0.00%	5.00%	5.88%	4.17%	7.32%	4.48%
Undecided	0.00%	35.00%	23.53%	20.83%	9.76%	22.39%

	American Indian		Asian		Hispanic/white		Hispanic/nonwhile		Black		White	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Architecture & Environmental Design	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	66.67%	33.33%	33.33%	66.67%	0.00%	100.00%
Agriculture & Natural Resources	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	100.00%
Arts: Visual & Performing	0.00%	0.00%	100.00%	0.00%	0.00%	100.00%	100.00%	0.00%	8.33%	91.67%	45.45%	54.55%
Biological Life Sciences	0.00%	0.00%	100.00%	0.00%	0.00%	100.00%	100.00%	0.00%	40.00%	60.00%	50.00%	50.00%
Business & Commerce	0.00%	0.00%	14.29%	85.71%	50.00%	50.00%	40.00%	60.00%	15.38%	84.62%	20.00%	80.00%
Communications	0.00%	0.00%	0.00%	100.00%	0.00%	100.00%	33.33%	66.67%	14.29%	85.71%	45.45%	54.55%
Computer & Information Sciences & Technologies	0.00%	0.00%	100.00%	0.00%	100.00%	0.00%	75.00%	25.00%	33.33%	66.67%	75.00%	25.00%
Education	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	25.00%	75.00%	0.00%	100.00%	20.00%	80.00%
Public Affairs & Services	0.00%	0.00%	0.00%	0.00%	50.00%	50.00%	66.67%	33.33%	12.50%	87.50%	0.00%	100.00%
Social Sciences & History	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	83.33%	16.67%	0.00%	100.00%	33.33%	66.67%
Library & Archival Sciences	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	100.00%	0.00%	0.00%	0.00%	0.00%	100.00%
Engineering & Engineering Technologies	0.00%	0.00%	50.00%	50.00%	100.00%	0.00%	100.00%	0.00%	60.00%	40.00%	100.00%	0.00%
Foreign & Classical Languages	0.00%	0.00%	0.00%	0.00%	50.00%	50.00%	50.00%	50.00%	14.29%	85.71%	0.00%	100.00%
Health Professions & Allied Services	0.00%	0.00%	33.33%	66.67%	0.00%	100.00%	40.00%	60.00%	18.75%	81.25%	9.09%	90.91%
Home Economics	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	100.00%	100.00%	0.00%
Language & Literature	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	100.00%	0.00%	100.00%
Mathematics	0.00%	0.00%	50.00%	50.00%	0.00%	0.00%	100.00%	0.00%	0.00%	100.00%	100.00%	0.00%
Military Science	0.00%	0.00%	0.00%	0.00%	50.00%	50.00%	100.00%	0.00%	0.00%	100.00%	66.67%	33.33%
Philosophy, Religion & Theology	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	100.00%	0.00%	0.00%
Physical Sciences	0.00%	0.00%	0.00%	100.00%	0.00%	100.00%	100.00%	0.00%	33.33%	66.67%	66.67%	33.33%
Undecided	0.00%	0.00%	14.29%	85.71%	25.00%	75.00%	60.00%	40.00%	0.00%	100.00%	33.33%	66.67%



	American Indian	Asian	Hispanic/white	Hispanic/nonwhite	Black	White
	Total	Total	Total	Total	Total	Total
Strongly Agree	0.00%	5.00%	0.00%	8.33%	7.32%	4.48%
Agree	0.00%	30.00%	23.53%	20.83%	36.59%	7.46%
Neither Agree nor Disagree	0.00%	40.00%	41.18%	29.17%	14.63%	43.28%
Disagree	0.00%	20.00%	11.76%	12.50%	24.39%	17.91%
Strongly Disagree	0.00%	5.00%	17.65%	29.17%	17.07%	26.87%
NA	0.00%	0.00%	5.88%	0.00%	0.00%	0.00%

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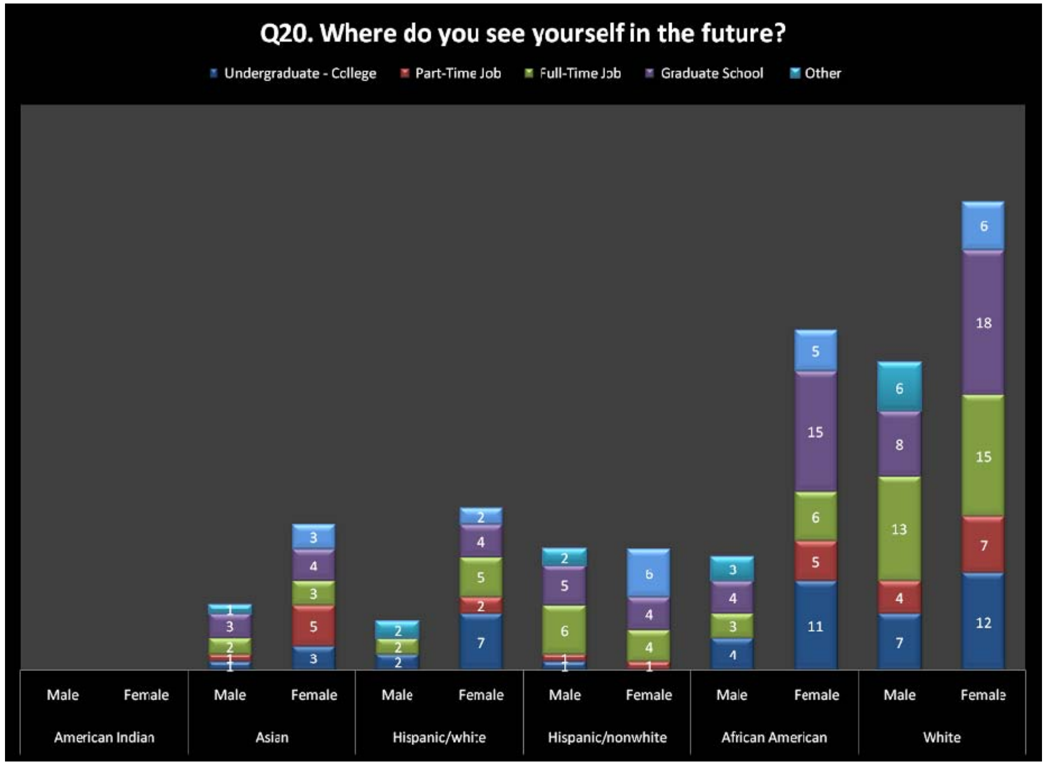
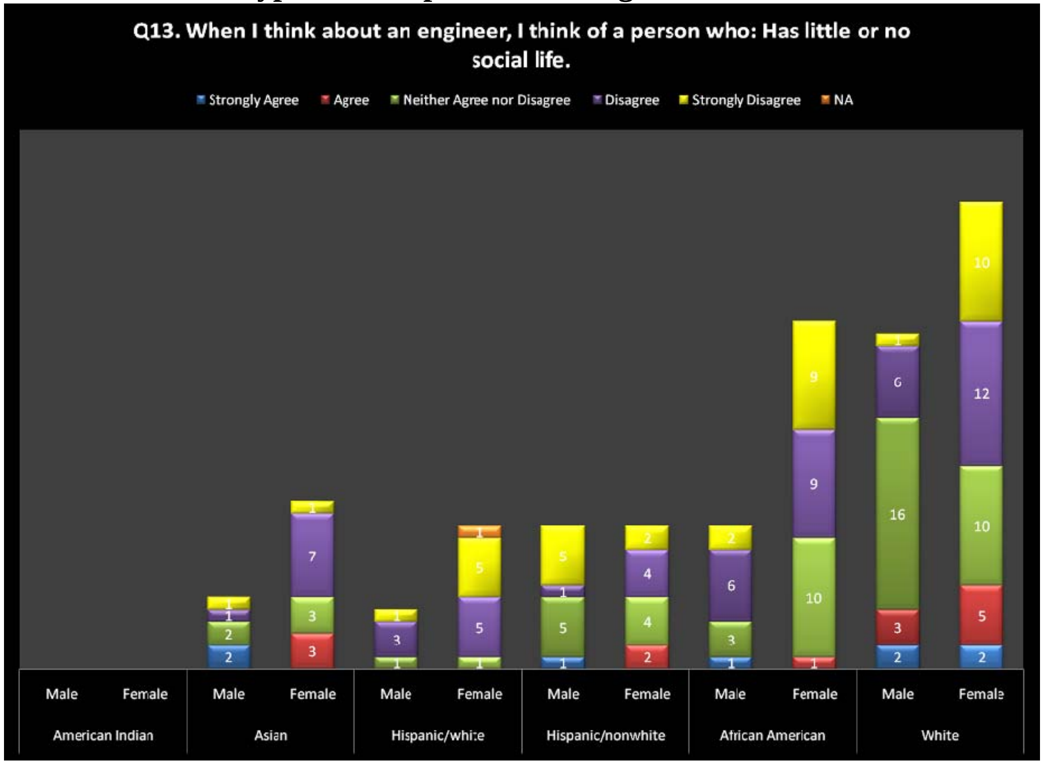
	American Indian		Asian		Hispanic/white		Hispanic/nonwhile		Black		White	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Strongly Agree	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	100.00%	0.00%	66.67%	33.33%	100.00%	0.00%
Agree	0.00%	0.00%	33.33%	66.67%	50.00%	50.00%	20.00%	80.00%	40.00%	60.00%	60.00%	40.00%
Neither Agree nor Disagree	0.00%	0.00%	37.50%	62.50%	42.86%	57.14%	71.43%	28.57%	0.00%	100.00%	44.83%	55.17%
Disagree	0.00%	0.00%	0.00%	100.00%	0.00%	100.00%	33.33%	66.67%	40.00%	60.00%	25.00%	75.00%
Strongly Disagree	0.00%	0.00%	0.00%	100.00%	0.00%	100.00%	42.86%	57.14%	0.00%	100.00%	33.33%	66.67%
NA	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%



	American Indian	Asian	Hispanic/white	Hispanic/nonwhite	Black	White
	Total	Total	Total	Total	Total	Total
Undergraduate - College	0.00%	20.00%	52.94%	4.17%	36.59%	28.36%
Part-Time Job	0.00%	30.00%	11.76%	8.33%	12.20%	16.42%
Full-Time Job	0.00%	25.00%	41.18%	41.67%	21.95%	41.79%
Graduate School	0.00%	35.00%	23.53%	37.50%	46.34%	38.81%
Other	0.00%	20.00%	23.53%	33.33%	19.51%	17.91%

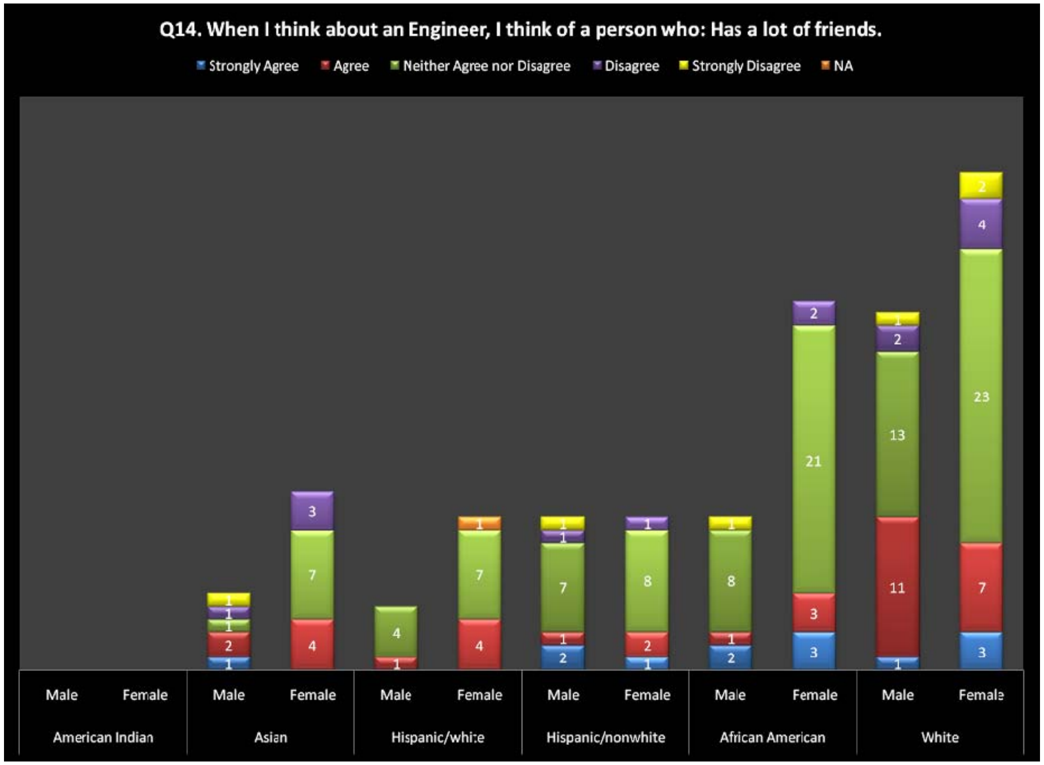
	American Indian		Asian		Hispanic/white		Hispanic/nonwhile		Black		White	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Undergraduate - College	0.00%	0.00%	25.00%	75.00%	22.22%	77.78%	100.00%	0.00%	26.67%	73.33%	36.84%	63.16%
Part-Time Job	0.00%	0.00%	16.67%	83.33%	0.00%	100.00%	50.00%	50.00%	0.00%	100.00%	36.36%	63.64%
Full-Time Job	0.00%	0.00%	40.00%	60.00%	28.57%	71.43%	60.00%	40.00%	33.33%	66.67%	46.43%	53.57%
Graduate School	0.00%	0.00%	42.86%	57.14%	0.00%	100.00%	55.56%	44.44%	21.05%	78.95%	30.77%	69.23%
Other	0.00%	0.00%	25.00%	75.00%	50.00%	50.00%	25.00%	75.00%	37.50%	62.50%	50.00%	50.00%

Appendix Q: Grade 12 Attitude toward the Stereotypical Perception of an Engineer



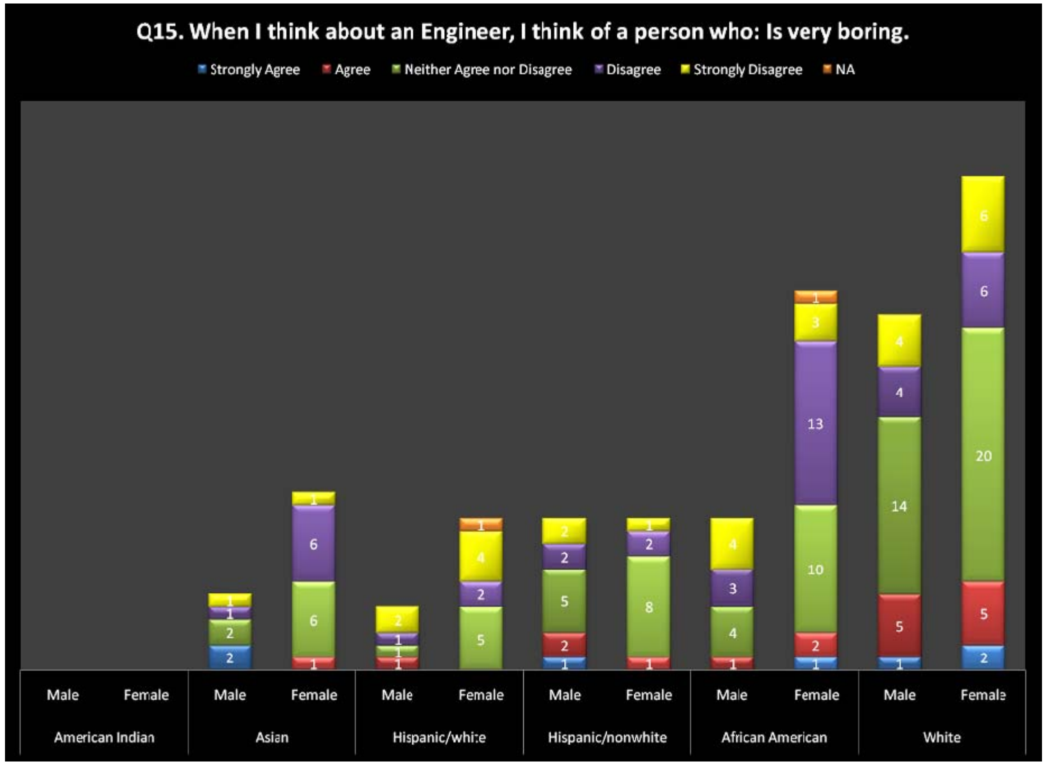
	American Indian	Asian	Hispanic/white	Hispanic/nonwhite	Black	White
	Total	Total	Total	Total	Total	Total
Strongly Agree	0.00%	10.00%	0.00%	4.17%	2.44%	5.97%
Agree	0.00%	15.00%	0.00%	8.33%	2.44%	11.94%
Neither Agree nor Disagree	0.00%	25.00%	11.76%	37.50%	31.71%	38.81%
Disagree	0.00%	40.00%	47.06%	20.83%	36.59%	26.87%
Strongly Disagree	0.00%	10.00%	35.29%	29.17%	26.83%	16.42%
NA	0.00%	0.00%	5.88%	0.00%	0.00%	0.00%

	American Indian		Asian		Hispanic/white		Hispanic/nonwhile		Black		White	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Strongly Agree	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	100.00%	0.00%	100.00%	0.00%	50.00%	50.00%
Agree	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	100.00%	0.00%	100.00%	37.50%	62.50%
Neither Agree nor Disagree	0.00%	0.00%	40.00%	60.00%	50.00%	50.00%	55.56%	44.44%	23.08%	76.92%	61.54%	38.46%
Disagree	0.00%	0.00%	12.50%	87.50%	37.50%	62.50%	20.00%	80.00%	40.00%	60.00%	33.33%	66.67%
Strongly Disagree	0.00%	0.00%	50.00%	50.00%	16.67%	83.33%	71.43%	28.57%	18.18%	81.82%	9.09%	90.91%
NA	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%



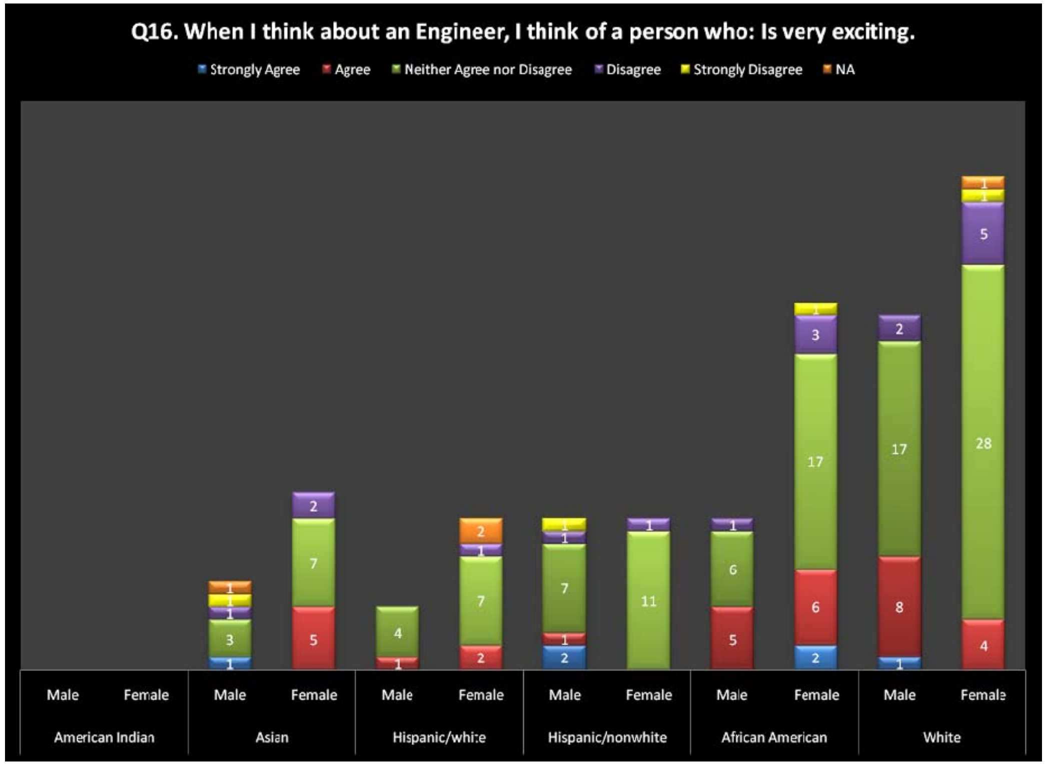
	American Indian	Asian	Hispanic/white	Hispanic/nonwhite	Black	White
	Total	Total	Total	Total	Total	Total
Strongly Agree	0.00%	5.00%	0.00%	12.50%	12.20%	5.97%
Agree	0.00%	30.00%	29.41%	12.50%	9.76%	26.87%
Neither Agree nor Disagree	0.00%	40.00%	64.71%	62.50%	70.73%	53.73%
Disagree	0.00%	20.00%	0.00%	8.33%	4.88%	8.96%
Strongly Disagree	0.00%	5.00%	0.00%	4.17%	2.44%	4.48%
NA	0.00%	0.00%	5.88%	0.00%	0.00%	0.00%

	American Indian		Asian		Hispanic/white		Hispanic/nonwhile		Black		White	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Strongly Agree	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	66.67%	33.33%	40.00%	60.00%	25.00%	75.00%
Agree	0.00%	0.00%	33.33%	66.67%	20.00%	80.00%	33.33%	66.67%	25.00%	75.00%	61.11%	38.89%
Neither Agree nor Disagree	0.00%	0.00%	12.50%	87.50%	36.36%	63.64%	46.67%	53.33%	27.59%	72.41%	36.11%	63.89%
Disagree	0.00%	0.00%	25.00%	75.00%	0.00%	0.00%	50.00%	50.00%	0.00%	100.00%	33.33%	66.67%
Strongly Disagree	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	100.00%	0.00%	100.00%	0.00%	33.33%	66.67%
NA	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%



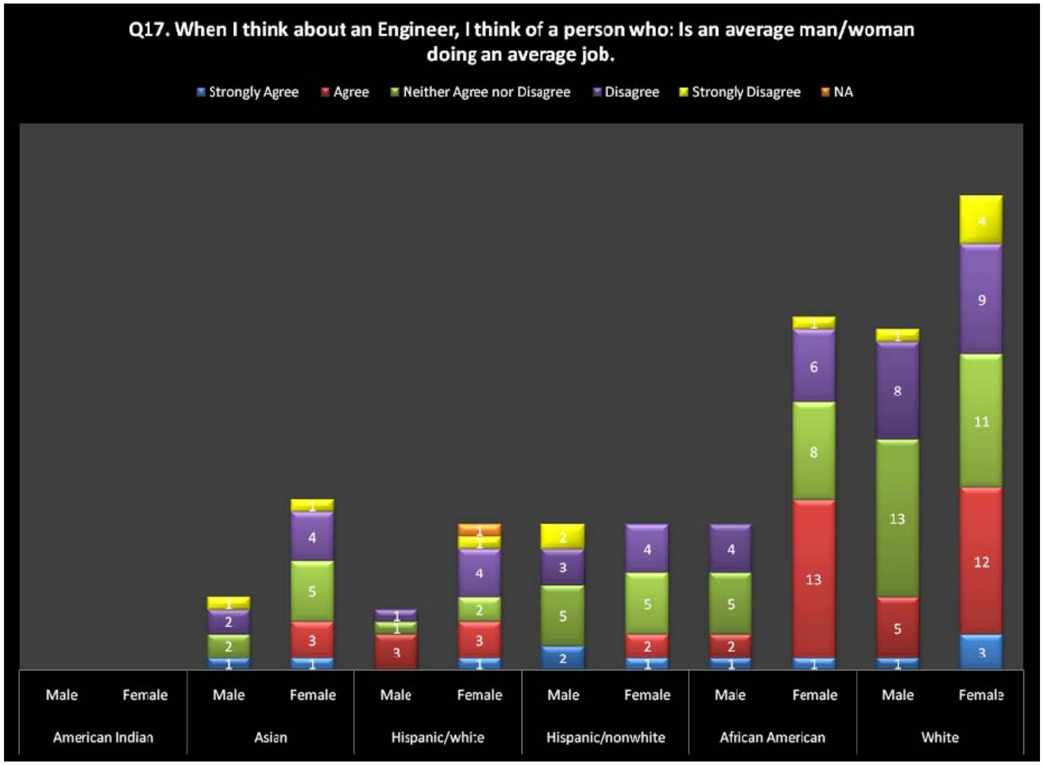
	American Indian	Asian	Hispanic/white	Hispanic/nonwhite	Black	White
	Total	Total	Total	Total	Total	Total
Strongly Agree	0.00%	10.00%	0.00%	4.17%	2.44%	4.48%
Agree	0.00%	5.00%	5.88%	12.50%	7.32%	14.93%
Neither Agree nor Disagree	100.00%	40.00%	35.29%	54.17%	34.15%	50.75%
Disagree	0.00%	35.00%	17.65%	16.67%	39.02%	14.93%
Strongly Disagree	0.00%	10.00%	35.29%	12.50%	17.07%	14.93%
NA	0.00%	0.00%	5.88%	0.00%	2.44%	0.00%

	American Indian		Asian		Hispanic/white		Hispanic/nonwhile		Black		White	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Strongly Agree	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	100.00%	33.33%	66.67%
Agree	0.00%	0.00%	0.00%	100.00%	100.00%	0.00%	66.67%	33.33%	33.33%	66.67%	50.00%	50.00%
Neither Agree nor Disagree	0.00%	0.00%	25.00%	75.00%	16.67%	83.33%	38.46%	61.54%	28.57%	71.43%	41.18%	58.82%
Disagree	0.00%	0.00%	14.29%	85.71%	33.33%	66.67%	50.00%	50.00%	18.75%	81.25%	40.00%	60.00%
Strongly Disagree	0.00%	0.00%	50.00%	50.00%	33.33%	66.67%	66.67%	33.33%	57.14%	42.86%	40.00%	60.00%
NA	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%



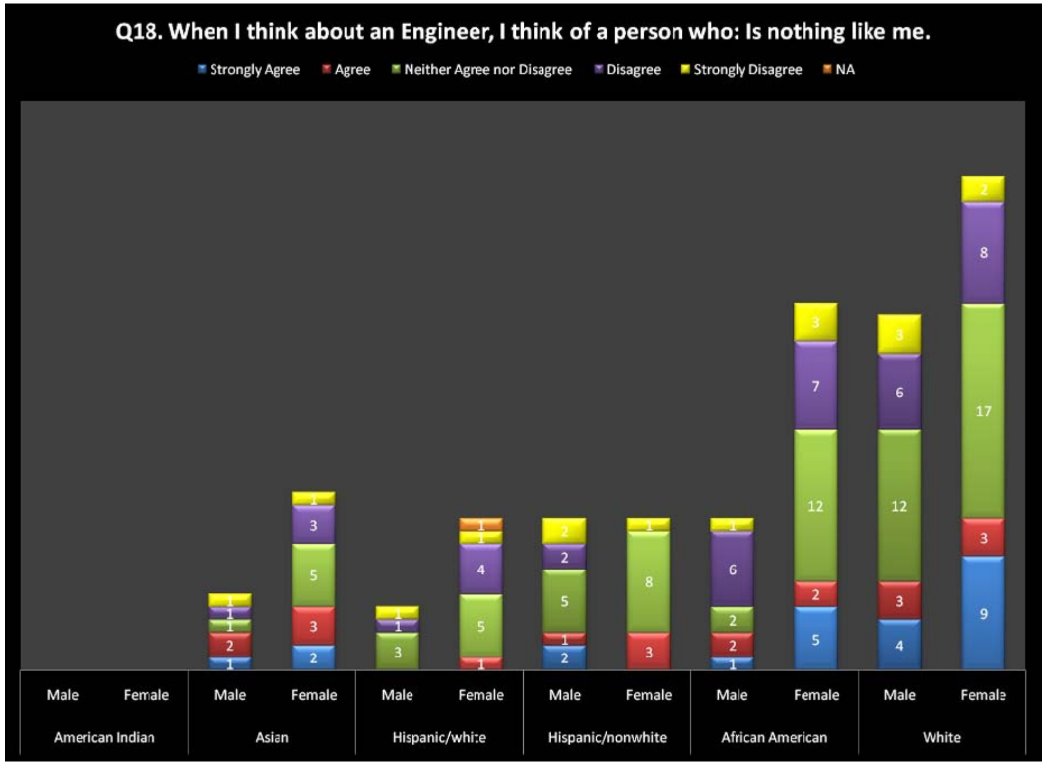
	American Indian	Asian	Hispanic/white	Hispanic/nonwhite	Black	White
	Total	Total	Total	Total	Total	Total
Strongly Agree	0.00%	5.00%	0.00%	8.33%	4.88%	1.49%
Agree	0.00%	25.00%	17.65%	4.17%	26.83%	17.91%
Neither Agree nor Disagree	0.00%	50.00%	64.71%	75.00%	56.10%	67.16%
Disagree	0.00%	15.00%	5.88%	8.33%	9.76%	10.45%
Strongly Disagree	0.00%	5.00%	0.00%	4.17%	2.44%	1.49%
NA	0.00%	5.00%	11.76%	0.00%	0.00%	1.49%

	American Indian		Asian		Hispanic/white		Hispanic/nonwhile		Black		White	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Strongly Agree	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	100.00%	100.00%	0.00%
Agree	0.00%	0.00%	0.00%	100.00%	33.33%	66.67%	100.00%	0.00%	45.45%	54.55%	66.67%	33.33%
Neither Agree nor Disagree	0.00%	0.00%	30.00%	70.00%	36.36%	63.64%	38.89%	61.11%	26.09%	73.91%	37.78%	62.22%
Disagree	0.00%	0.00%	33.33%	66.67%	0.00%	100.00%	50.00%	50.00%	25.00%	75.00%	28.57%	71.43%
Strongly Disagree	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	100.00%	0.00%	100.00%
NA	0.00%	0.00%	100.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%



	American Indian	Asian	Hispanic/white	Hispanic/nonwhite	Black	White
	Total	Total	Total	Total	Total	Total
Strongly Agree	0.00%	10.00%	5.88%	12.50%	4.88%	5.97%
Agree	0.00%	15.00%	35.29%	8.33%	36.59%	25.37%
Neither Agree nor Disagree	0.00%	35.00%	17.65%	41.67%	31.71%	35.82%
Disagree	0.00%	30.00%	29.41%	29.17%	24.39%	25.37%
Strongly Disagree	0.00%	10.00%	5.88%	8.33%	2.44%	7.46%
NA	0.00%	0.00%	5.88%	0.00%	0.00%	0.00%

	American Indian		Asian		Hispanic/white		Hispanic/nonwhile		Black		White	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Strongly Agree	0.00%	0.00%	50.00%	50.00%	0.00%	100.00%	66.67%	33.33%	50.00%	50.00%	25.00%	75.00%
Agree	0.00%	0.00%	0.00%	100.00%	50.00%	50.00%	0.00%	100.00%	13.33%	86.67%	29.41%	70.59%
Neither Agree nor Disagree	0.00%	0.00%	28.57%	71.43%	33.33%	66.67%	50.00%	50.00%	38.46%	61.54%	54.17%	45.83%
Disagree	0.00%	0.00%	33.33%	66.67%	20.00%	80.00%	42.86%	57.14%	40.00%	60.00%	47.06%	52.94%
Strongly Disagree	0.00%	0.00%	50.00%	50.00%	0.00%	100.00%	100.00%	0.00%	0.00%	100.00%	20.00%	80.00%
NA	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%



	American Indian	Asian	Hispanic/white	Hispanic/nonwhite	Black	White
	Total	Total	Total	Total	Total	Total
Strongly Agree	0.00%	15.00%	0.00%	8.33%	14.63%	19.40%
Agree	0.00%	25.00%	5.88%	16.67%	9.76%	8.96%
Neither Agree nor Disagree	0.00%	30.00%	47.06%	54.17%	34.15%	43.28%
Disagree	0.00%	20.00%	29.41%	8.33%	31.71%	20.90%
Strongly Disagree	0.00%	10.00%	11.76%	12.50%	9.76%	7.46%
NA	0.00%	0.00%	5.88%	0.00%	0.00%	0.00%

	American Indian		Asian		Hispanic/white		Hispanic/nonwhile		Black		White	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Strongly Agree	0.00%	0.00%	33.33%	66.67%	0.00%	0.00%	100.00%	0.00%	16.67%	83.33%	30.77%	69.23%
Agree	0.00%	0.00%	40.00%	60.00%	0.00%	100.00%	25.00%	75.00%	50.00%	50.00%	50.00%	50.00%
Neither Agree nor Disagree	0.00%	0.00%	16.67%	83.33%	37.50%	62.50%	38.46%	61.54%	14.29%	85.71%	41.38%	58.62%
Disagree	0.00%	0.00%	25.00%	75.00%	20.00%	80.00%	100.00%	0.00%	46.15%	53.85%	42.86%	57.14%
Strongly Disagree	0.00%	0.00%	50.00%	50.00%	50.00%	50.00%	66.67%	33.33%	25.00%	75.00%	60.00%	40.00%
NA	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%