Evaluating ASM Materials Camp New England

An Interactive Qualifying Project

submitted to the faculty of

Worcester Polytechnic Institute

In partial fulfillment of the requirements for the

Degree of Bachelor of Science

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Date:

March 1, 2012

Submitted to:

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Abstract

Worcester Polytechnic Institute has partnered with the Materials Information Society to create ASM Materials Camp New England, an outreach program intended to interest high school students in STEM fields. To improve the efficacy of this program, information from participant surveys, personal observations, and interviews with organizers was summarized and analyzed. Recommendations identifying potential improvements for the program and the evaluation process were generated. These suggestions may be utilized in future camps to interest a greater number of students in STEM.

Acknowledgements

The project team would like to thank the numerous people who assisted us throughout this project.

First and foremost, the team would like to thank our project advisors, Professor Chrysanthe Demetry and Professor Jianyu Liang, for their guidance and support. Without their instruction and feedback, the level of quality achieved with this paper would not have been possible.

We would like to thank the ASM Materials Camp New England planning committee for providing crucial input resulting from their personal experiences with this program.

We would like to thank Dr. Jeanne Hubelbank, WPI Evaluation Consultant, for providing insight and helping us to improve drafts of surveys.

We would like to thank Professor Richard Sisson and his 2011 Materials Science and Engineering Seminar class for providing us with an opportunity to present our first term of work.

Finally, we would like to thank Worcester Polytechnic Institute for providing us with a variety of resources that facilitated this project.

Executive Summary

The United States is currently experiencing a deficiency of students interested in pursuing science, technology, engineering, and math (STEM) careers (White House, 2012). While the number of science and engineering job opportunities is projected to increase, the number of qualified applicants is insufficient (Lacey & Wright, 2010). In order to fortify this section of the American labor force, numerous public and private organizations have initiated outreach programs with the intent to attract students to STEM fields (Nadelson & Callahan, 2011). The Materials Information Society (ASM) sponsors ASM Materials Camp New England, a materials science and engineering outreach program hosted at Worcester Polytechnic Institute. However, the effectiveness of this program and its previous evaluation system has never been extensively analyzed. The ASM Materials Camp New England planning committee, a voluntary group of science and engineering professionals tasked with organizing the program, desire a detailed assessment of the program and evaluation system in order to identify any feasible improvements.

Project Goals and Objectives

The goal of this project was to improve ASM Materials Camp New England by providing recommendations for the program and the evaluation process. This was completed by following three objectives:

- ***Assess the strengths and weaknesses of the 2011 program and evaluation system***. Using several sources of information, the team synthesized a list of program aspects that either strongly or poorly satisfied the planning committee's stated objectives for the program. Data sources that the team utilized to assess the program included the quantitative and qualitative survey results. After the surveys were completed by participants at the end of the program, the data was compiled and analyzed in order to identify the most and least effective parts of the program. The team also presented the quantitative and qualitative results to the planning committee for the program. Afterwards, the committee offered insight concerning their goals for the program and observations of the camp. Personal observations from the 2011 ASM Materials Camp New England were also taken into account when the team assessed the program and evaluation system as a whole.

- ***Address the weaknesses of the 2011 ASM Materials Camp New England***. In order to improve future programs, the team identified weaknesses of the camp and produced a list of recommendations to resolve these issues. Utilizing the multiple data sources and extensive background research regarding best practices of STEM outreach, the team generated a draft of recommendations for the program. This draft was submitted to the planning committee for comments on significance and feasibility, and was modified accordingly.
- ***Address the weaknesses of the previous evaluation system***. The team systematically analyzed each question on the 2011 post-camp survey in order to address usability of the resulting data. The results were then assessed to determine how effectively they addressed the program goals of the planning committee. Repetitive or unnecessary questions were removed, and more questions relevant to the effectiveness to the program were included.

Additional evaluation methods such as a pre-camp survey were thoroughly researched and considered for future improvements. A list of recommendations for improving the evaluation system and a tentative draft of the 2012 survey were presented to the planning committee for commentary. This feedback was utilized to finalize the 2012 evaluation system.

Findings

Before drawing any conclusions, extensive research involving STEM outreach programs, effective evaluation systems, and methods of data analysis was completed. This background was necessary in order to compile and evaluate data from the program surveys, committee feedback, and personal observations. The analysis yielded the following results:

- ***Effectiveness of the camp in achieving program objectives:*** The summative survey questions on the 2011 post-camp evaluation yielded high ratings. Several students agreed that the ASM Materials Camp New England increased their interest in science and engineering fields; other statements pertaining to camp goals also received very positive responses. With this data, the team found that the program was successful in achieving the objectives defined by the planning committee.
- ***Students' interest in hands-on, interactive activities:*** Both the preliminary research and the team's analysis results concluded that hands-on, interactive activities were an effective method of educating and interesting students. Several students cited the most active workstations as their preferences.

- ***Students' disfavor of lecture-based activities:*** The lowest-rated parts of the program were consistently lecture-based activities. When asked about what they strongly disliked about the camp, many students specifically recommended removing portions of the program such as the lunchtime lecture.
- ***Importance of role models in encouraging students to pursue careers in materials science and other related fields:*** The committee, personal observations, and survey data all provided evidence supporting the value of role models for prospective STEM students. The 2011 program results displayed a strong student interest in STEM professionals, particularly those in a similar age group such as graduate students, with which the camp participants could freely converse about materials science and other related fields.
- ***Efficacy of the previous evaluation system:*** Several areas of improvement were identified for the 2011 evaluation system. While several questions on the post-camp survey yielded utilizable information, some were either repetitive or not relevant for the purposes of assessing effectiveness of meeting program goals. Another issue was the absence of a reference point, such as a pre-camp survey, for comparing the before-and-after impact of the camp on student interest in STEM. The 2011 evaluation system also had a limited scope of information; the source of data that was almost exclusively used by the planning committee was the student survey.

Recommendations

The team synthesized information from the 2011 survey results, planning committee feedback, and personal camp observations in order to provide recommendations. The analysis yielded several recommendations for ASM Materials Camp New England:

- ***Increase the ratio of active learning activities to passive learning activities.*** From the various sources of data, the team concluded that students enjoy hands-on, interactive activities and dislike lecture-based activities. The 2011 program consisted of three lectures in addition to workstations which included lecture portions, leaving limited time for applied activities. The team recommends increasing the time spent in hands-on, interactive and decreasing the time spent in lecture in order to interest the students and better achieve program objectives.
- ***Increase the accessibility of role models involved with the program.*** In the past, ASM Materials Camp New England followed a strict schedule and allowed little time for participants to converse with camp volunteers. The team recommends that the participants are given more opportunities to talk to the science and engineering professionals in order to increase their interest in STEM fields. This would simultaneously please students and satisfy program objectives.
- ***Explore the possibility of distributing surveys to camp organizers and volunteers.*** At the 2011 program, the only written data gathered was retrieved

from a post-camp participant survey. This limited the breadth of the results, but surveying other members at the camp such as the educators and graduate students could provide useful insight. The team recommends that the planning committee consider designing a survey for camp organizers in future programs; if additional members were surveyed, more input regarding improvements for ASM Materials Camp New England could be gathered.

- ***Utilize the new pre- and post-camp surveys generated by the team***. The team produced pre- and post-camp surveys which were assessed by the planning committee and improved upon further review. This evaluation system would effectively gauge program effectiveness; therefore, the team recommends that the planning committee implements these surveys for the 2012 ASM Materials Camp New England.

Authorship

Maura Killeen, Lauren Giacobbe, and Daniel Hullihen each contributed equally to this project.

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1.0: Introduction

A myriad of new employment opportunities are being created in science, technology, engineering, and math (STEM) fields. According to the U.S. Bureau of Labor Statistics, computer and mathematical occupations will grow by 785,700 new jobs, or 22.2%, between 2008 and 2018. Architecture and engineering occupations are projected to grow by 270,600 jobs, or 10.3%, in the same period (Lacey & Wright, 2010). In order to satisfy this growing demand, a supply of applicants with sufficient education, experience, and enthusiasm must exist. However, the National Science Foundation reports that nearly 53% of all degree-holding workers in science and engineering fields are over 40 years old, and approximately 14% of American scientists and engineers are 55 or above (2002). If the average retirement age is 66 years old (Social Security Administration, 2012), there will soon be a deficit of scientists and engineers in the U.S. labor market. This could severely diminish America's status as a leader in the global scientific and technological community if younger students are not inspired to pursue STEM-related careers.

One of many potential solutions to this deficit is the creation of outreach programs in order to engage students in the fields of science, technology, engineering and math. The purpose of these programs is to educate participants and motivate them to pursue STEM career paths (Nadelson & Callahan, 2011). These activities are often funded by employers, universities, or government organizations. For example, Worcester Polytechnic Institute (WPI) hosts a number of STEM programs for local primary and secondary school students. One of these outreach activities is ASM

Materials Camp New England, which is held on campus at WPI in May of each year and sponsored by the Materials Information Society (ASM).

In order for outreach programs to be systematically improved upon or considered successful, detailed evaluation and analysis strategies must be implemented. While brief surveys have been provided to participants after previous iterations of ASM Materials Camp New England, several survey questions were vague or misleading, and very little analysis was performed on the data. The purpose of this project was to provide recommendations for improvements to ASM Materials Camp New England and the associated evaluation methods. The project team accomplished this by:

- Observing the 2011 ASM Materials Camp New England
- Conducting meetings, interviews, and presentations with the ASM Materials Camp New England planning committee in order to establish clear objectives
- Researching best practices in STEM outreach and education, relevant methods of data collection and analysis, and program evaluation
- Compiling, summarizing, and analyzing the available data
- Generating recommendations for improvements to future iterations of ASM Materials Camp New England

This report will present the results of these actions in the following format. First, readers will be provided with a summary of related background information, including the importance of STEM in the United States, best practices in STEM education and outreach, and appropriate evaluation techniques. The methodology utilized by the project team will then be discussed. Next, the findings achieved via these methods will be summarized. Conclusions drawn from these findings about issues with the program and evaluation process will be presented, and recommendations will be made outlining potential solutions to these problems. Readers can expect to gain a broader knowledge of the ASM Materials Camp New England and its evaluation process.

2.0: Background & Literature Review

In this chapter, background information is provided to aid readers in understanding the necessity of this project. The first section begins with a summary of the abundant STEM career opportunities and the disparity of students pursuing these fields in order to address the national context. In the second section, the apparent lack of interest among students in STEM fields is addressed. In section three, a potential solution to this deficit is discussed with the creation of STEM outreach programs. Section four presents a specific example of secondary school outreach, ASM Materials Camp New England, which is a one-day educational program focusing on materials science and engineering. Finally, section five discusses program evaluation processes relevant to ASM Materials Camp New England.

2.1: Deficit of Scientists and Engineers in the U.S. Labor Market

Despite the United States' history of scientific and technological achievements, America is currently falling behind foreign nations in quality of STEM education (PCAST, 2010). In his 2012 State of the Union address, President Barack Obama emphasized the importance of inspiring students to pursue these fields. The President stated, "[I] hear from many business leaders who want to hire in the United States, but can't find workers with the right skills. Growing industries in science and technology have twice as many openings as we have workers who can do the job" (White House, 2012). This is particularly significant when the national unemployment rate is extremely high, at approximately 8.3% (U.S. Bureau of Labor Statistics, 2012).

In order to stimulate the American economy and alleviate unemployment, a greater number of citizens must obtain higher-level science, technology, and engineering degrees (White House, 2012).

Due to the growing influence of technology in the global economy, many new job opportunities are being created in STEM fields. For example, between 2000 and 2010, STEM employment in the United States grew by 7.9% compared to 2.6% for non-STEM employment (Langdon, McKittrick, Beede, Khan, & Doms, 2011). Many science, technology, and engineering employers are experiencing difficulty recruiting qualified candidates to fill these new positions. As a result of this deficiency, several STEM employers, universities, and professional societies have initiated outreach programs in order to inform students about career opportunities in their fields. These programs are intended to inspire a greater number of students to pursue relevant education and career paths (Nadelson & Callahan, 2011).

The necessity for an increased number of scientists and engineers is even more pressing when considering international competition. According to the National Science Foundation (NSF), "Governments in many parts of the developing world have come to view science and technology (S&T) as integral to economic growth and development, and they have set out to build more knowledge-intensive economies in which research, its commercial exploitation, and intellectual work would play a growing role." Many developing nations are now pursuing economic advancement by providing incentives for businesses and educators to focus on scientific and technological research. As a result of these efforts, the global community is becoming increasingly competitive in STEM-related fields. In order to maintain its current leadership in these disciplines, America must produce a higher number of graduates with relevant degrees. The most effective method of accomplishing this is to inspire a greater number of talented students to seriously consider science, technology, and engineering careers (National Science Foundation, 2010).

2.2: Lack of Interest in STEM Pathways among Secondary School Students

One major difficulty inherent in drawing students to STEM careers is an apparent lack of interest among secondary school students. According to a study conducted by the Business-Higher Education Forum, 69% of twelfth grade students stated that they are not interested in STEM fields (2011). Numerous researchers have conducted investigations into students' decreasing interest in the applied sciences and related fields over the past decade (Lindahl 2007; Lyons 2005, 2006; Maltese & Tai, 2010; Osborne & Collins, 2001). It is often concluded that this disinterest originates with students' inaccurate perceptions about STEM fields and professionals.

Misconceptions regarding STEM fields arise among secondary school students for a variety of reasons. The National Research Council and the U.S. Department of Labor have expressed that many students have inaccurate or deficient knowledge about what scientific and technological fields involve, which may lead them to pursue other careers that they understand more completely (1997; 2007). Because high school students are often not required to take higher-level science classes, many students do not have the opportunity to extrapolate what scientists and engineers do on a daily basis. Even in lower-level science courses that students are required to take, complex ideas may be introduced too quickly for students to fully absorb and comprehend.

According to the Missouri Department of Elementary and Secondary Education and the U.S. Department of Labor, many curriculums focus on memorization of concepts and equations before students understand the related reasoning and applications. This means that students who learn at a slower pace are often left behind, and may begin to perceive science and engineering fields as difficult and intimidating (2005; 2007).

Many secondary school students also have inaccurate perceptions of professionals working in STEM fields (Fralick, Kearn, Thompson, & Lyons, 2009). This is often the result of Americans' portrayal of scientists as "remote, withdrawn, secretive, conventional, having few interests and being unpopular" (Society for Science & the Public, 1975). It is difficult for students to identify with or aspire to become these negative stereotypes of scientists and engineers. In addition to negatively stereotyping STEM professionals' personalities, popular culture often places greater emphasis on certain demographics of scientists. Researchers at the University of California at Berkeley observed that modern science is widely believed to be the domain of white men. The majority of well-known, easily recognizable scientists are Caucasian males, such as Albert Einstein and Charles Darwin. The popularity and recognition of these men can deter young students who do not readily identify with this specific demographic (Misconceptions about science, n.d.). A recent study found that by the eighth grade, the percentage of female students that were interested in STEM-related careers was half that of the male students (Fralick et al., 2009). Females may perceive these careers as inappropriate for them, and may not be interested in pursuing a field in which they "do not belong." These perceptions are mistaken, and in order to increase the number of students pursuing science and engineering careers, an effort should be made to present students with an accurate depiction of STEM professionals (Hibbert, 2008).

2.3: Effective Practices in STEM Outreach Programs

The primary goal of many STEM outreach programs is to increase student interest in science and engineering fields. Extensive analysis of these outreach programs has been conducted, and certain recommendations are consistently generated by researchers suggesting methods to better accomplish program objectives. These recurring suggestions include educating through engaging, hands-on activities and encouraging students to interact with role models who are currently involved in STEM fields.

From multiple evaluations of K-12 outreach programs, it can be concluded that interactive, hands-on learning is an effective approach to science and engineering education (Miranda & Hermann, 2010; Gomes, 2009). Several organizations, including the National Science Foundation, recommend STEM activities that simultaneously engage and teach students (2009). In a summary of available resources on best teaching techniques for engineering, Felder et al. also stress the importance of active learning to promote long-term retention of information by students. These researchers suggest presenting practical applications of the program content and allowing students to work in groups to actively analyze problems. These processes are some of the most effective techniques for encouraging students to understand and enjoy the educational material (Felder, 2000).

Providing students with the opportunity to speak and interact with STEM professionals can be an extremely successful technique in educating and interesting students. A recent survey from the American Chemical Society found that 91% of female and minority scientists and engineers polled believe role models are a deciding factor for current students considering STEM careers (Bayer Corporation, 2010). Various outreach organizations, including the Society for Advancement of Chicanos and Native Americans in Science (SACNAS), are advocating for an increase in the accessibility of relatable science and engineering professionals to students. Luis Gonzalez, an MIT alumnus and information systems engineer, states that "I see the boost of self-esteem students get when they see others in these roles. Not having many graduate students or professors that I could relate to […] was a little tough" (Horwedel, 2006, p. 36). Employers such as the Water Environment Federation (WEF) also stress that a positive impression of a STEM role model can be extremely influential on students. In their newsletter, outreach volunteer Lyn Gomes notes that even sharing struggles and explaining interests can help students identify with science and engineering professionals (Gomes, 2009).

2.4: ASM Materials Camp New England

ASM International is one example of the numerous proponents of STEM outreach. ASM sponsors a variety of educational camp opportunities for both students and teachers ("ASM Materials Camp Student Camps," 2011). Students receive insight into engineering careers and are encouraged to pursue materials science; while teachers are trained in efficient methods of educating students and increasing interest in STEM subjects. These programs are offered at locations throughout the United States, as well as at several Indian universities. Many ASM camps last five days; other "mini" programs focus on breadth rather than depth of information and only last one day (Vollaro & Johnson, 2004). The ASM Materials Camp for the New England region, hosted at Worcester Polytechnic Institute (WPI), follows this single-day format. ASM Materials Camp New England provides educational opportunities for students who live in the regions of the Boston, Worcester, Rhode Island, and Northern New England ASM chapters (Girolimon, 2010).

According to the 2012 planning committee for ASM Materials Camp New England, the overarching goal of the program is to entice a greater number of students to study engineering-related curricula in college and pursue related careers. The planning committee for the ASM Materials Camp New England believes that this can be accomplished by conveying to participants that materials science and engineering are interesting, exciting fields containing a wide variety of intellectual challenges and employment opportunities. High school students are introduced to graduate students and volunteers who are currently working in the applied sciences. This could potentially enable students to visualize their futures should they choose to pursue a similar career, and allow students to gain a more accurate perception of what engineering students and professionals do on a day-to-day basis. A secondary goal of this program is to recruit additional participants for future camps. One way by which this can be accomplished is to make a positive impact on camp participants. Students who thoroughly enjoy the program are more likely to return to their schools and encourage peers to apply for future events (2012 Planning Committee, group interview, September 26, 2011).

ASM Materials Camp New England has been held on campus at WPI since 2006. The program typically begins at 8:30AM and ends at 3:30PM with a one-hour break for lunch. While limitations on space and resources prevent the camp from accepting more than sixty participants, acceptance rates are usually high due to an approximately equal number of applicants. When there is not enough space for all applicants, priority is given to those who have not previously attended the program. Volunteers included professors from WPI and Wentworth Institute of Technology, engineers from companies such as Genzyme, previous ASM Materials Camp New England chairs, and graduate students from the WPI materials science program. The majority of students learned about the camp from their teachers, or by communicating with students who had previously attended the program.

The 2011 camp comprised lectures given to the entire group of program participants and workstations where smaller groups of students explored specific applications of engineering and materials science. The lectures were given at the start of the program, after the lunch break, and at the end of the day. The topics of the 2011 lectures were:

- **Materials Engineering:** Diran Apelian discussed opportunities and challenges in materials engineering and gave an overview of the schedule. He challenged students to participate in the workstation activities and ask questions throughout the day.

- **The Recycling Industry:** David Spencer spoke about the challenges he has encountered while working with the recycling company wTE. He emphasized the importance of having an engineering background in business.
- **Important Aspects of Design:** Fay Butler discussed the importance of understanding the limitations of manufacturability from a design standpoint, and constructed a steel dish using a claw hammer and an anvil.

During the time in between these lectures, students were divided into small groups which rotated through each of the workstations. While the majority of these provided students with opportunities to engage in hands-on, interactive activities, each station was a unique experience for participants. Because all workstations were held concurrently, each activity took place in a different lab or classroom at WPI. The eight workstations included:

- **Casting:** Students carve their own cast, which is then filled with zinc alloy. The resulting mold can be taken home as a souvenir.
- **Cryogenics:** Participants use liquid nitrogen to freeze various objects, including flowers and rubber balls, and examine the changes in properties.
- **Hydrogels:** An engineer lectures on the usage of hydrogels in biomedical engineering. Students then utilize hydrogels to seal a hole in a pig's lung.
- **Microstructures:** Participants are told about how a material's physical properties are determined by its microstructure. Students then observe various materials on a microscopic level and are provided a photograph of one of the sample materials' microstructure.

- **Musical Instruments**: A university professor gives a lecture about how sound waves are generated. Various instruments are played, and the resulting waves are observed using an oscilloscope.
- **Physical Properties**: Students observe how various types of materials, including polycarbonate, acrylic, and Styrofoam, respond to stress. One experiment involves dropping a sharpened mass onto samples of different materials.
- **Polymers**: Various types of natural and synthetic plastics are discussed. Participants create a screwdriver handle using simplified injection molding, and receive samples of common polymers to take home.
- **Shape Memory Alloys**: Volunteers demonstrate how compressed springs made of shape memory alloys return to their original states when exposed to high temperatures. Students may then experiment with these springs and keep one as a souvenir.

ASM Materials Camp New England participants are asked to fill out a brief survey at the end of the program. Questions regarding students' demographic information, reactions to specific aspects of the camp, and opinions about the overall quality of the program have been asked. A copy of the 2011 ASM Materials Camp New England survey can be found in Appendix B. In previous years, the planning committee has consulted the quantitative portion of the survey responses in order to determine which workstations should be altered for the following camp. They have also reviewed and discussed any notable suggestions from the open-ended, qualitative survey questions when considering more substantial changes to the program structure (2012 Planning Committee, group interview, September 26, 2011).

2.5: Methods of Data Collection and Analysis for Program Evaluation

In order to aid readers in understanding a critique of the previous ASM Materials Camp New England evaluation system, this section provides background information on principles and common practices of program evaluation. Subsection one provides a brief overview of collecting and analyzing quantitative data, while subsection two does the same for qualitative data. Subsection three discusses how quantitative and qualitative data can be combined in a mixed-methods approach. In subsection four, purposes for collecting data (specifically, summative and formative evaluation) are discussed. Finally, common evaluation designs that incorporate all of these topics are discussed in subsection five.

2.5.1: Quantitative Data

When evaluators require information to objectively analyze a specific aspect of a program, quantitative data might be collected. Closed-ended survey questions often generate quantitative data, which is numerical. One method of quantitative data collection, which was utilized in the previous ASM Materials Camp New England survey, is a Likert scale. A typical Likert scale presents responders with numerical levels of agreement, usually ranging from 1 (“strongly disagree”) to 5 (“strongly agree”), for a given statement (Liou, Desjardins, & Lawrenz, 2010; Hayden, Ouyang, Scinski, Olszewski, & Bielefeldt, 2011). Camp participants were able to select one of these levels of agreement for statements about each workstation, such as “this learning activity was interesting." These inquiries generated quantitative data about a specific topic, student interest in each workstation.

The process of analyzing quantitative data is straightforward. There are fewer opportunities for subjective interpretation of numerical data, which can reduce bias in its analysis (Lawrenze & Huffman, 2006; Joint Committee on Standards for Education Evaluation, 1994). Means, standard deviations and other statistical calculations are computed. This information can then be summarized using charts, tables, and graphs.

2.5.2: Qualitative Data

Quantitative feedback is more focused and directed than open-ended responses, or qualitative feedback. For example, inquiring about the size and weight of an object will yield a more predictable answer than asking for someone's opinion of that object. However, qualitative questions can enable responders to express broader, more detailed information than they could when selecting from a list of possible answers. Qualitative feedback may also contain information about the reasoning behind a certain opinion. This can allow evaluators to better understand participant's perceptions of a program compared to the more limited information in quantitative data (Lawrenze & Huffman, 2006; Bryman, 1994; Miles & Huberman, 1994; Joint Committee on Standards for Educational Evaluation, 1994).

Due to the greater amount of information available, the summary and analysis of qualitative feedback often requires more effort than the corresponding processes for quantitative data. There is also an increased risk of bias, because evaluators must make additional decisions about which aspects of the information to focus on.

According to Bryman (1994), Leech and Onwuegbuzie (2007), as well as Miles and Huberman (1994), commonly used methods of qualitative data analysis include:

- **Classical Content Analysis**: Evaluators examine data, and divide responses into categories that are described by code words or phrases. They then compare the number of responses in each category.
- **Constant Comparison Analysis (or Grounded Theory)**: Evaluators use classical content analysis to categorize responses, and then identify themes that connect different categories.
- **Word Count**: Evaluators determine how many times relevant words or phrases are used in the responses. This can be useful for identifying patterns.

There are advantages and limitations to every popular method of analysis for qualitative data. In order to address these, researchers suggest combining techniques to produce a customized method that will be most effective for a specific data set (Leech and Onwuegbuzie, 2007; Joint Committee on Standards for Educational Evaluation, 1994; Bryman, 1994; Miles & Huberman, 1994).

2.5.3 Mixed-Methods Approaches

Many evaluators combine quantitative and qualitative data in a "mixed-methods" approach to program evaluation. This enables stakeholders to examine multiple facets of a program and draw more informed conclusions (Lawrenze & Huffman, 2006; Hesse-Biber, 2010; Doyle, Brady & Byrne, 2009; Lyons & DeFranco, 2010). While separate quantitative and qualitative methods have been implemented successfully, Lawrenz and Huffman consider the mixed-methods approach to be most useful when evaluating STEM outreach programs (2006).

2.5.4: Summative and Formative Evaluation

Program evaluation systems are typically implemented to fulfill two purposes. The first objective, summative evaluation, is to determine how successful a program is at meeting its stated goals (Fitz-Gibbon & Morris, 1987; Priest, 2001; Scriven, 1991; Worthen & Sanders, 1997). One example of summative evaluation from the previous ASM Materials Camp New England survey would be when students were asked if they were more likely to consider studying science or engineering as a result of their experience at the program. The second motive, formative evaluation, is to identify ways in which the program can be improved (Fitz-Gibbon & Morris, 1987; Priest, 2001; Scriven, 1991; Worthen & Sanders, 1997). The question "can you suggest anything that we could do to improve the quality of the camp" is an example of formative evaluation from the previous survey. Program evaluation designs often comprise both summative and formative inquiries, which collect both quantitative and qualitative data.

2.5.5: Program Evaluation Designs

One common method of program evaluation is the "post-only" design, in which stakeholders are given a survey at the end of a program. This is more helpful for formative evaluation because evaluators are able to gather feedback about program improvements with only one survey. However, the post-only design is somewhat limited with respect to summative evaluation because evaluators cannot necessarily determine which aspects of participant feedback are a direct result of the program (Fitz-Gibbon & Morris, 1987; Millsap, 1980).

A second common evaluation design is the “pre-post” design, which involves administering a pre-test in addition to a post-test. This method provides evaluators with a point of comparison, so that they might be able to identify changes in feedback resulting from program participation. While this design involves administering an addition survey, it can be considerably more effective for determining program efficacy (Fitz-Gibbon & Morris, 1987; Millsap, 1980).

In addition to a pre- and post-test, one method of program evaluation administers a “retention test” some period of time after the program. This is often useful for identifying any long term impact that a program may have had on participants (Fitz-Gibbon & Morris, 1987). This method requires additional effort and resources because participants are no longer on site at the program. However, this design can be worthwhile if a program’s stated goals include making a long term impact on participants.

Several evaluation designs involve collecting feedback from individuals other than program participants. According to researchers, it is necessary to request information from various stakeholders, and consider multiple perspectives, in order to determine how well the program is meeting its stated goals (Priest 2001; Lawrenze & Huffman, 2006; Fitz-Gibbon & Morris, 1987).

3.0: Methods

In this chapter, the methods utilized for this project are divided into three main objectives and presented. In section one, the techniques used to identify the strengths and weaknesses of the previous program and evaluation process are discussed. Section two discusses the potential solutions to the weaknesses of the current program; while section three discusses potential solutions to the weaknesses of the current evaluation method.

3.1: Identifying Strengths and Weaknesses of the Previous Program and Evaluation System

In order to systematically provide recommendations for the program and evaluation methods, the team analyzed information from the following sources:

- Quantitative and qualitative survey results
- Feedback from the ASM Materials Camp New England planning committee
- Personal observations from the 2011 ASM Materials Camp New England

As described in the previous chapter, the participant survey distributed at the end of the program consisted of various quantitative and qualitative questions, including "How do you rate your ability to solve engineering problems?" and "What did you particularly like about this camp?" Forty-three participants submitted surveys, providing responses to all of the quantitative statements and one or more of the qualitative questions. The team only analyzed data from the 2011 ASM Materials Camp New England due to a lack of data from previous years. The available information was organized and summarized; and the qualitative and quantitative responses were separated in order to apply different data analysis techniques.

For the quantitative data, the team calculated averages and sample standard deviations to summarize overall trends and data variance among workstations, respectively. The qualitative survey information was evaluated using constant comparison analysis (Leech & Onwuegbuzie, 2007). In this process, the data was organized by assigning codes, or descriptive words which encompass specific responses, to student comments. These codes were then grouped by similarity until trends could be identified and the responses could be separated into categories. This method was particularly useful for the ASM Materials Camp New England survey results because there were a wide variety of responses to the open-ended questions.

In September 2011, the team presented the compiled quantitative survey data to the ASM Materials Camp New England planning committee in order to receive feedback. The committee expressed greater interest in the qualitative feedback, because they felt that this was the most candid source of insight into student opinions. Committee members shared opinions identifying areas of improvement for the camp, observations of students' reactions to the program, and expectations regarding what conclusions might be drawn from the survey responses. After completing the quantitative and qualitative analysis of the survey data, the team accounted for input from committee members when drawing conclusions and generating recommendations.

The team attended the 2011 ASM Materials Camp New England for observational purposes. Information regarding reactions from participants, teaching methods utilized at workstations, and interactions between students and volunteers was gathered. The teams' personal observations were considered when generating recommendations for the program and preparing new survey questions.

3.2: Addressing the Weaknesses of the Previous Program

After the survey data was analyzed, the team then worked to address the weaknesses of the 2011 ASM Materials Camp New England in order to improve future iterations of the program. Questions that team members sought to answer during this process included:

- Why were the scores of some workstations lower than those of others?
- Which aspects of the program format correlated with negative student responses?
- How can these aspects be reduced or eliminated from the program?

In order to determine why students responded less favorably to some parts of the program, the team researched successful practices of other science and engineering outreach programs. Any consistently mentioned practices were compared to the methods utilized at ASM Materials Camp New England. Where parallels were present, there was greater evidence that those methods of STEM instruction succeed in improving various aspects of the program.

After assessing positive and negative aspects of the camp, planning committee goals, observations of the camp, and national instructing recommendations, a list of identified problems and potential solutions was composed. A draft of the team's recommendations for the program was submitted to the planning committee with the intention of improving the 2012 ASM Materials Camp New England.

3.3: Addressing the Weaknesses of the Previous Evaluation System

The team analyzed multiple facets of the evaluation system in order to recommend improvements. Some of the research questions guiding this analysis included:

- What are the strengths and weaknesses of the current evaluation system?
- To what extent does the current evaluation system help the organizational committee determine if the program is meeting their goals?
- What evaluation techniques should be incorporated into the current evaluation system as a means to improve it?

Determining the goals of ASM Materials Camp was necessary for the team to understand what information was needed from the evaluation system and which portions of the system were not useful. After this was completed, the next step involved researching evaluation systems of similar outreach programs in order to recognize other practices that could benefit ASM Materials Camp New England. Feedback from the organizational committee was also taken into consideration when determining which methods of evaluation were most appropriate for the 2012 program.

In order to determine whether valuable information could be retrieved from the survey, each question had to be systematically analyzed. Additionally, correlation coefficients for every possible combination of questions were calculated. This revealed any potential patterns or relationships among the responses to statements regarding each workstation. This enabled the team to determine whether each question was contributing effectively to the evaluation process.

After the team reviewed the 2011 survey and determined how successfully it allowed participants to provide useful feedback, the team then investigated how well the survey data allowed the organizational committee to determine whether the program was meeting their goals. The capacity of the survey for formative and summative evaluation was then determined. The team recognized which types of evaluation each survey question was generated for, but also explored whether or not useful data was being collected for each type of evaluation.

Another issue that the team addressed was when and how frequently data should be collected. Best practices were researched in order to see how often other evaluators collect data.

Currently, the evaluation system is designed to allow program participants to provide feedback through answers to quantitative and qualitative questions. The team also investigated other potential sources of information, such as feedback from program organizers, volunteers, and observers. In order to obtain information from these individuals, the team presented a summary of the survey data and asked for input. This helped to develop a better understanding of the program. The team then investigated the how well the current evaluation system allowed other stakeholders in the program to provide feedback.

Once the team determined that all areas of improvement for the evaluation system had been investigated, a draft of a new survey was compiled and presented to the planning committee. The team then incorporated feedback from committee members into the draft, and produced the survey included in Appendix D.

4.0 Findings

In this chapter, the findings resulting from the team's analysis of ASM Materials Camp New England and its evaluation system are summarized. In section one, the summative evaluation conducted with the 2011 survey is discussed. The second section presents a discussion of the prevalence of student interest in interactive activities. In section three, the students' disfavor of passive activities is discussed. Section four addresses the impact of role models at the previous program. Finally, section five examines the efficacy of the previous evaluation system.

4.1 Summative Evaluation of the Previous Program

In the 2011 survey, students could provide data for the purpose of determining program efficacy. This data was collected through the following statements:

- "This learning activity stimulated my interest in the subject matter."
- "I am more likely to consider pursuing a career in Engineering or Science."
- "I am more likely to consider studying or taking courses in science and engineering fields."

Students highly agreed with these statements. Between "strongly disagree" (1) and "strongly agree" (5), students rated each statement with a 4 or 5. This information is summarized in Figure 1.

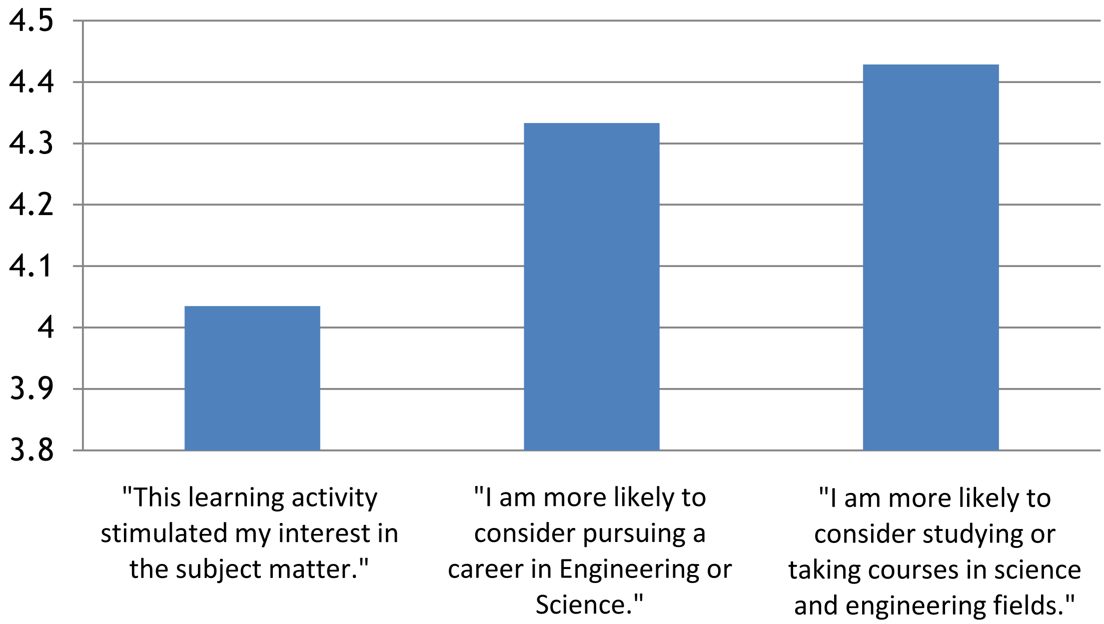

Figure 1: Average student response to statements related to the stated goals of the program, on a scale of "strongly disagree" (1) to "strongly agree" (5)

Between all of these statements, camp participants most strongly agreed that they were more likely to consider taking courses in science and engineering fields. Students agreed the least with the statement concerning how much all of the workstations stimulated their interest in the subject matter. This can be explained by the fact that there were more mixed responses for the latter statement, resulting in a lower average score. Overall, student feedback for the camp with respect to program objectives was positive; from these data, the 2011 ASM Materials Camp New England can be considered a success.

4.2 Students' Interest in Hands-on, Interactive Activities

Analysis of both the quantitative and qualitative survey data resulted in strong evidence of participant approval regarding primarily hands-on workstations. As discussed in Section 2.4, each workstation at ASM Materials Camp New England was organized differently. Because of this variance, the 2011 survey asked students for separate quantitative responses about each workstation. The stations that involved more engaging, interactive activities generally received more positive responses. There were also opportunities for students to provide qualitative responses, and several of these referenced positive opinions of more active teaching styles.

The quantitative survey questions asked students to indicate on a Likert scale of "strongly disagree" (1) to "strongly agree" (5) how well each of five statements described each workstation. The five statements were:

- This learning activity is interesting.
- The information presented in this learning station is easy to understand.
- I have learned a fair amount of valuable information from this learning activity.
- The time spent at this learning station was right.
- This learning activity stimulated my interest in the subject matter.

A complete summary of the quantitative results of the 2011 survey can be found in Appendix E.

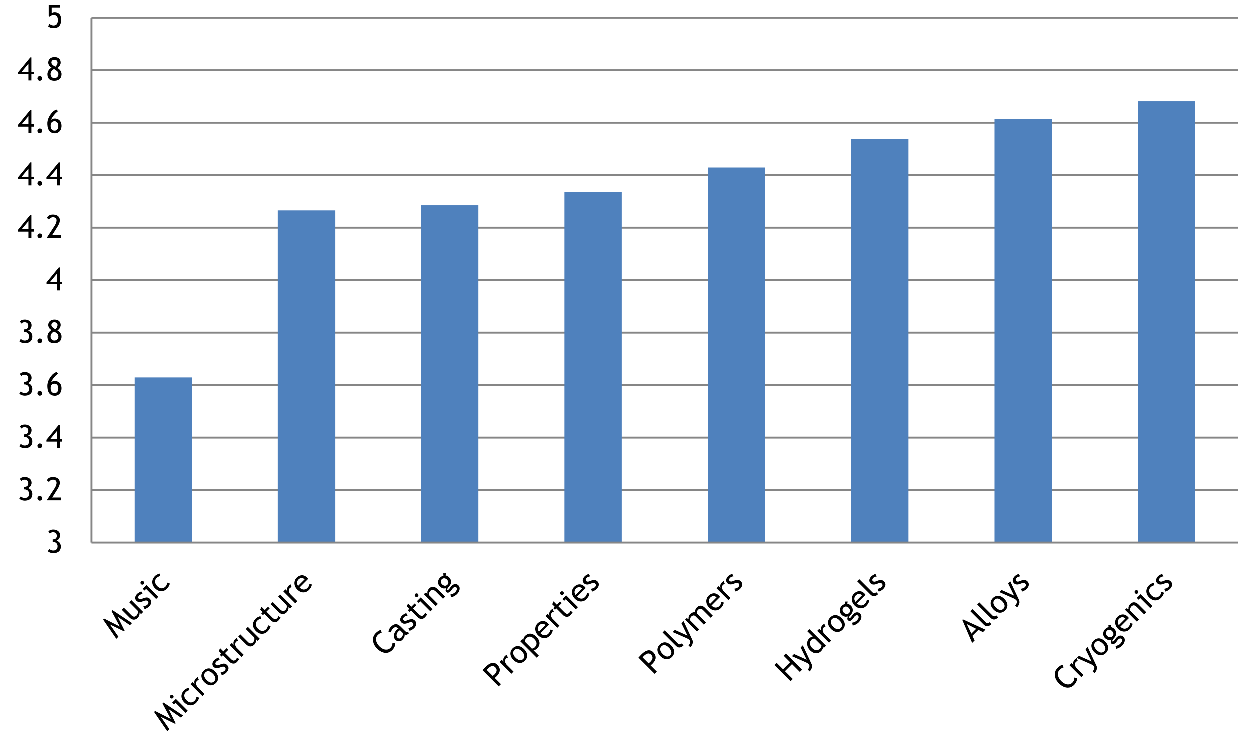

Figure 2: Average overall score for each workstation

Figure 2 was generated by calculating the mean of all responses to the quantitative statements regarding each workstation. Because the five Likert scale statements were phrased in such a way that a response of "strongly agree" indicated positive feedback, a greater average overall score implies that students favored the corresponding workstation. This graph shows that students responded more positively to hands-on activities like Cryogenics, Alloys and Hydrogels. Musical Instruments is the only workstation with a significantly lower average overall score, which was calculated to be 3.62. The second lowest average overall score is that of the Microstructures workstation, which is 4.26. The highest average overall score was Cryogenics, which was calculated to be 4.68. The difference between the average overall scores of the two lowest scoring workstations, Microstructures and Musical

Instruments, is 0.64. This is less than the difference between the average overall scores of the highest and the second lowest, Cryogenics and Microstructures, which was 0.42. The substantial difference between Musical Instruments and the other workstations emphasizes how much less favorable student responses were for this activity.

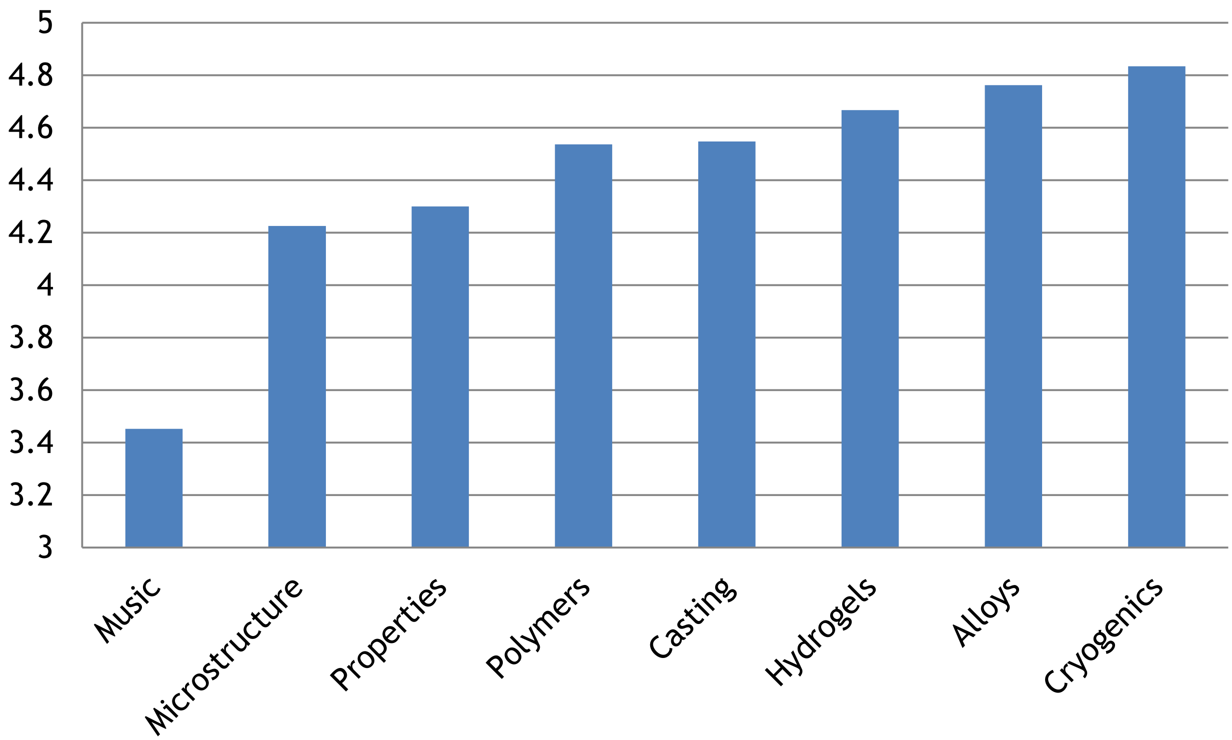

Figure 3: Average student response to the statement "the learning activity is interesting" for each workstation

Figure 3 presents the average response to the statement "The learning activity is interesting" for each workstation. Thirty-eight students, approximately 90% of the participants who completed the survey, stated that they "strongly agree" with this statement for the Cryogenics workstation. Similarly high frequencies of positive responses were found with the Shape Memory Alloys, Hydrogels, Casting, and Polymers stations. Each of these five workstations included activities during which participants physically handled objects to complete a task. Because the quantitative responses to each statement align similarly, with hands-on workstations receiving higher average responses, it can be concluded that students favored these activities because of the hands-on style of learning.

In the qualitative data obtained from the open-ended survey questions, there were numerous positive references to hands-on activities. Approximately 57% of the responses to the question "What did you particularly LIKE about this camp?" included mentions of active, engaging activities such as crafting souvenirs. Examples of student responses included:

- "I really liked all of the hands-on activities."
- "I liked that most experiments/presentations were hands-on…"

Responses to the inquiry "Can you suggest anything that we could do to improve the quality of the camp?" also provided insight into how positively students reacted to active, engaging activities. While only eighteen students answered this qualitative question, nearly half of them mentioned hands-on activities, with responses such as:

- "Keep hands-on things, summarize slides and posters."
- "Make it [the camp] even more interactive."

Approximately thirty-nine percent of the participants expressed that maintaining or increasing the number of hands-on, interactive activities would improve the program.

The team's personal observations of the camp provided additional indications that students reacted favorability to interactive learning activities. It was noted that at workstations with active, hands-on activities, student participants were more engaged and alert. When students were asked throughout the day about what they had learned so far, many responded with references to workstations where they had physically interacted with materials. When considering the 2011 survey data, the team's personal observations, and statements from the planning committee, there is ample evidence that hands-on, interactive activities were an enjoyable experience for camp participants as well as an effective method of interesting students in materials science.

4.3 Students' Disfavor of Lecture-Based Activities

While the majority of students responded favorably about all camp activities, feedback about the more passive activities was not as positive as feedback about hands-on activities. In the Musical Instruments workstation, students were seated in a lecture hall as an instructor spoke about sound waves and methods of producing them. Various musical instruments were demonstrated and discussed. As discussed in the previous section, average responses to Likert scale questions for the Musical Instruments workstation were considerably lower than the other workstations. This was also the only workstation which received negative qualitative comments targeting a specific module. In responses to open-ended questions, some students commented:

- "The music module was boring and some points were vague."
- "I didn't like the lectures (especially music)."

It is possible to conclude that this workstation received less positive feedback because students were not actively engaged, or because this teaching style was more passive, compared to the other workstations.

In addition to workstations with more passive presentations, guest speakers gave lectures related to materials science and engineering in the morning, after lunch, and at the end of the program. The team observed that these discussions were not particularly engaging for students, and that many participants did not seem as enthused about the lectures as they were about the hands-on workstations. Several responses to the qualitative survey questions reinforced this observation. Approximately 40% of student responses to the question “What did you particularly DISLIKE about this camp?” contained references to the guest speakers’ presentations or lectures-based workstations. These responses included:

- “The lecture after lunch.”
- “Some modules had too much of a lecture that got boring.”
- “The modules during which we just sat and listened to a lecture.”

Additionally, when participants were asked what they would change about the camp, 8 of the 15 responses suggested adding more hands-on activities. Three participants specifically suggested cutting lecture time in some shape or form. In conclusion, students generally disfavored the more passive, classroom-based camp activities.

Unfortunately, the previous survey did not request for students to specifically evaluate the three lectures. While some students commented on these in the qualitative responses, there is a lack of available data to improve the lectures for the 2012 program.

4.4 Accessibility of Role Models for Student Participants

One aspect of outreach programs that may influence students to view STEM fields as more viable career choices is the presence of role models who are involved with those fields. Participants might be better able to envision themselves in science and engineering professions if they have interacted with a relatable individual who is pursuing or has attained a similar occupation. This could help students to view fields that they previously considered difficult or out of reach as more attainable. The presence of role models also helps to dispel any misconceptions that students might have about STEM professionals.

The planning committee for the 2012 ASM Materials Camp New England expressed that they would like to see more interaction between WPI students and camp participants. This would hopefully allow high school students to visualize where they might be in a few years should they choose to pursue a career in STEM. This might also encourage students to consider applying to more technical colleges, such as WPI.

While there were no survey questions that directly referenced the accessibility of STEM professionals at ASM Materials Camp New England, approximately 9% of students referred to the program staff as one of the aspects they most enjoyed about the program. Examples of student responses to the question “What did you particularly LIKE about this camp?” included:

- “Everyone seemed both passionate and knowledgeable about their station.”
- “How friendly the staff were at each station”

- “…The speakers were also interesting. They brought engineering into real life.”
- “…I liked having professionals talk.”

The fact that the quality of program staff was one of the first positive aspects of the camp to be mentioned by these students suggests that they were impacted by the presence of engineering professionals at the program. This is a fulfillment of one of the major goals expressed by the planning committee, which was to provide student participants with a positive impression of engineering professionals.

4.5 Efficacy of the Previous Evaluation System

In this section, results of the 2011 survey analysis are provided. In subsection one, the importance of useful responses and survey questions which satisfy this need are discussed. Correlations between questions and possible redundancies in the survey are investigated in subsection two. Subsection three covers the efficacy of the previous evaluation design, such as the time the tests were administered to particular stakeholders. Finally, subsection four discusses how effectively the previous evaluation system yielded data for summative and formative evaluation.

4.5.1 Non-Actionable Feedback

Some questions and statements on the survey did not provide meaningful data for evaluators to act upon. Excessive ambiguity was one explanation for the ineffectiveness of the survey. Particularly vague statements included:

- “The size of the student group was appropriate.”
- “Lunch and snack were well-arranged.”
- “The time spent at this learning station was right.”

Students were asked to rate these statements from “strongly disagree” (1) to “strongly agree” (5). However, when participants disagreed with the ambiguous statements, the factors that deterred the students could not be determined.

The open-ended questions gave students the opportunity to explain their least or most favorite part of the camp, but participants did not have the opportunity to elaborate on their quantitative responses. For example, the students were not prompted to respond whether or not the groups were too big or too small. The same problem occurred for the statement inquiring whether or not the lunch and snack were well arranged; if the statement received negative feedback, program organizers could make no recommendations derived from useful data. An additional statement asked if the time spent at the learning stations was right. Once again, if the responses are negative, there is no evidence to suggest whether more or less time should be allocated to the workstation. This lack of utilizable data prevents evaluators from definitively determining how to improve certain aspects of the program.

4.5.2 Correlations between Responses to Survey Questions

Survey statements regarding the workstations yielded high correlation coefficients (greater than +0.9). The results suggest that there is a level of interdependence or redundancy between the statements.

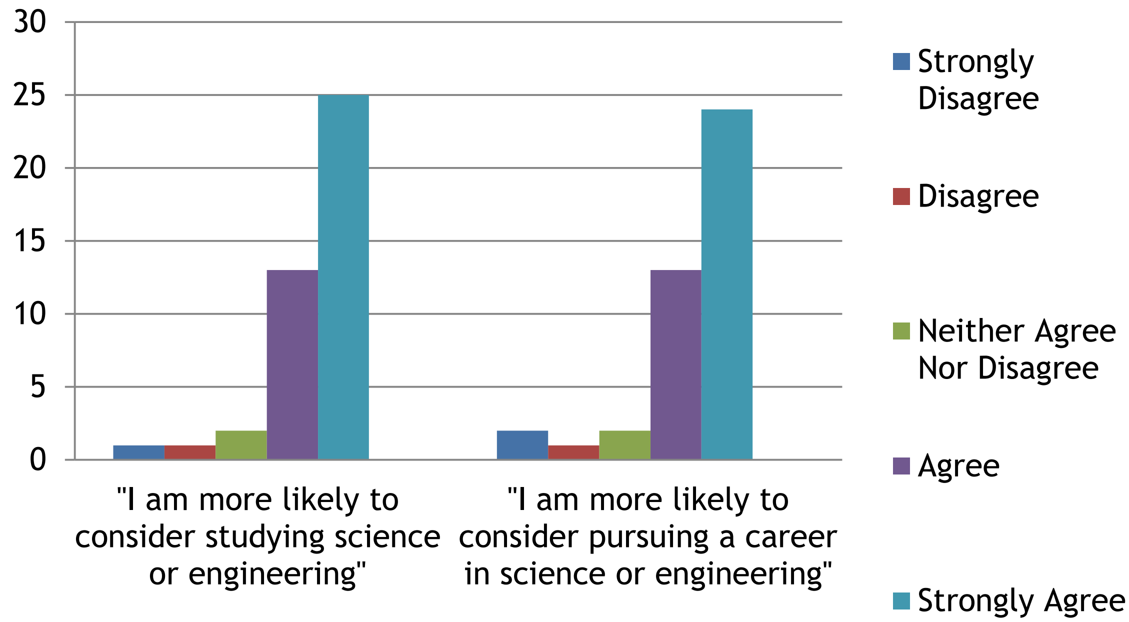

Figure 4: Student responses to two similar questions on the 2011 survey

Figure 4 shows the 2011 results for the statements “As a result of my experience today, I am more likely to consider studying or taking courses in science and engineering fields” and “As a result of my experience today, I am more likely to consider pursuing a career in science or engineering.” The data are extremely similar; for example, 25 students strongly agreed with the first statement and 24 students strongly agreed with the second statement. The results yielded a high correlation coefficient of 0.90; this confirms that the two questions were redundant since they produced similar results. Participants may have considered the questions identical and responded accordingly with the same level of agreement.

4.5.3 Capacity for Summative and Formative Evaluation

The previous evaluation system did not allow responders to provide a sufficient amount of information for evaluators to determine program efficacy. This data should ideally help evaluators determine how much the program is inspiring students to study science and engineering-related curricula and to pursue related careers. While there were questions regarding the overall quality of the program, few of the questions directly related to any of the stated objectives of the planning committee.

The majority of the 2011 evaluation system was dedicated to formative evaluation. While students were able to provide information that evaluators could use to improve the program, the planning committee noted that some questions and statements did not result in data that could be acted upon. These questions and statements are discussed in section 4.5.1.

4.5.4 Areas for Improvement

In the previous evaluation system, only camp participants could provide feedback. Due to this limitation, camp volunteers and organizers were unable to provide input regarding how the camp was being conducted. Based on background research presented in section 2.4, it is important to collect feedback from multiple stakeholders involved in the program. This additional information provides evaluators with a better understanding of how the program was managed. Evaluators can then use this information to find and address areas for improvement (Fitz-Gibbon, 1987).

Another notable aspect of the evaluation system design is when and how often tests are administered. The previous evaluation system followed a “post-only” evaluation design, which provided no point of comparison that evaluators could use to determine the program’s impact on the participants.

5.0 Conclusions & Recommendations

In this chapter, problems with the current format and evaluation method of ASM Materials Camp New England are identified; and suggestions for improvements that might remedy these issues are proposed. The first section discusses the recommendation of removing the after-lunch lecture and devoting that time to additional hands-on workstations. The second section presents the suggestion of increasing the accessibility of role models involved with the program. The third section recommends the implementation of the new pre- and post-camp surveys generated by the team.

5.1 Increase the Ratio of Active Learning Activities to Passive Learning Activities

This study concludes from previous student survey responses and personal observations that the present format of ASM Materials Camp New England could be modified in order to increase the engagement of student participants. This could help to better accomplish the program goals because if a student is more interested and engaged in the program, the experience is more likely to leave a lasting impression, and the student may gain a more positive opinion of STEM careers. **To accomplish this, the team recommends increasing the time available for hands-on, interactive activities by eliminating the midday lecture.**

5.1.1 Introduce a Greater Number of Engaging, Interactive Activities

The workstations that involved students in interactive, engaging activities piqued interest and educated participants more effectively than the classroom-based lectures. Evidence of this was present throughout the survey responses and the project team's observations, as discussed in section 4.1. While implementation of multiple styles of teaching may be most effective when appealing to a wide variety of students, an increased number of active workstations is recommended by the team.

5.1.2 Reduce the Number of Classroom and Lecture Based Activities

The team also recommends that lecture time be decreased so that the focus of the program is the hands-on workstations. In a one-day outreach program, limitations on time necessitate prioritization of activities. During the 2011 ASM Materials Camp New England there were classroom-based lectures given at the beginning, middle, and end of the day. Certain workstations also contained passive, lecture-based teaching. Decreasing lecture time by focusing workstations on hands-on activities and removing the midday presentation would allow students more time in the smaller, interactive workstations.

As discussed in section 4.2, a number of student responses called for decreases in time devoted to lectures. Workstations that received the most negative feedback were primarily passive, so that students sat and listened or observed. Additionally, several students specifically mentioned the midday lecture as a portion of the camp which they disliked. Survey responses and student commentary reveal a significantly greater amount of interest in more interactive, hands-on workstations than the lecture-based teaching.

Several students claimed in qualitative feedback that they felt "rushed" at workstations. The project team does not feel that the data collected from previous camp surveys is specific enough to determine the ideal length of each workstation. However, this is an important factor contributing to the quality of the camp. The current distribution of time and activities could be studied after more detailed data is collected so that the length of workstations can be optimized.

5.2 Increase the Accessibility of Role Models

The team recommends increased interaction between volunteers (such as educators, graduate students, and STEM professionals) and participants at the 2012 ASM Materials Camp New England. Having the opportunity to talk to volunteers such as STEM undergraduates could inspire the high school students and increase their interest in pursuing related careers. **One method of accomplishing this would be to implement a "question and answer" session during which a panel of volunteers would take questions from students.** This could take the place of the afternoon lecture, and panel members could prepare brief talking points to be used in the event that there are not enough questions to fill the allotted time.

Both the background research and the available data for the 2011 program confirm that role models are an influential factor in appealing to the high school students, as discussed in section 4.3. The qualitative survey responses yielded multiple positive comments about the staff and the volunteers. This was supported by personal observations of positive student-volunteer interactions. The committee also articulated the importance of increased communication in order to dispel misconceptions about STEM professionals and cultivate interest in these careers.

5.3 Improve the Program Evaluation System

This section discusses several issues that the team identified with the previous evaluation method for ASM Materials Camp New England. The first subsection addresses the lack of input from stakeholders other than student participants. The second suggests improvements to the previous post-camp survey. The third subsection recommends the implementation of a new pre-camp survey to provide a point of comparison for data collected at the program.

5.3.1 Explore Opportunities for Collecting Feedback from Additional Stakeholders

While the previous evaluation system facilitates the collection and analysis of feedback from student participants, there is not yet an opportunity for other stakeholders to express opinions about ASM Materials Camp New England. The team identified students' chaperones or teachers and program volunteers as potential sources of useful feedback. Due to time constraints, the team was not able to draft a survey to collect input from these individuals. **However, the team recommends that the solicitation of feedback from additional program stakeholders be explored in future iterations of ASM Materials Camp New England.**

5.3.2 Improve the Previous Post-Camp Survey

This study concluded that there were several issues with the previous post-camp survey at ASM Materials Camp New England. These included ambiguous, non-actionable, and redundant questions, as well as a failure to collect potentially important data. **The team has designed a new post-camp survey for ASM Materials Camp New England, which can be found in Appendix D. The team recommends that this updated survey be implemented in the 2012 program.**

The new draft of the post-camp survey has the potential to collect much more useful data than the previous version. As discussed in section 4.4, the 2011 survey contained little summative evaluation and several irrelevant or repetitive questions. The new post-camp survey will focus on the objectives defined by the planning committee. For example, discussion of science and engineering fields and careers is a greater priority with the new survey. With the implementation of this revised survey, the program may be systematically evaluated with a plethora of relevant feedback.

5.3.3 Implement a Pre-Camp Survey

One major issue with the previous ASM Materials Camp New England evaluation system was the lack of data comparable to the post-camp responses. In order to conduct more meaningful summative evaluation, information should be collected from participants before and after the program. In this manner, accurate conclusions can be drawn about which aspects of post-camp feedback are direct results of the program. **The team has created a draft of a pre-camp survey for ASM Materials Camp New England, which can be found in Appendix C. The team recommends that this pre-camp survey be implemented at the 2012 program.**

When summative program evaluation is conducted with only a post-camp survey, there is no information for the collected data to be compared to. Because of this, it can be argued that any evidence of accomplishment of program goals is not necessarily a result of the program. For example, if a student claims in a post-camp survey response for ASM Materials Camp New England that he or she is interested in pursuing a career in science or engineering, it could be that this student was already interested in science or engineering careers prior to the program. This interest would make the student more likely to attend an event where they would learn about applied sciences. However, if a pre-camp survey is implemented, the changes in interest in these careers can be measured. This allows for more steadfast summative evaluation to be conducted.

The pre-camp survey designed by the team facilitates both formative and summative evaluation. Both surveys ask questions about students' knowledge of science and engineering, as well as their interest in STEM careers. The changes in these responses can be measured for summative evaluation purposes. The pre-camp survey also includes a section about students' expectations for the program, which corresponds to a section on the post-camp survey reflecting on their experience. These responses can be compared to gain a better understanding of why students attend the program and whether or not their expectations are being met.

Additional follow-up information could be collected from students to determine any long-term impacts of the program. For example, a survey could be sent to participants some period of time after the program. This could be a valuable opportunity to conduct summative evaluation, such as inquiring about students' educational intentions. It could also be useful for formative evaluation, because students might want to express new opinions after a period of reflection. Because this longitudinal evaluation would require annual effort and additional resources, the team chose not to investigate it as a part of this project. However, the team has identified this as an area for future exploration and consideration for the ASM Materials Camp New England planning committee.

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Appendix A: Flyer for the 2012 ASM Materials Camp New England

Announcing the 2012
ASM Materials Camp
New England Area

The Materials Information Society

Monday May 7, 2012
Worcester Polytechnic Institute
Worcester , MA

VISION: A one day program to excite and encourage young people to pursue careers in materials science, applied sciences and engineering disciplines.

WHEN: Monday May 7, 2012 8:30 am to 3:30 pm

WHO: The camp is open to HIGH SCHOOL Sophomores and Juniors.

WHERE: Worcester Polytechnic Institute, 100 Institute Road, Worcester, MA

WHAT: Students selected for this one day Materials Camp will participate in hands-on learning modules designed to demonstrate the nature of materials. Topics will demonstrate how materials are engineered through processing to perform as desired. Modules include Casting, Cryogenics, Shape Memory Alloys & more!

COST: FREE. **Note:** Participants must make their own transportation arrangements.

APPLY: On line Here

All applications must be submitted by February 29, 2012.

See an online version of this flyer at www.asm-ma.org/2012_ASMMCNE_flyer.html

For more information, please send us an e-mail at MatCampNE@gmail.com

To watch a video of a previous year at ASM Materials Camp New England visit www.youtube.com/ASMCampNE

Find us on FaceBook!

Sponsored by the Boston, Northern New England, Rhode Island and Central Massachusetts Chapters of ASM International, Corporate Sustaining Members and the ASM Materials Education Foundation

Appendix B: Student Survey for the 2011 ASM Materials Camp New England

ASM New England Materials Camp May 9, 2011
Worcester Polytechnic Institute
ASM international Foundation

Post-Camp Survey

1. **What is your gender?**

   Male ________ Female ________

2. **Please write your career interest (s) below.**

   ____

4. **What is your ethnicity? (NSF categories)**

   - ☐ Black, non-Hispanic
   - ☐ American Indian or Alaskan Native
   - ☐ Asian or Pacific Islander
   - ☐ Hispanic
   - ☐ White, non-Hispanic
   - ☐ Non-resident alien
   - ☐ prefer not to provide

5. **Please identify your prior experiences with science and engineering. Check all that apply.**

   - ☐ None
   - ☐ Courses in primary school, middle school and/or high school
   - ☐ Independent study in middle school and/or high school
   - ☐ Internship
   - ☐ Employment
   - ☐ University outreach programs (Please describe ________________________________)
   - ☐ Science and engineering camps (Please describe ________________________________)
   - ☐ Other (Please describe ____)

6. **How much experience have you had in solving real-life engineering projects or problems?**

   ❍ None ❍ A little ❍ Some ❍ Much ❍ A great deal

7. **How do you rate your ability to solve engineering problems?**

   ❍ Excellent ❍ Good ❍ Average ❍ Fair ❍ Poor

1

Following questions pertain to overall quality of the camp:

Overall quality: (1=poor, 5=excellent)	poor			excellent		NA
8. My overall rating of the quality of this camp is	1	2	3	4	5	NA
9. The educational value of camp is	1	2	3	4	5	NA
10. The organization of the camp is	1	2	3	4	5	NA
11. The lab facilities are	1	2	3	4	5	NA
12. The organization of the camp is	1	2	3	4	5	NA

Overall quality: (1=strongly disagree, 5=strongly agree)	Strongly disagree			Strongly agree		NA
13. It is easy to travel to WPI	1	2	3	4	5	NA
14. Lunch and snack were well-arranged	1	2	3	4	5	NA
15. Materials camp stuff are helpful	1	2	3	4	5	NA
16. The size of student group was appropriate	1	2	3	4	5	NA
17. As a result of my experience today, I am more likely to consider studying or taking courses in science and engineering fields	1	2	3	4	5	NA
18. As a result of my experience today, I am more likely to consider pursuing a career in Engineering or Science	1	2	3	4	5	NA

Your thoughtful answers to the following question would be helpful to the camp organizers

19. What did you particularly LIKE about this camp?

20. What did you particularly DISLIKE about this camp?

21. Can you suggest anything that we could do to improve the quality of the camp?

22. Would you encourage a friend to participate in this camp? Why or why not?

23. Any other suggestions or comments?

Following questions pertain to individual learning stations:

Casting *(1=strongly disagree, 5=strongly agree)*	Strongly disagree			Strongly agree		NA
1. The learning activity is interesting.	1	2	3	4	5	NA
2. The information presented in this learning station is easy to understand	1	2	3	4	5	NA
3. I have learned a fair amount of valuable information from this learning activity	1	2	3	4	5	NA
4. The time spent at this learning station was right	1	2	3	4	5	NA
5. This learning activity stimulated my interest in the subject matter	1	2	3	4	5	NA

Music Instrument *(1=strongly disagree, 5=strongly agree)*	Strongly disagree			Strongly agree		NA
3. The learning activity is interesting.	1	2	3	4	5	NA
4. The information presented in this learning station is easy to understand	1	2	3	4	5	NA
5. I have learned a fair amount of valuable information from this learning activity	1	2	3	4	5	NA
6. The time spent at this learning station was right	1	2	3	4	5	NA
7. This learning activity stimulated my interest in the subject matter	1	2	3	4	5	NA

Polymers *(1=strongly disagree, 5=strongly agree)*	Strongly disagree			Strongly agree		NA
1. The learning activity is interesting.	1	2	3	4	5	NA
2. The information presented in this learning station is easy to understand	1	2	3	4	5	NA
3. I have learned a fair amount of valuable information from this learning activity	1	2	3	4	5	NA
4. The time spent at this learning station was right	1	2	3	4	5	NA
5. This learning activity stimulated my interest in the subject matter	1	2	3	4	5	NA

Shape Memory Alloys *(1=strongly disagree, 5=strongly agree)*

	Strongly disagree			Strongly agree		NA
1. The learning activity is interesting.	1	2	3	4	5	NA
2. The information presented in this learning station is easy to understand	1	2	3	4	5	NA
3. I have learned a fair amount of valuable information from this learning activity	1	2	3	4	5	NA
4. The time spent at this learning station was right	1	2	3	4	5	NA
5. This learning activity stimulated my interest in the subject matter	1	2	3	4	5	NA

Physical Properties *(1=strongly disagree, 5=strongly agree)*

	Strongly disagree			Strongly agree		NA
1. The learning activity is interesting.	1	2	3	4	5	NA
2. The information presented in this learning station is easy to understand	1	2	3	4	5	NA
3. I have learned a fair amount of valuable information from this learning activity	1	2	3	4	5	NA
4. The time spent at this learning station was right	1	2	3	4	5	NA
5. This learning activity stimulated my interest in the subject matter	1	2	3	4	5	NA

Microstructure *(1=strongly disagree, 5=strongly agree)*

	Strongly disagree			Strongly agree		NA
1. The learning activity is interesting.	1	2	3	4	5	NA
2. The information presented in this learning station is easy to understand	1	2	3	4	5	NA
3. I have learned a fair amount of valuable information from this learning activity	1	2	3	4	5	NA
4. The time spent at this learning station was right	1	2	3	4	5	NA
5. This learning activity stimulated my interest in the subject matter	1	2	3	4	5	NA

Hydrogels *(1=strongly disagree, 5=strongly agree)*	Strongly disagree			Strongly agree		NA
1. The learning activity is interesting.	1	2	3	4	5	NA
2. The information presented in this learning station is easy to understand	1	2	3	4	5	NA
3. I have learned a fair amount of valuable information from this learning activity	1	2	3	4	5	NA
4. The time spent at this learning station was right	1	2	3	4	5	NA
5. This learning activity stimulated my interest in the subject matter	1	2	3	4	5	NA

Cryogenics *(1=strongly disagree, 5=strongly agree)*	Strongly disagree			Strongly agree		NA
1. The learning activity is interesting.	1	2	3	4	5	NA
2. The information presented in this learning station is easy to understand	1	2	3	4	5	NA
3. I have learned a fair amount of valuable information from this learning activity	1	2	3	4	5	NA
4. The time spent at this learning station was right	1	2	3	4	5	NA
5. This learning activity stimulated my interest in the subject matter	1	2	3	4	5	NA

Thank you!

Appendix C: Proposed Pre-Camp Survey for the 2012 ASM Materials Camp New England

Draft of Pre-Camp Survey Questions

Materials Camp IQP

Disclaimer – Please answer the following questions as completely and accurately as possible. Your responses will not affect your admission to the ASM Materials Camp in any way. This information will only be used to improve the program. There are no correct or incorrect responses; an answer such as "I don't know" is completely acceptable. Thank you!
What is your gender?

- ☐ Male
- ☐ Female
- ☐ Prefer not to Specify

What is your current grade level?

- ☐ Sophomore (Grade 10)
- ☐ Junior (Grade 11)
- ☐ Other: ___________________________

Please indicate whether you agree with the following statements about why you decided to attend the ASM Materials Camp New England program by circling a number between 1 (Strongly Disagree) and 5 (Strongly Agree).

	Disagree				Agree
1) I think it will be informative.	1	2	3	4	5
2) I think it will be fun.	1	2	3	4	5
3) I want to know more about materials science and engineering.	1	2	3	4	5
4) I want to know more about careers in materials science and engineering.	1	2	3	4	5
5) I want to know more about WPI.	1	2	3	4	5

Please indicate whether you agree with the following statements by circling a number between 1 (Strongly Disagree) and 5 (Strongly Agree).

	Disagree				Agree
1) I am strongly interested in pursuing a career in science, technology, or engineering.	1	2	3	4	5
2) A lot of what I have learned about science, technology, and engineering comes from formal classes.	1	2	3	4	5
3) A lot of what I have learned about science, technology and engineering comes from informal activities such as extra-curriculars, outreach programs, independent study, employment, or camps.	1	2	3	4	5
4) I have an accurate idea of what an engineer does on a day-to-day basis.	1	2	3	4	5

Appendix D: Proposed Post-Camp Survey for the 2012 ASM Materials Camp New England

Draft of Post-Camp Survey Questions
Materials Camp IQP
02/2/2012

What is your gender?

- ☐ Male
- ☐ Female
- ☐ Prefer not to Specify

What is your current grade level?

- ☐ Sophomore (Grade 10)
- ☐ Junior (Grade 11)
- ☐ Other: ___________________________

Please indicate whether you agree with the following statements about the ASM Materials Camp New England program by circling a number between 1 (Strongly Disagree) and 5 (Strongly Agree).

	Disagree				Agree
1) It was informative.	1	2	3	4	5
2) It was fun.	1	2	3	4	5
3) I learned a lot about materials science and engineering.	1	2	3	4	5
4) I learned a lot about careers in materials science and engineering.	1	2	3	4	5
5) Student volunteers and professionals significantly influenced my perspective on materials science and engineering in a positive way.	1	2	3	4	5
6) I learned a lot about WPI.	1	2	3	4	5

Please indicate whether you agree with the following statements by circling a number between 1 (Strongly Disagree) and 5 (Strongly Agree).

	Disagree				Agree
1) I am strongly interested in pursuing a career in science, technology, or engineering.	1	2	3	4	5
2) A lot of what I have learned about science, technology, and engineering come from formal classes.	1	2	3	4	5
3) A lot of what I have learned about science, technology and engineering come from informal activities such as extra-curriculars, outreach programs, independent study, employment, or camps.	1	2	3	4	5
4) I have an accurate idea of what an engineer does on a day-to-day basis.	1	2	3	4	5

[These five statements will be presented once for each station:]

Please indicate whether you agree with the following statements by circling a number between 1 (Strongly Disagree) and 5 (Strongly Agree).

	Disagree				Agree
1) This activity stimulated my interest in the subject matter.	1	2	3	4	5
2) The information presented was understandable.	1	2	3	4	5
3) This activity was informative.	1	2	3	4	5
4) This activity was fun.	1	2	3	4	5
5) More time should be devoted to this workstation.	1	2	3	4	5

What specific aspects of the camp did you like, if any?

What specific aspects of the camp did you dislike, if any?

Do you have any suggestions for changes that might improve the program?

Feel free to write any additional comments here.

Thank you for your effort!

Appendix E: Summary of the 2011 Student Survey Responses

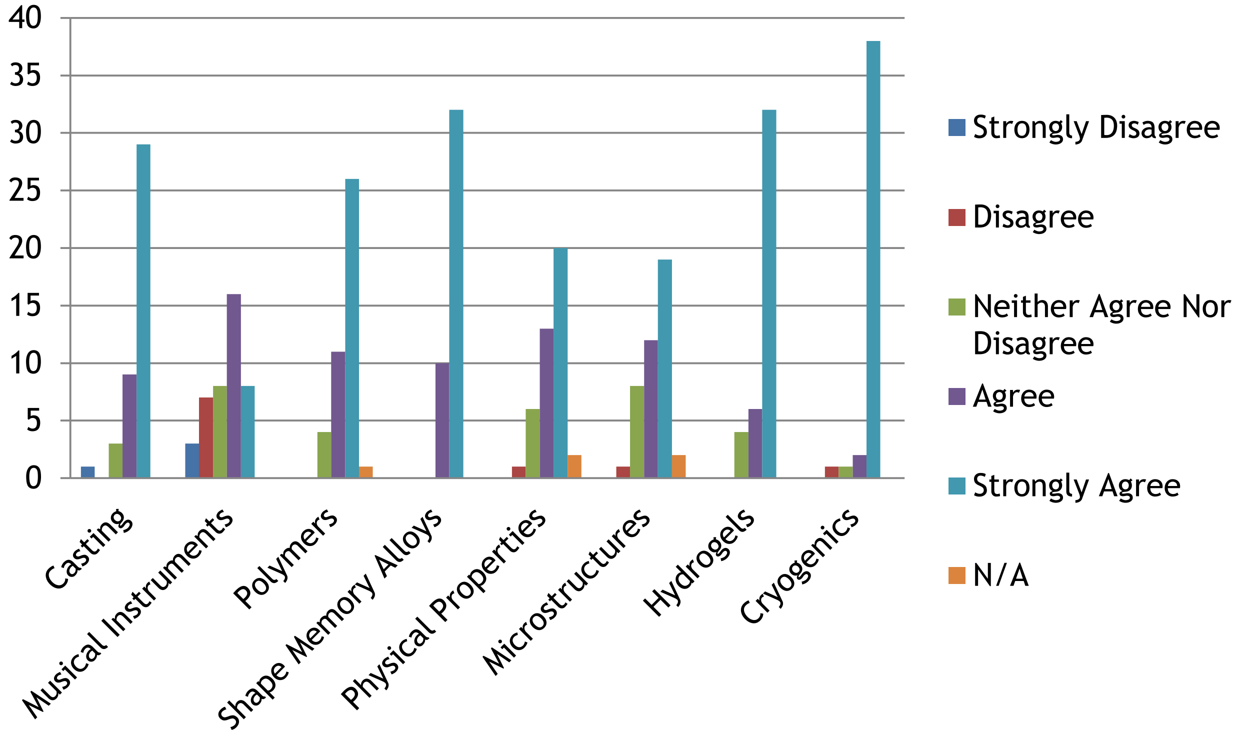

Figure 5: Student responses to the statement "the learning activity is interesting" for each workstation

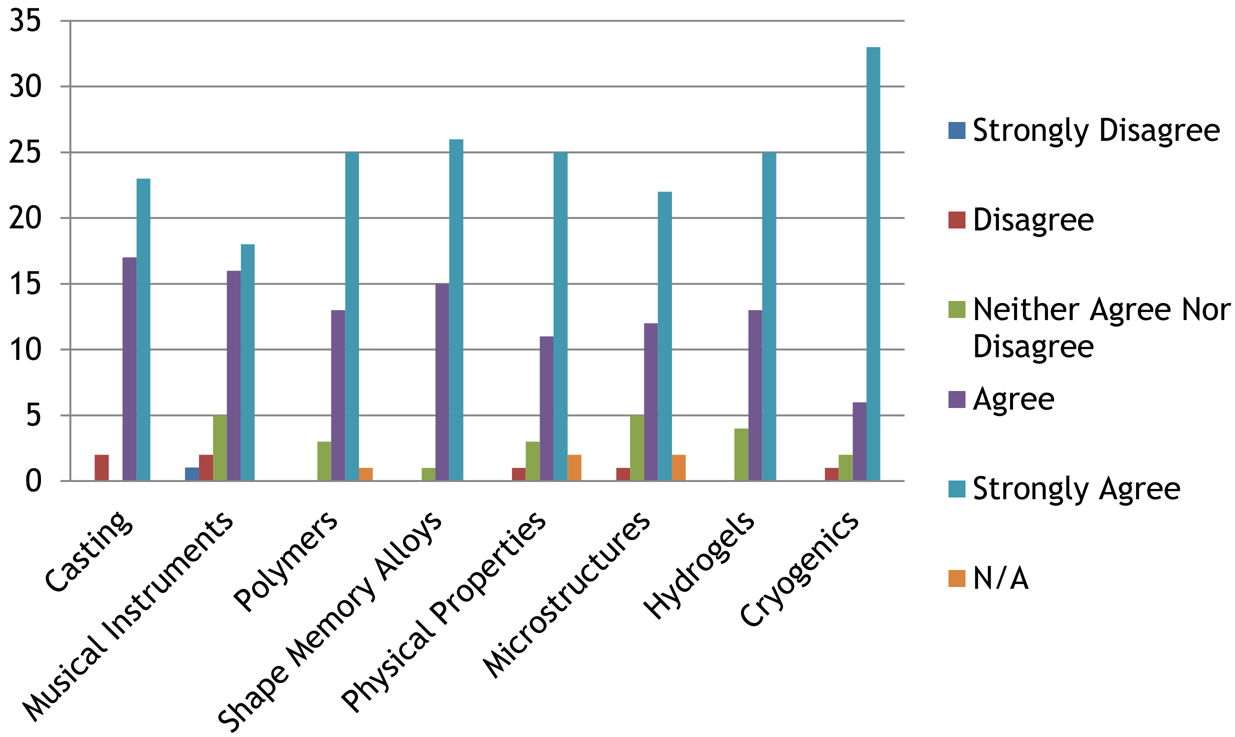

Figure 6: Student responses to the statement "the information presented in this learning station is easy to understand" for each workstation

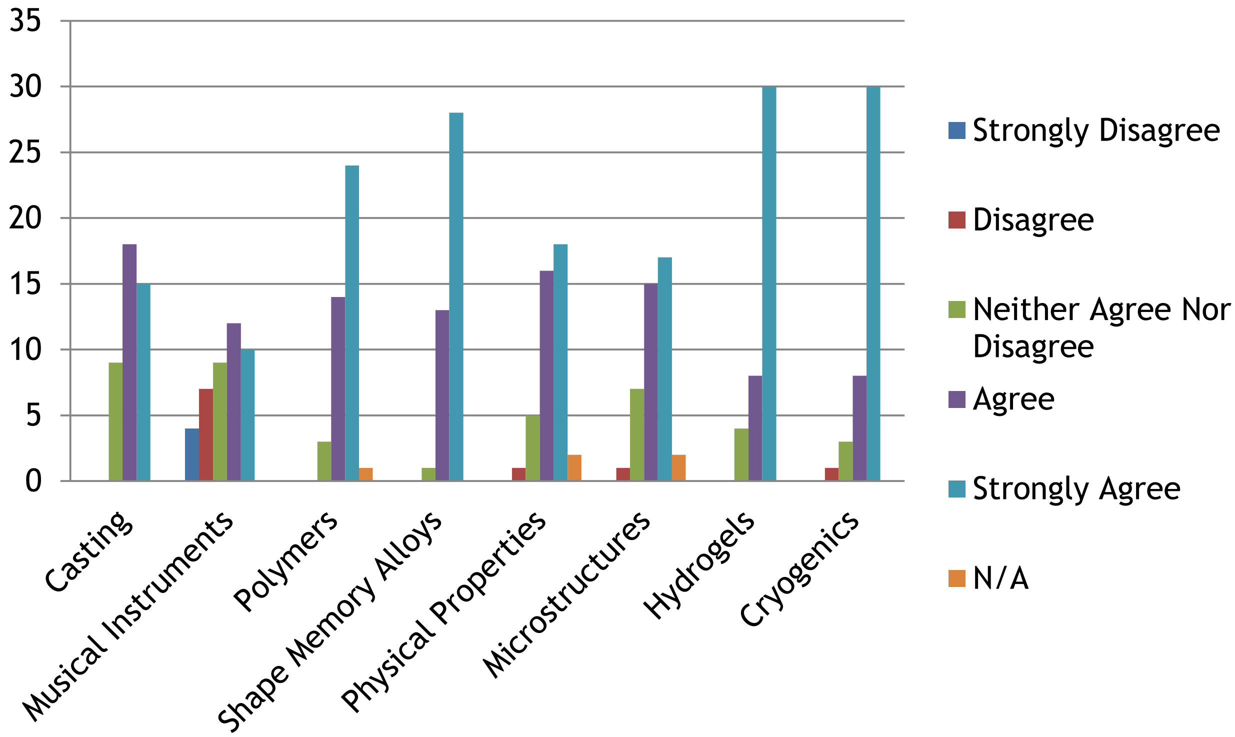

Figure 7: Student responses to the statement "I have learned a fair amount of valuable information from this learning activity" for each workstation

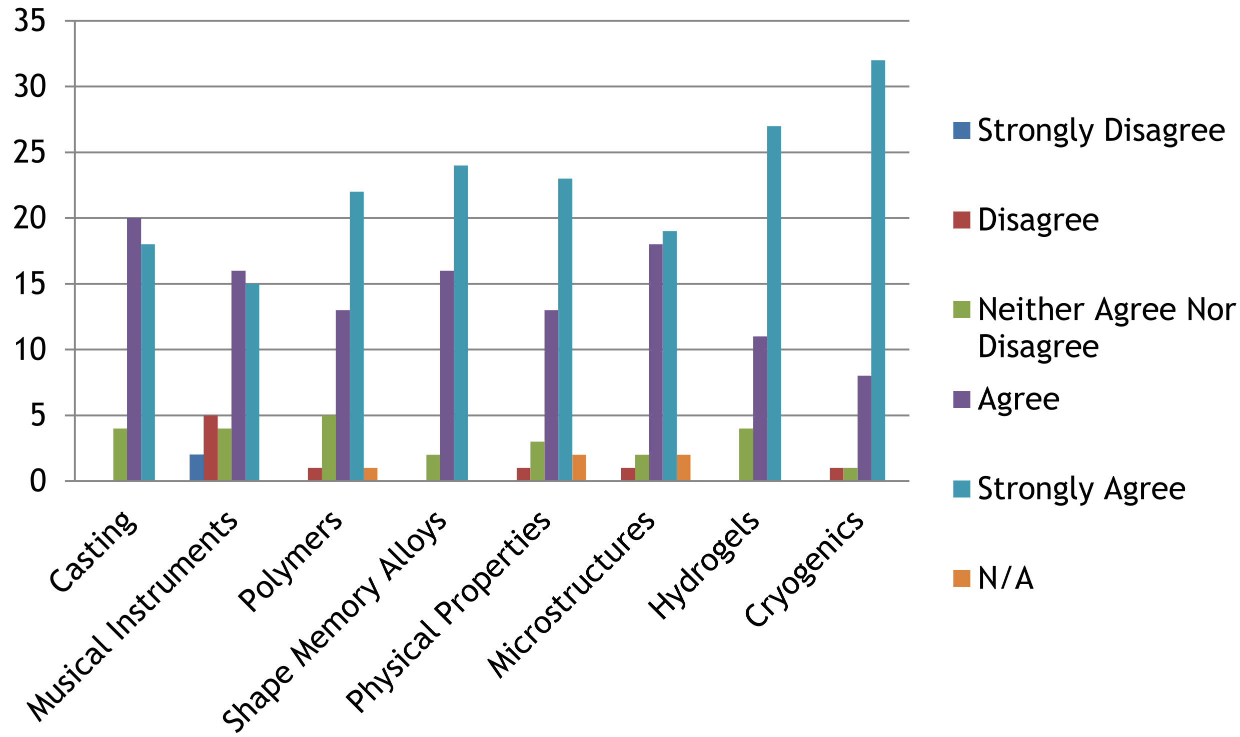

Figure 8: Student responses to the statement "the time spent at this learning station was right" for each workstation

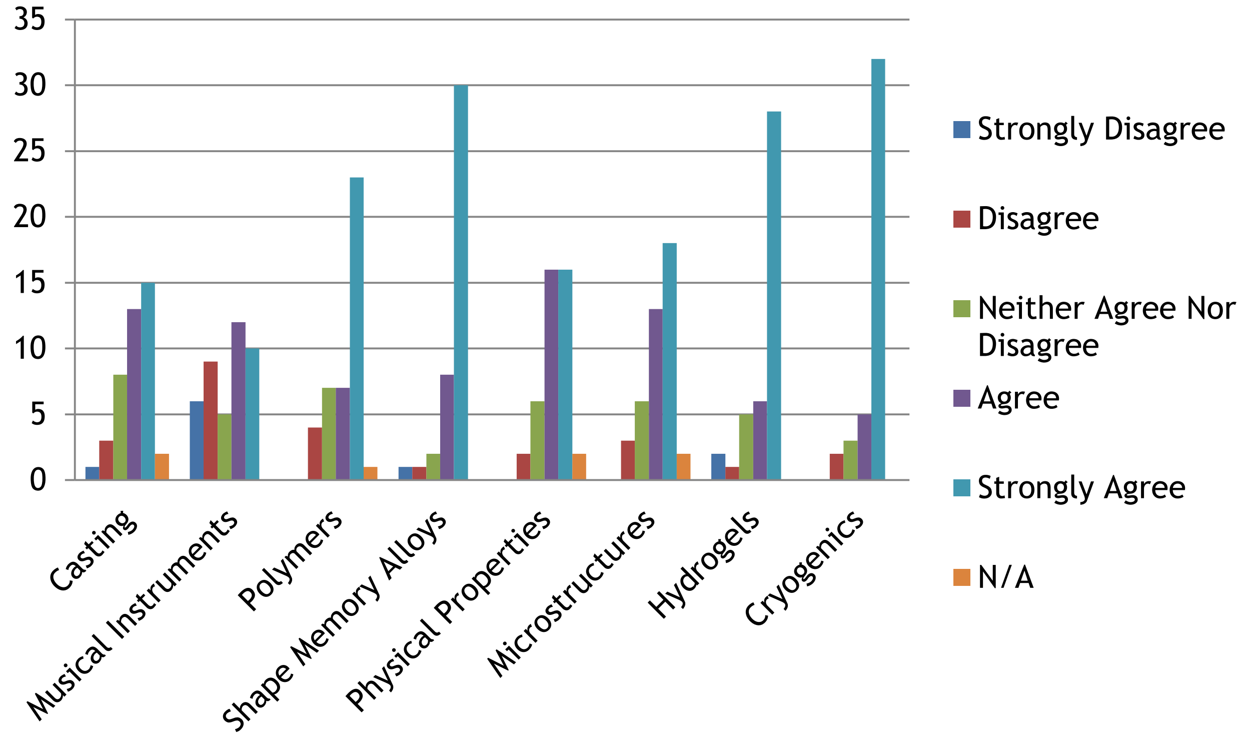

Figure 9: Student responses to the statement "this learning activity stimulated my interest in the subject matter" for each workstation

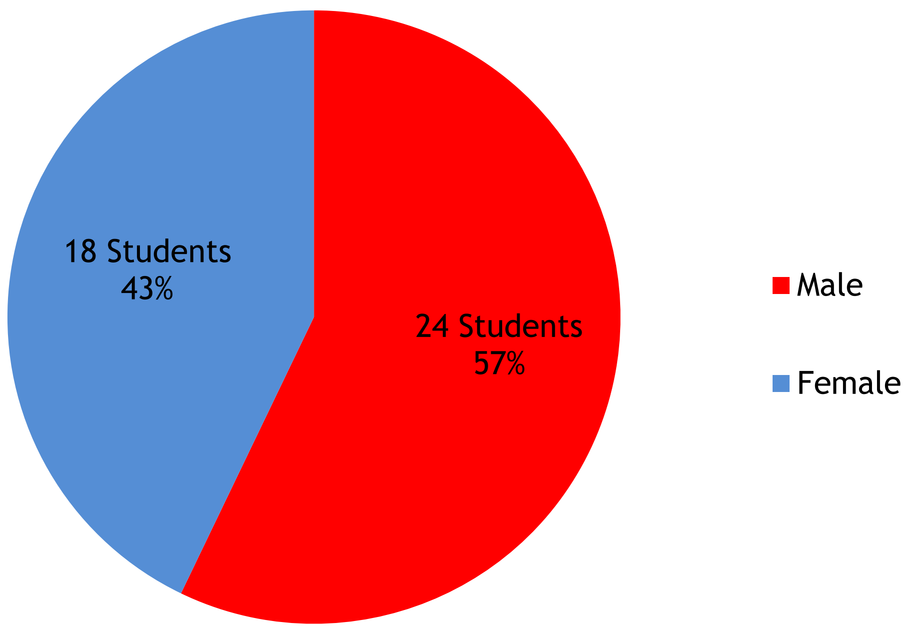

Figure 10: Gender demographics for the 2011 survey responses

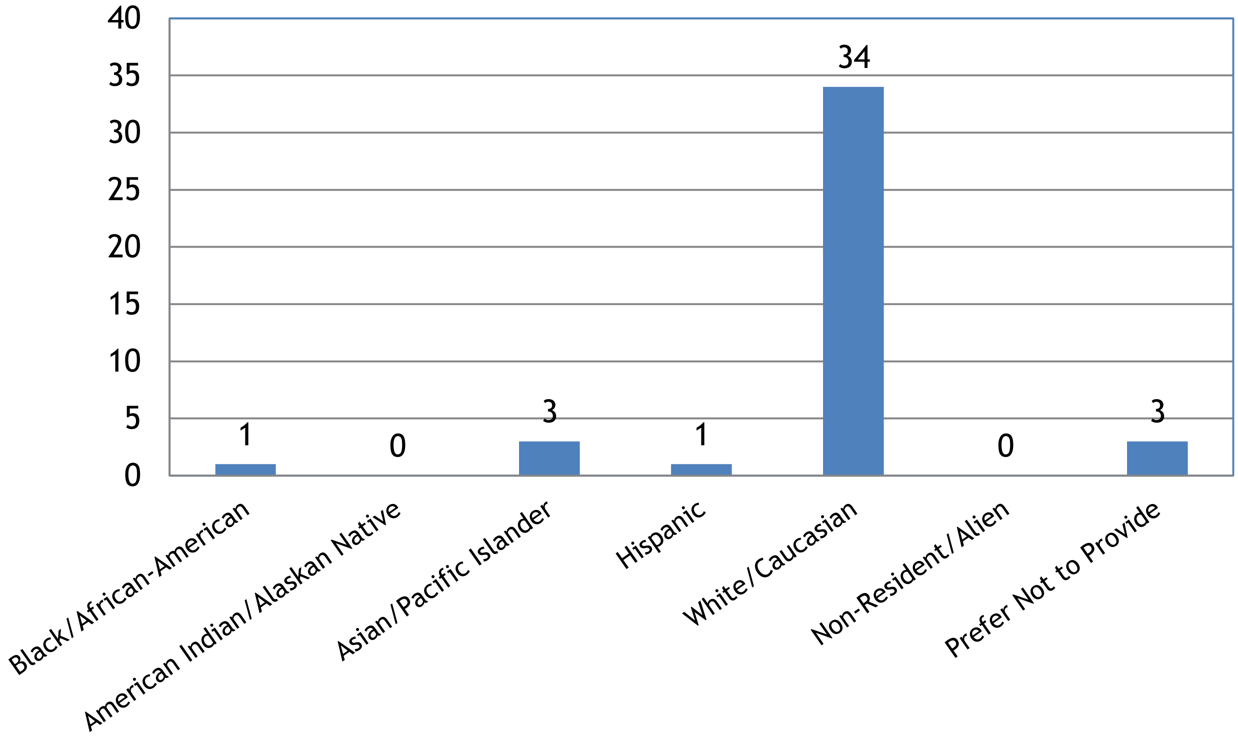

Figure 11: Ethnicity demographics for the 2011 survey responses

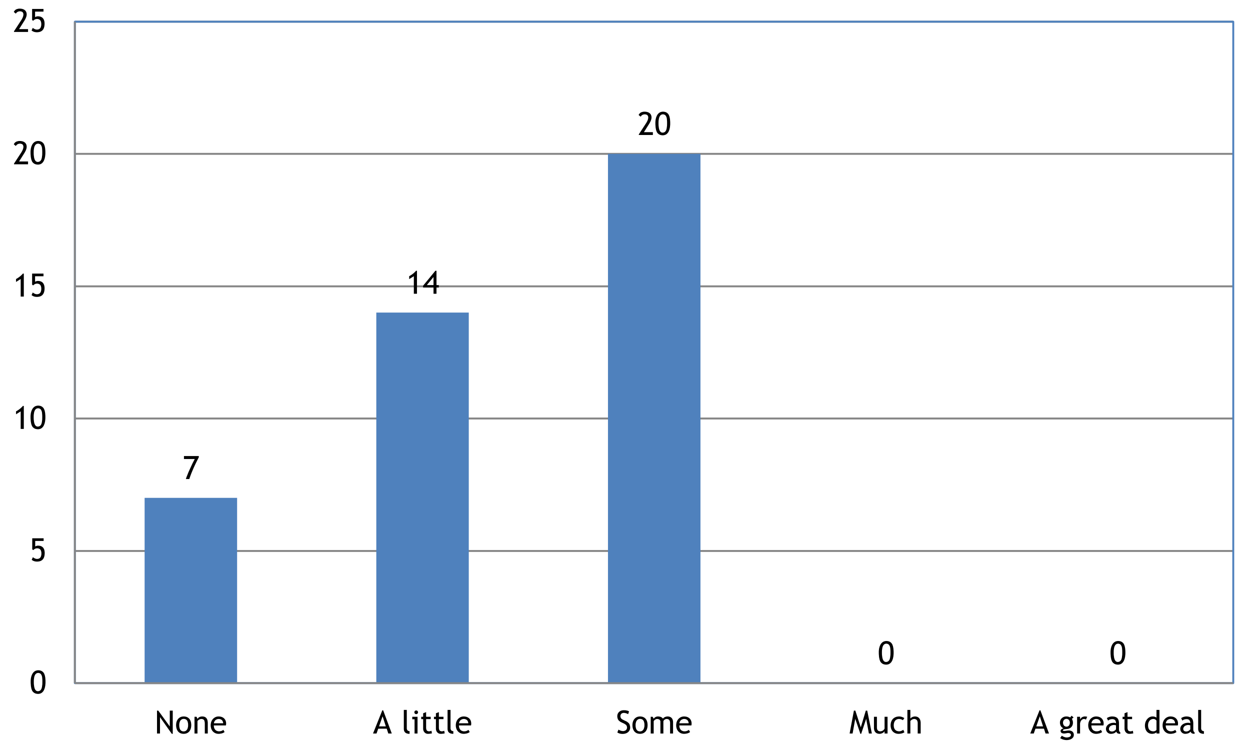

Figure 12: Student responses to the question "how much experience have you had in solving real-life engineering projects or problems?"

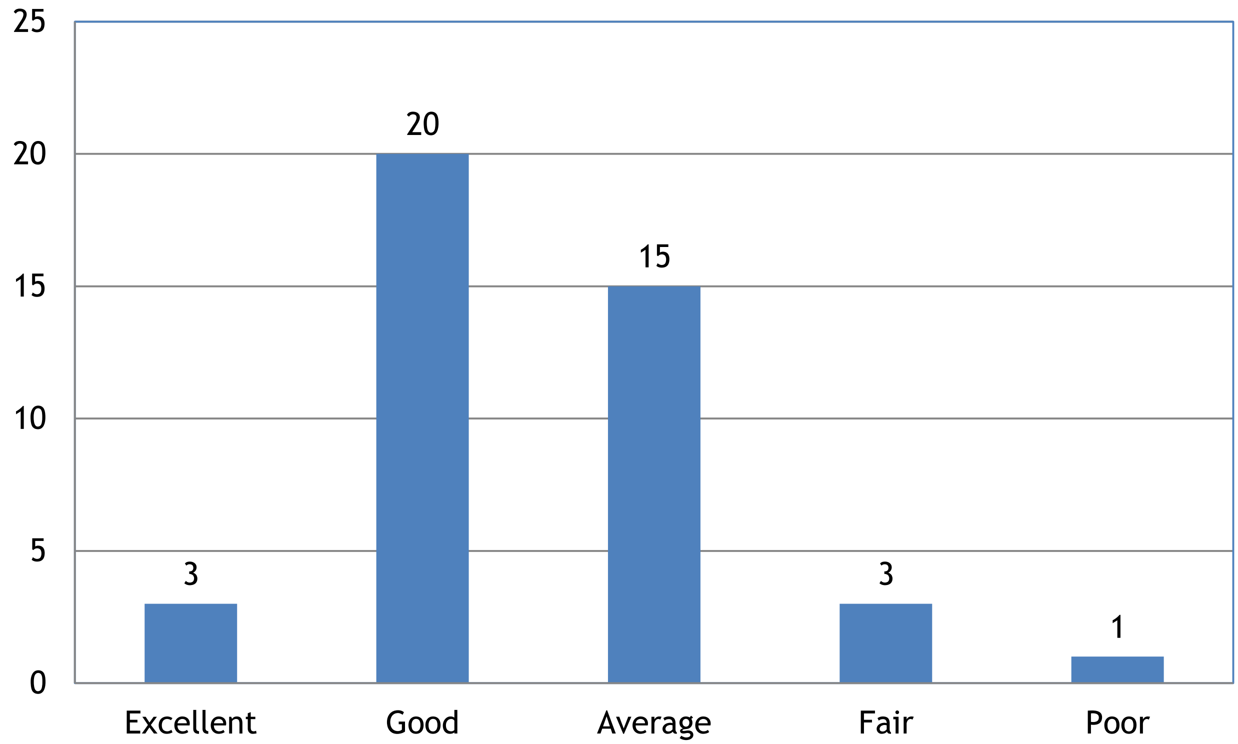

Figure 13: Student responses to the question "how do you rate your ability to solve engineering problems?"

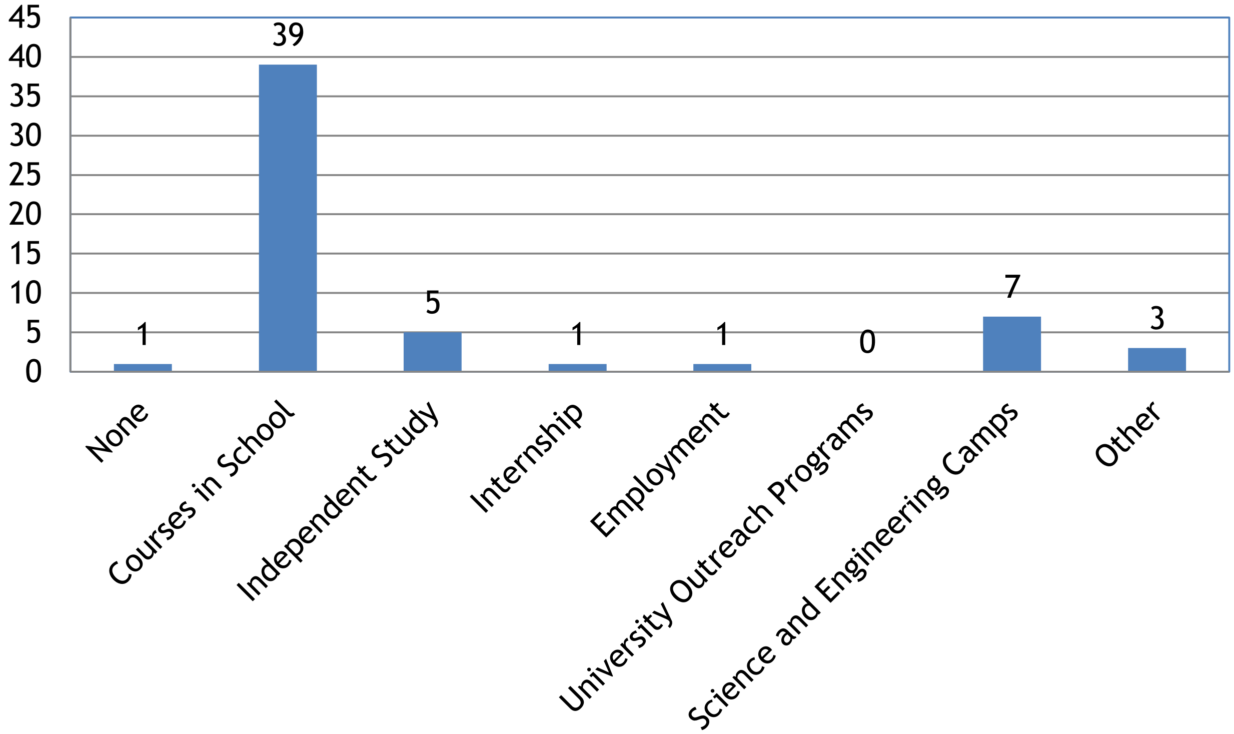

Figure 14: Student responses to the statement "please identify your prior experience with science and engineering"