ASEE's 123rd Annual • Conference & Exposition • New Orleans, LA • June 26-29, 2016

New Orleans JAZZED about Engineering Education

Paper ID #15086

Creation and Implementation of an Open-Ended Design Course for a High School Summer STEM Program (Evaluation)

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Abstract

This evaluation paper discusses the design of a new six week course in the Cooper Union Summer science, technology, engineering, and math (STEM) Program for high school students. Existing courses in the program focused on a single engineering discipline (electrical, chemical, mechanical, or civil) with well-defined projects chosen by the professor. The new course focused on open-ended engineering design and multidisciplinary entrepreneurship. Most courses at the high school level utilize a clear design goal so that students can spend their time in design of a solution and construction. However, there are clear advantages to introducing open ended design to students earlier, including addressing the ABET Criteria parts e) an ability to identify, formulate, and solve engineering problems and h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.[1] It has also been shown that students' intrinsic motivations in the design of a project can inspire further engagement in engineering. The procedure for creating the course materials and methods of instruction are discussed, as well as student project results and a qualitative and quantitative assessment of the course.

Introduction

The Cooper Union Summer Science, Technology, Engineering, and Math (STEM) Program for high school students had undergone a change in teaching and project method over the past four years. Started over twenty years ago, the program had originally been completely funded by donations, with accepted high school students having the opportunity to work on research projects with professors at the university. Now, the program has moved to a course like structure while still including student group research projects in every section. All sections are taught by engineering professors with support from undergraduate and graduate teaching assistants (TAs).

The length of the summer program was 6 weeks in July – August, 2015. Students attended Monday – Thursday each week from 9:30 am – 3:30 pm with an hour break for lunch, and the program was non-residential. Courses were offered that focused on mechanical, electrical, civil, and biomedical engineering, as well as two courses that focused on multidisciplinary problem solving and design. Of those two, one focused on green energy solutions and the other was an open-ended product design course that focused on entrepreneurship and global or personal problems that required an engineered solution. Because the course utilized a makerspace type environment, it was referred to by the faculty and students as the "Makerspace" course. This paper will address the creation and implementation of that course. The research questions for the course were whether high school students can successfully complete an open-ended engineering design project and if such projects can increase confidence that these students can study and enter STEM fields.

In addition to the course specific lectures and laboratory work, the Summer STEM Program included several seminars and workshops for all sections to teach students about patent law, technical writing and presentation skills, college admissions, and careers in engineering and STEM. There was also a general mid-way assembly featuring a panel on Women in STEM and inclusion.

Literature Review

Teaching the engineering design process with a project based course can be a good introduction to engineering concepts for high school students. From the Next Generation Science Standards (NGSS) on engineering design, "students are expected to be able to define problems – situations that people wish to change – by specifying criteria and constraints to acceptable solutions; generating and evaluating multiple solutions; building and testing prototypes; and optimizing a solution."[2] The NGSS also discusses how these practices and definition have not been included in previous science standards for K-12 education. As these practices become more popular in K-12 engineering education literature, summer STEM programs and intensives are including the engineering design process in their curriculum.[3, 4]

The engineering design process can also be a way to enforce STEM concepts while increasing student interest in engineering work and majors. Wicklein provided five reasons why emphasizing engineering design for high school technology education would be beneficial. Specifically, reasons include using engineering design as a framework to design and organize any curriculum and to integrate students' studies in mathematics, science, and technology.[5]

There has also recently been a push to include multidisciplinary open-ended design in first-year engineering courses. Previously, many established first year engineering programs and most high school summer STEM programs utilized robot projects or predefined problems to teach engineering design. However, assigning students a problem to solve diminishes some of the engineering design process, which often starts with a questioning, iterative brainstorming session to identify problems on a global or personal scale that can be solved by an engineered solution or product. From Bandura, self-efficacy is defined as "people's beliefs about their capabilities to produce effects."[6] First-year engineering programs have shown that including the engineering design process with an entrepreneurial aspect can improve student self-confidence in their abilities.[7] As first-year programs move to these types of projects, there is more curriculum and research to adapt the material to high school programs.[7, 8]

Correspondingly, several universities have researched the effects of outreach and service-learning on undergraduate engineering and high school student interest and retention in engineering.[9] Emphasizing service projects or engineered products that address a societal need at the high school level can increase project involvement.

Finally, a condensed version of an academic makerspace was created for this course. Recent research and growth of makerspaces in large universities has shown that they can foster engineering design and independent multidisciplinary student-led projects.[10] As the idea becomes more popular, smaller makerspaces are being adopted by libraries, high schools, and K-12 STEM programs.[11]

Methods

Course Materials and Preparation

The course was taught as a double section – there were 41 students with two professors and seven TAs. For the first week of the course, the students were divided into two classes based on prior experience. After the first week, the two sections were combined into one, larger class section. One professor teaches computer science at the high school level, and one professor teaches first-year engineering design. The TAs were interviewed before the start of the summer program and were selected based on their previous project, product design, coding, computer aided design (CAD), and teaching experience. Four of the TAs were studying mechanical engineering, two were studying electrical engineering, and one was studying chemical engineering. They ranged in level from sophomore to senior; all were undergraduates. Five of the TAs had participated in an undergraduate summer elective course where students teamed up to create a marketable invention. Their experience in prototyping and product design from that course was invaluable to the high school Makerspace course.

The 3D printers purchased to create the "makerspace" aspect of the course were from Tinkerine, a Canadian company. The Tinkerine Ditto Pro model prints PLA material only and does not have a heated bed plate. The printers were selected based on their simple and open form factor, so that the students would be able to easily learn how to operate the machines themselves. The open form factor and non-heated bed plate allowed the students to observe their designs and the operations of the printers closely and safely while printing. Tinkerine also provides a strong educational website with many pre-designed labs and designs. In addition to the printers, general lab hand tools and disposable supplies were purchased for the course. They are detailed in Table 1.

Table 1: Maker Space Equipment, Tools, and Materials

	Description	Quantity
Equipment:	3D Printer	8
	Soldering Iron	1
Hand tools:	Plier	8
	Wire Stripper	8
	Tweezer	8
	Palette Knife	8
	X-Acto Knife	8
Materials:	Painter's Tape	1
	PLA Filament	20
	Modeling Clay	1
	Hook Up Wire	10

Student kits for the course were assembled before the start of the program. Each student in the Makerspace course received a Sparkfun Redboard, which is an Arduino UNO alternative. They were also given a cable to connect to the board to a computer and a plastic box with the components listed in Table 2. The components were chosen to give students the basics needed to create many sensor and control circuits.

Table 2: Components Provided in the Individual Student Kits

Part Description	Quantity in Kit
Plastic box with dividers	1
Sparkfun Redboard and connecting cable (USB type A to mini-B)	1
Breadboard, full size	1
DC motor	1
Wireless transceiver (nRF24L01+)	1
Switch	2
Piezo element	1
NPN transistor	2
Diode	2
Temperature sensor	1
Photocell	1
Phototransistor	1
Resistor (various values)	20
Capacitors (electrolytic and ceramic)	2
LEDs (green, blue, and red assorted)	5

Student Demographic Information

The student demographic information for this course is shown in Figures 1 and 2. The gender distribution of the course was roughly equal to the entire program (~37% female students). The course included a higher percentage of students who had completed their junior year than the program (80% and 71% respectively).

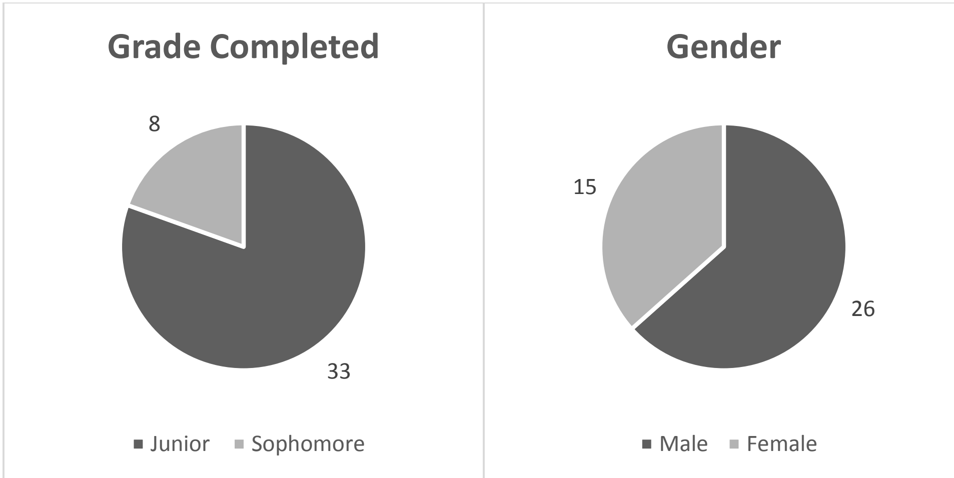

Figure 1: Student Age and Gender

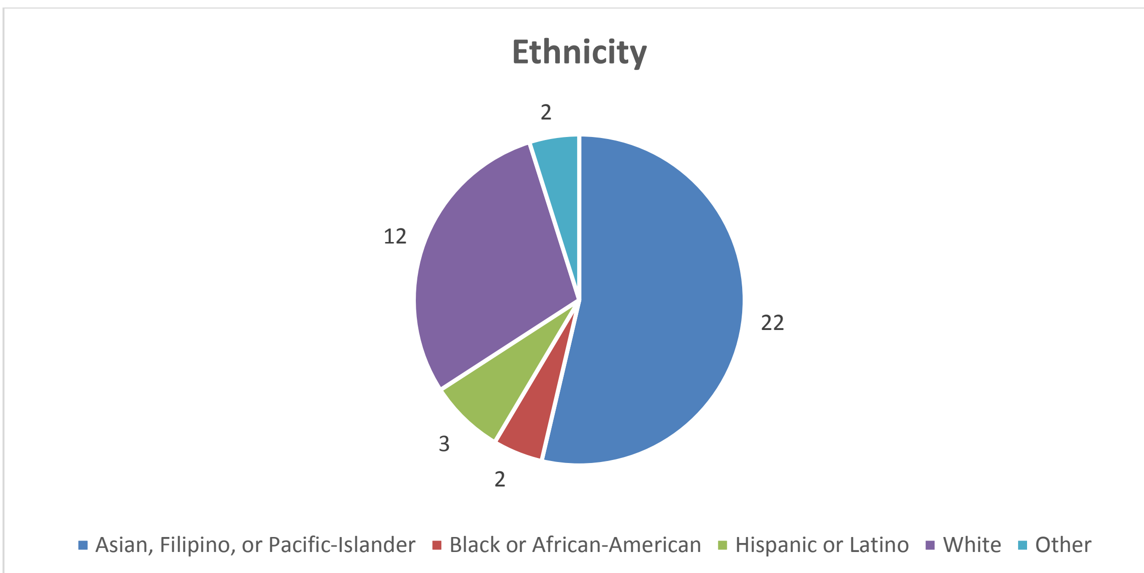

Figure 2: Student Ethnicity

First Week

For the first week, the students were split roughly in half based on prior coding experience, which was not required. The students with little or no coding experience, group #1, were taught Arduino and circuit basics for the first two days. Group #1 used the piezo element, LEDs, and photocell to create a simplistic "alarm clock," which lit up an LED and played a tune when the photocell detected that it was either too late or too dark. This project was used in the first week to teach the basics of algorithm formation, the Arduino IDE and commands, and sensor-control circuits.

The more experienced group, #2, worked through a more complicated Arduino project using wireless communication with the nRF24L01 boards provided in their kit and the ESP8266 wireless transceiver board from Sparkfun. The focus of this project was learning different device communication capabilities and control. The boards were specifically chosen as low cost devices that could be used to develop Internet of Things (IoT) projects (a new and cutting edge means of devices communicating with both the internet and each other). The students learned the basics of creating a server on the board and making the board into an access point (AP) to allow devices to communicate at larger distances. Security concerns when working with connected devices were mentioned, but they were not covered in depth.

Both groups rotated through a CAD tutorial and lab taught by a senior mechanical engineering TA on the third day of the first week. Each student had to create a castle structure in Solidworks. This exercise taught the basics of CAD: how to load and start a design, how to access and create objects in the program, and how to export and generate a completed file to be given to a 3D printer or another user.

On the first day of the program, the students had been given a list of project ideas (shown in Table 3) and a brainstorming session was held. Each students had the opportunity to comment on any project that sounded interesting to them (not limited to the given list). Throughout the first week, as they worked through their labs, the students were instructed to think of what they would be interested in doing for their final project. On the last day of the first week, students spent several hours brainstorming individually with leading questions: what annoys you in your day to day life? What could be improved? What do people need? How could engineering help people? They each came up with three things that bothered them in their daily life or could be beneficial to users. In the afternoon, they each presented to the class their top annoyance or idea as something they would like to work on. The two instructors took notes on student interest during the presentations and then formed the student groups for the start of the second week, taking into account complementing skill sets and whether the students noted they wanted to work on hardware, software, or both. Gender and age were noted while forming the groups in order to achieve a mix of ages and genders in each, but student interest was the deciding factor.

Table 3: Final Project Ideas Provided to the Students

General Subject	Possible Project Ideas
Apps:	• Movie recommender • Chatbot • Geolocation program • Games • Ship or airplane monitor/location finder • Atmospheric conditions based on software defined radio (SDR) • Image processing • RFID or Bluetooth Low Energy (BLE) app with device
Wearable Technology:	• Garment or wearable object that uses solar or renewable energy • Device that tests the air around the user • Clean air monitoring, personal environment monitoring • Wearable speakers or antennas • Glove or gesture controlled device • UV sensor and notification system • Assistive devices for users with disabilities
Home Automation:	• Sensing and control for the university building using data provided by a mechanical engineering professor • 3D printed model of room or several rooms, incorporating sensors and controls • Human presence sensor with microphone • Plant/soil monitor and watering system • Pet feeder • Security monitoring system incorporating new features
Biomedical or Biomechanical:	• Device to encourage working out or assist with losing weight • 3D printed prosthetics • Heart rate monitor with app • Anxiety detection device that provides feedback and/or a calming sensation • Sensors or device that corrects posture

Team Selection and the Second Week

Measures were taken to place students with similar interests in the same group while maintaining a roughly equal group size. With a double course section of 41 students, there were ten groups, with one group having five students. The focus of the second week was building on the fundamentals of prototyping and product design as the student groups finalized their projects.

To start the week, a short lecture was given on the engineering design process. Students then worked in their assigned groups to brainstorm and focus on a single final project. In the afternoon, a senior mechanical engineering TA gave a lecture on 3D printing and design. The focus was on showing the students failed and successful designs that had been printed, so that they could start to understand and think about what the 3D printers should or should not be used for. After another short brainstorming session in their groups, the students were introduced to entrepreneurial invention concepts through the “Lean Launchpad” business concept. They watched the “How to Build a Startup” videos on the Udacity website, a company that offers massive open online courses (MOOCs).

For the rest of the second week, students had the opportunity to start using the 3D printers with test designs. They were not required to print something related to their project; the goal was to allow them to get used to operating the printers themselves. There was always a supervising professor or TA in the maker space room, but independent work was encouraged. Students also worked on their final project proposal (due at the end of the second week) and started prototyping. The week ended with several more startup design videos and the students turned in a list of team member roles and their final project design before attending a college fair at a neighboring university.

Weeks 3 – 6

During the third week, the focus of the course was on selecting materials and parts for the student projects. Each group had a budget of $50.00 to purchase additional, project specific parts; they could also use any of the parts in their individual kits for the project and any parts they found at home. The TAs and professors worked with the students to guide them with sensor options for their desired project outcome. Students sent their final parts list to the professors, who ordered from a variety of suppliers including Amazon, Sparkfun, and Adafruit. Once students had selected parts, they worked in their groups to come up with pseudocode for the operation and programming of their design.

The remaining three weeks of the course were set up as supervised lab and project work time. The professors and TAs asked leading questions and provided help when needed, but the students were encouraged to work on and test their prototype independently. They had access to computers with CAD, Arduino, and Android Studio (app development) software, and lab space in the makerspace. Students who elected to be trained by the university’s shop operators had access to further woodworking and hand tools. In addition, an undergraduate TA operated a laser cutter throughout the program and performed cuts as requested by the students.

For project documentation, each group was required to create a blog (hosted on a free site such as WordPress). During the writing workshop, each team came up with a mission statement for their prototype and a technical description to add to their blog. The students posted semi-daily updates on their prototype development during weeks 4-6 and team member roles and descriptions.

Seminars

During the first two weeks of the program, the students heard a presentation lecture given by an experienced acting coach and a technical writing lecture by a facilitator from the university's writing center. The acting coach demonstrated voice, eye contact, gesture, and body language presentation techniques. Short seminars were also held on college admissions and STEM careers. In the third week, a patent lecture was given by one of the university professors with a law degree and entrepreneurial experience.

During weeks 4-5 of the program, the acting coach and writing facilitator visited individual classrooms to work with students on technical writing and presenting. For the Makerspace course, the focus of these workshops was to create a technical description of their prototype and to practice presenting in front of the class. In week 5, each team created and gave a project presentation to the acting coach. Both the coach and the course professors gave feedback to each student which helped them prepare for their final presentations. On the last day of the program, students presented their project work to all students, faculty, and guests of the program.

Analysis of Results

The success of the student projects was assessed qualitatively by the professors based on the groups' final presentations and prototype. If the students within a team were positive about the work they had accomplished over the summer, able to effectively present their design process and work, and the prototype was at least partially functioning, the project was considered successful. As shown in Table 4, students choose a mix of suggested project ideas and their own, though the majority of projects were in the wearable technology subject area.

Projects that students associated with personally were generally successful. The "LightHouse" team all experienced the aggravation of falling asleep on the train and missing their stop. "The Anxiety Avengers" team had all experienced anxiety or anxiety attacks about something or some event. Likewise, projects that answered or addressed the question "What do people want or need?" like the "Exo-Hand," "My Air," "Soulrunner6," "The Omnishoe," "TIPS," "LightHouse," and "The Anxiety Avengers" were successful.

Teams and projects that were less successful were either too ambitious for the program length ("Energy Kicks," "H.E.L.P. Drone," "Seahawk") and/or experienced teamwork problems during the initial group brainstorming sessions ("H.E.L.P. Drone," "Seahawk"). In the second case, students wanted to build a specific device (a drone) and spent the majority of their second and third week design time vacillating between that topic and several others, until they were forced to start implementing a design and prototype. One way to address this would be to enforce stricter project guidelines for students who wish to do a project not based on the suggested topics. For example, the requirements could be that team project ideas must satisfy a global or societal need, create a STEM outreach project, or come up with a new idea within the general subject areas given. Issues with teamwork could be addressed by having more flexible team sizes. There was not a specific reason why the teams needed to be roughly equal since the teams were not competing against each other. Allowing for flexibility with smaller teams (2-3 students) might make it easier for some teams to agree on an idea. A short lecture on teamwork and behavior during brainstorming and enforcing a teamwork agreement could also help high school students work together more effectively.

Table 4: Final Projects Created During the Course

Student Project Name	General Subject	Prototype or Design Goal	Based on Suggested Topics?
"Energy Kicks"	Wearable Technology	Shoes that generate electricity	Yes
"The Anxiety Avengers"	Wearable Technology	Watch to detect and help anxiety attacks	Yes
"H.E.L.P. Drone"	Home Automation/Drone	Rescue boat and homing device	No
"Exo-Hand"	Biomechanical	Assistive exoskeleton for users with difficulty grasping	Yes
"Seahawk The Amphibious Bicopter"	Drone	Drone that can operate in water and air	No
"Soulrunner6"	Wearable Technology	Wearable music player that matches music tempo to runner speed	Partially
"My Air"	Wearable Technology and App	Device to test air quality and gas presence with interactive app	Yes
"The Omnishoe"	Wearable Technology/ Industrial Design	Shoe with swappable soles	No
"Technical Indoor Positioning System (TIPS)"	App with Hardware	App to provide indoor directions based on beacon signals	No
"LightHouse by TrainTech"	Wearable Technology and App	Armband to wake train travelers with app to input destinations on NJ transit	No

To assess the efficacy of the program, entry and exit surveys were administered to the students. A parental consent form was sent out for the two surveys, and students were only given the survey to fill out if consent was given. The entry and exit surveys included gender, ethnicity, and course questions. The entry surveys also included questions for admissions research such as where the student heard about the program and if they had applied and been accepted to other programs. The entry surveys asked if they had any other experience with science or engineering research projects and envisioned career field. The exit surveys included program evaluation questions. A selection of the questions are presented in Figures 3 and 4, and the full surveys are shown in Appendix A of the paper.

*Please answer the following questions either yes (**Y**), no (**N**) or don't know (**NA**).*

I am planning to attend college.	Y N NA
If I attend college, I intend to study science or engineering.	Y N NA
I know exactly what I want to do after high school.	Y N NA
I understand what scientists and engineers do.	Y N NA
I feel academically prepared for college.	Y N NA
I am familiar with the college environment.	Y N NA

Figure 3: Selection of Entry Survey Questions

I am planning to attend college.	Y N NA
If I attend college, I intend to study science or engineering.	Y N NA
This summer, have you changed your mind about what you want to study?	Y N NA
I know exactly what I want to do after high school.	Y N NA
I understand what scientists and engineers do.	Y N NA
I feel academically prepared for college.	Y N NA
I am familiar with the college environment.	Y N NA
I am more aware of college admission procedures.	Y N NA
I feel more comfortable making technical presentations.	Y N NA
I am more aware of my own speaking/presentation skills.	Y N NA
I plan to apply to Cooper Union for undergraduate studies.	Y N NA
I am more aware of what is needed to obtain a job.	Y N NA
I fully understand my project.	Y N

Figure 4: Selection of Exit Survey Questions

Both the entry and exit survey contain redundant questions. It can be seen in the full surveys that the ethnicity options on the surveys do not match the options offered to students on their application (shown in Figure 2 of this paper). Also, as can be seen from these selections, the surveys do not adequately address engineering learning outcome assessment. There is a single question about this on both surveys: "I understand what scientists and engineers do." The structure of the program as a summer camp instead of a year or semester long course is one reason why the surveys might not have contained these questions. The courses do not have homework or tests and are conducted more like a summer research project (which is how the program was originally set up). However, the program as a whole needs to implement an improved survey with additional questions focusing on student STEM concept knowledge and self-efficacy in order to improve.

The surveys have a single question about students' individual course or project: "I fully understand my project." Of the 200 students in the entire program, 122 completed an exit survey. Of the 41 total students in the Makerspace course, 22 completed an exit survey. The Makerspace answers were compared to the answers of students in the other courses and the program as a whole. For this new course, 95% (21 out of 22) of the students surveyed said that they fully understood their project. This is the highest response across all other courses and the program as a whole and is shown in Figure 5. For the other courses, the percentage of students who fully understood their project varied from 59% – 93%.

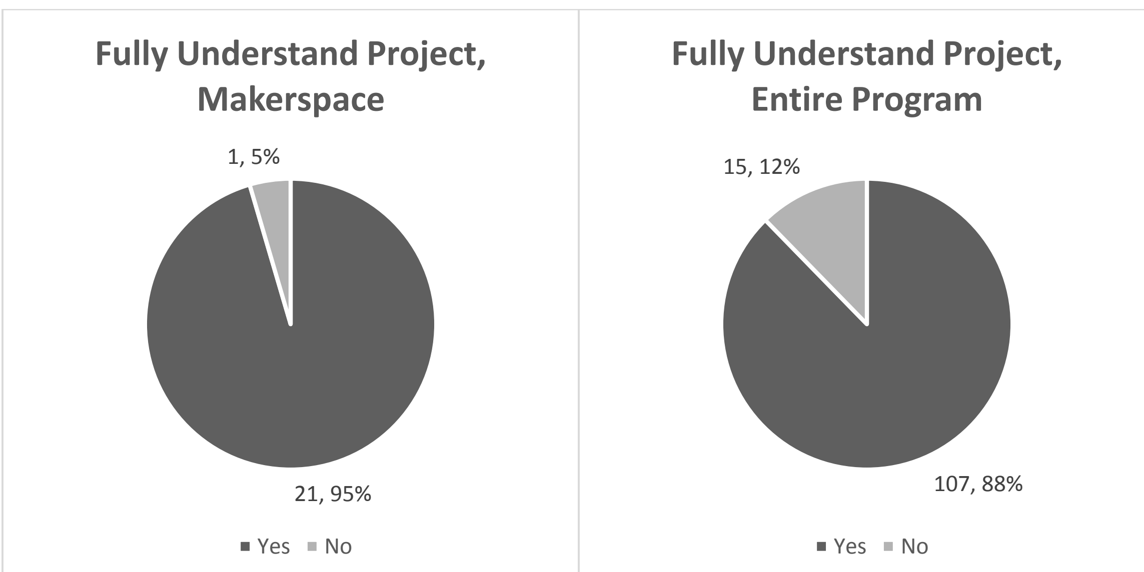

Figure 5: Student Self-Assessment of Project Understanding

The response to the second and third questions on the exit survey assessed student interest and confidence in their ability to major in science or engineering. The percentage of students who responded that they plan to study science or engineering, if they go to college, was highest in the Makerspace class. This is shown in Figure 6, and responses for the other courses ranged from

59% – 93%. However, the next question on the survey ("did summer change their mind") impacts the interpretation of those responses and is shown in Figure 7. A lower percentage of students indicated that this course and summer program changed their mind about what they planned to study (the third question in Figure 4). This could be partially due to the higher concentration of older students (those who had completed their junior year) in the Makerspace class. Older students might have previously been exposed to STEM concepts or decided to study STEM before entering the program.

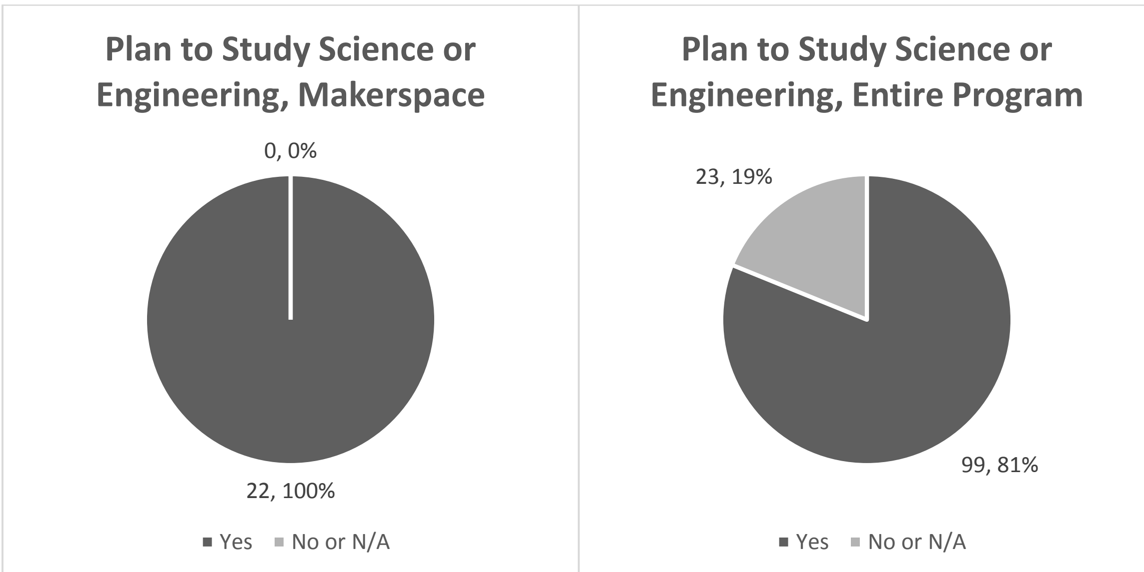

Figure 6: Student Response on Future Plans

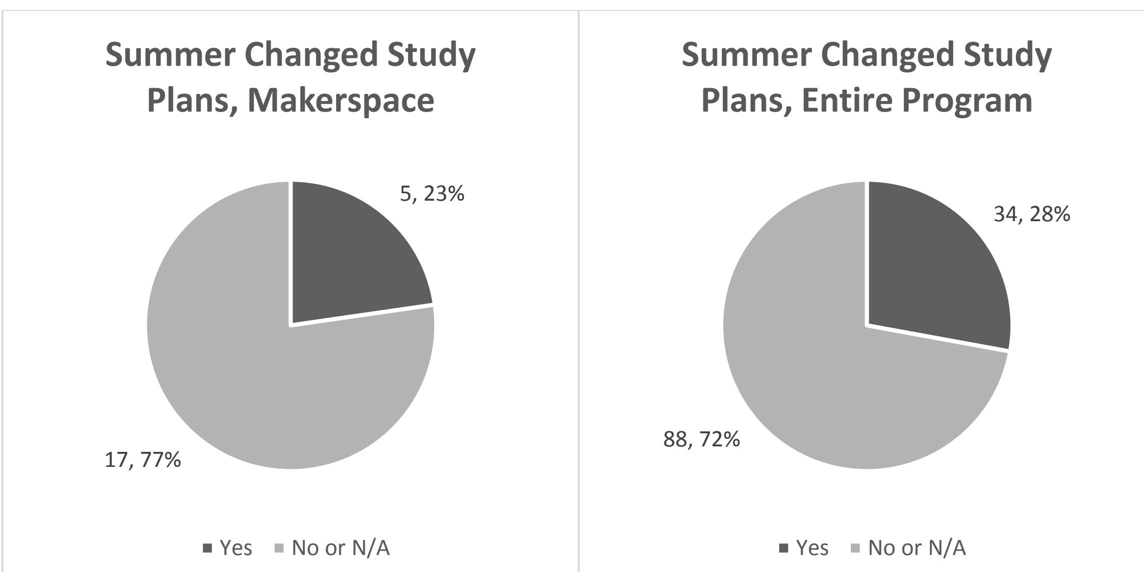

Figure 7: Student Response on Change in Future Plans

Finally, Figures 8 and 9 show the response to the question “I understand what scientists and engineers do” from the entry and exit surveys for the Makerspace course and the entire program. All respondents in the course felt that they understood what scientists and engineers do by the end of the program. The program wide responses also improved from 88% to 90%.

The responses to Figures 5 – 9 demonstrate that student confidence in engineering project design abilities and interest in studying science or engineering increased through the course compared to the pre-defined projects taught in other courses. The open-ended project options allowed students to take ownership of their projects and student groups were encouraged to work independently. By conducting their own background research and attempting to engineer their own solution or product, student self-efficacy was bolstered as they proved to themselves that they could complete their prototypes.

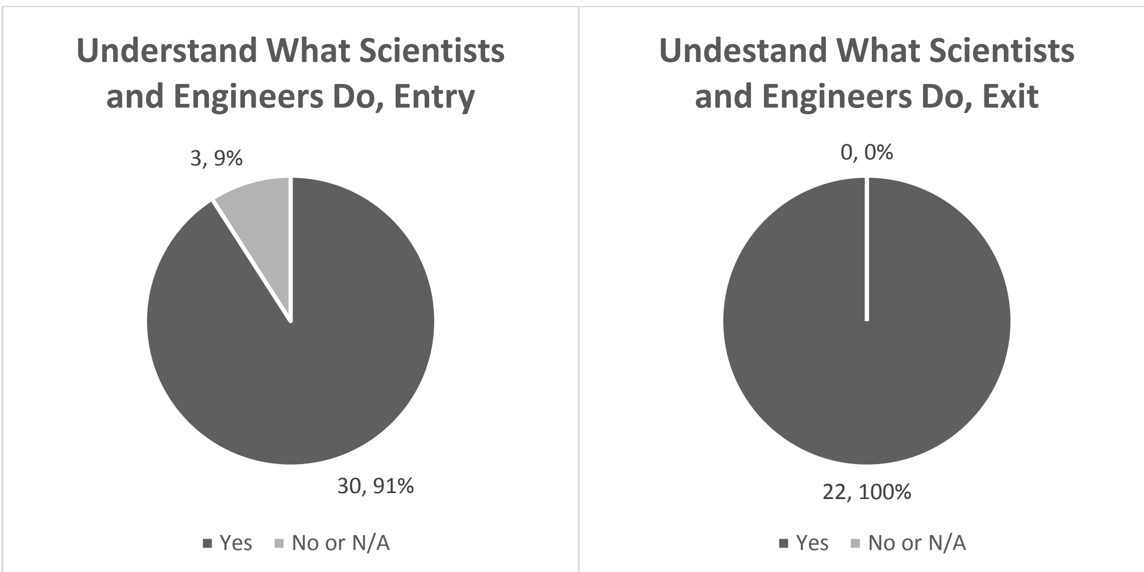

Figure 8: Student Response on STEM Career Understanding, Makerspace

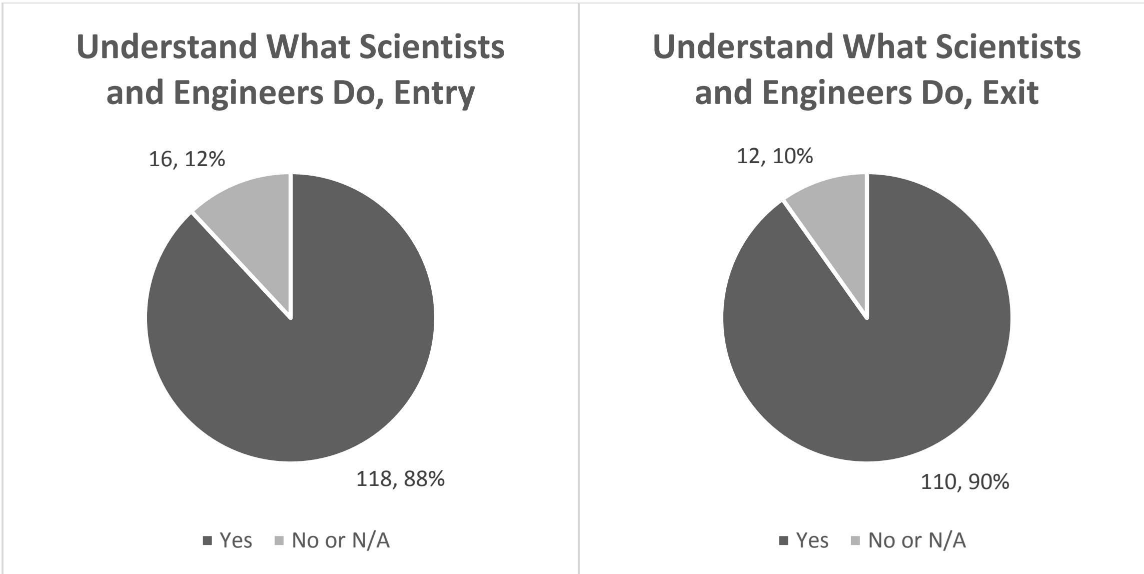

Figure 9: Student Response on STEM Career Understanding, Entire Program

While the documentation requirements of the course and program were kept light in order to maximize lab and student project work time, both could have been greatly improved with additional documentation. Starting and enforcing daily checklists from the student teams within the second week would have helped to keep brainstorming and initial design work on track. Student blogs should have been started earlier. Program-wide, improved entry and exit surveys with Likert scale responses would allow for additional analysis of the course, student project motivation, and student self-assessment across gender, age, and previous STEM experience and interest. From the limited answers and data points collected, the course was the most successful at either increasing or inciting student interest in STEM fields and confidence in their engineering project design work.

Conclusion and Recommendations

The engineering design process can be a way to enforce STEM concepts while increasing student interest in engineering work and majors. Having a multidisciplinary, open-ended project based course can improve self-efficacy based on the assessment results of the course surveys. At the end of the program, 95% of the respondents in the Makerspace course felt that they fully understood their project. Also, 100% of the respondents were planning to study science or engineering if they planned to attend college. Both of these responses were the highest of all offered courses for summer 2015. High school students are more than capable of going through the engineering design process and creating their own designs with the help of TAs and professors.

The electronic parts in the student kits were helpful in starting students with their projects and were given to each student in the course to keep at the end. A makerspace environment was successfully created and utilized throughout the summer, and the students were able to design and print their own CAD creations for their projects. The equipment purchased to build the makerspace for this course is being used as a small undergraduate makerspace throughout the school year to encourage student design and creativity. Undergraduate students active in the makerspace are encouraged to apply to be TAs for the following summer STEM program.

To improve the course, more flexibility in group sizes and emphasizing teamwork are suggested, as well as stricter criteria for student design ideas outside of the suggested topics. Students must be able to define the need they are addressing for their project. Better student documentation of their design process from the start of the course would also improve their project work. A rubric of expected results or desired outcomes should be generated for the student projects and given to the students in the first week. This could include increased documentation requirements and would allow for improved student- and professor- analysis of student engineering design concepts.

To improve the program, updated surveys are needed and highly recommended. Moving to a Likert scale and utilizing assessment tools created by K-12 STEM education researchers will allow for more statistical analysis of the survey responses. Certain questions that were redundant could be replaced by questions more common to the K-12 division. More data points would allow for assessment of response differences across age, gender, and ethnicity. Longitudinal surveys should also be used to assess the long term success of the course in improving student self-efficacy and interest in STEM majors and careers. The authors suggest that these improvements be made for the future across the entire program and analyzed in future papers.

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Appendix A – Entry and Exit Surveys

The Cooper Union for the Advancement of Science and Art

Albert Nerken School of Engineering

Summer STEM Program - 2015 – Student Entry Survey

This survey is voluntary and anonymous. The information that we gather will be used for statistical purposes only. Once, again this survey is optional; however, your participation will help us to improve the program for future students. Even surveys that are completed partially are valuable.

Gender (please circle):	Male Female
How did you learn about this program? *(Please print)*	teacher: ______________________ principal: ______________________ student: ______________________ brochure internet other (please specify): ______________________
Please circle your ethnic origin	African/Caribbean American American Indian/Alaskan Native Asian Caucasian (non-Hispanic) Hispanic Middle Eastern Multi-ethnic Other, please specify: ______________________
Which project team are you in?	iGEM ☐ Saving the World ☐ Makerspace ☐ Digital Electronics ☐ Racecar Design ☐ Hurricane Sandy ☐ Rube Goldberg ☐
Was this project your first choice?	Yes No Please circle

Were you accepted into any other summer program(s): Yes No

If so, which one?____

____

If yes, why did you choose this program:

____

____

____

*Please answer the following questions either yes (**Y**), no (**N**) or don't know (**NA**).*

I am planning to attend college.	Y	N	NA
If I attend college, I intend to study science or engineering.	Y	N	NA
I know exactly what I want to do after high school.	Y	N	NA
I understand what scientists and engineers do.	Y	N	NA
I feel academically prepared for college.	Y	N	NA
I am familiar with the college environment.	Y	N	NA

Have you had any previous experiences in science and/or engineering research? Please circle your response and use the space provided, if needed.	No experience Internship at other college (Where? ____________________) Internship at companies (Where? ______________________) Internship at cultural organizations (Where? _____________) Project at own high school Project at other high school (Where? __________________) Other: _______________________________________
In your future career, what field do you see yourself working in (please circle)?	Business Finance Arts Science/Engineering Public Policy/Politics Professions (Law, Medicine, etc.) Other: _______________________________________

In the space below, please provide us with any other comments you may have.

Thank you for your participation in this survey and best of luck in your enrichment and research this summer!

The Cooper Union for the Advancement of Science and Art

Albert Nerken School of Engineering

<u>Summer STEM Program - 2015 - Student Exit Survey</u>

This survey is voluntary and anonymous. The information that we gather will be used for statistical purposes only. Once, again this survey is optional; however, your participation will help us to improve the program for future students. Even surveys that are completed partially are valuable.

High School:

Please circle your response:

Project:	iGEM ☐	Saving the World ☐
	Makerspace ☐	Digital Electronics ☐
	Racecar Design ☐	Hurricane Sandy ☐
	Rube Goldberg ☐	
Gender:	Male	Female

*Pease answer the following questions either yes (**Y**), no (**N**) or don't know (**NA**).*

I am planning to attend college.	Y	N	NA
If I attend college, I intend to study science or engineering.	Y	N	NA
This summer, have you changed your mind about what you want to study?	Y	N	NA
I know exactly what I want to do after high school.	Y	N	NA
I understand what scientists and engineers do.	Y	N	NA
I feel academically prepared for college.	Y	N	NA
I am familiar with the college environment.	Y	N	NA
I am more aware of college admission procedures.	Y	N	NA
I feel more comfortable making technical presentations.	Y	N	NA
I am more aware of my own speaking/presentation skills.	Y	N	NA
I plan to apply to Cooper Union for undergraduate studies.	Y	N	NA
I am more aware of what is needed to obtain a job.	Y	N	NA
I fully understand my project.	Y	N	

I would recommend this program to others.	Y N
The Summer STEM Program lived up to my expectations.	Y N
If not, why not? *You may circle more than one.*	Faculty Teaching assistant(s) Project Group dynamics Other: _________________
This program has inspired me to pursue my college education in engineering, science or math? If so, please elaborate ________________________________ ____ ____	Y N

ADDITIONAL COMMENTS, SUGGESTIONS OR COMPLAINTS MAY BE ADDED BELOW