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Designing effective STEM outreach activities to inspire students to ultimately pursue careers in the Electrical and Computer Engineering fields

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Designing effective STEM outreach activities to inspire students to pursue careers in the Electrical and Computer Engineering fields (Evaluation)

Abstract: The primary goal of the K–12 education system is to equip students for success beyond high school. Early exposure to college-level opportunities, such as STEM outreach programs, can significantly impact students' academic and career paths. Participation in STEM activities enables students to make informed decisions about their educational and professional futures, potentially increasing enrollment in STEM fields and fostering a more skilled workforce. In line with this mission, Wentworth Institute of Technology offers a pre-college summer Engineering Exploration program, designed to expose high school students to various engineering disciplines over two weeks.

This paper outlines the design and implementation of Electrical and Computer Engineering (ECE) modules within the program, followed by a detailed discussion of the objectives, including deepening students' understanding of fundamental ECE concepts, enhancing their interest in the field, and encouraging them to consider pursuing college degrees in ECE. To assess these modules' effectiveness, we collected quantitative and qualitative data through post-activity surveys. These surveys were crafted to address the following key questions: Were the STEM modules effectively designed? Did the modules inspire students to consider pursuing ECE majors in college? Did students' interest in ECE increase? Did their understanding of ECE-related topics improve? How did students' earlier exposure to the ECE field (if any) help with their interests and engagements with the activities? What adjustments are needed if any of the objectives mentioned are not fully met?

The study analyzes the survey data, examining students' prior exposure to the ECE field, changes in their confidence and interest after attending the module, and their likelihood of pursuing an ECE-related career. The correlations between initial knowledge and increased interest, as well as between increased confidence and career aspirations in the ECE field is explored. The paper concludes with recommendations for refining these outreach activities to enhance their educational impact and students' engagement and interest in the areas of ECE. The objective of the study is to find a direct relationship between increasing interest levels and the training of more professionals who can contribute to the rapid advancement of ECE disciplines, ultimately having a significant impact on improving the world.

Introduction

The Bureau of Labor Statistics (BLS) projects that occupations in Science, Technology, Engineering, and Mathematics (STEM) will grow by 10.4% from 2023 to 2032, significantly outpacing the 3.6% growth expected for non-STEM occupations [1]. The technology sector remains a key driver of this expansion, fueled by advancements and the demand for innovation across industries. Therefore, in response to the growing need for a larger and more diverse pool of STEM professionals—including educators, researchers, and practitioners—governments and educational institutions continue to prioritize STEM education [2]. Data from the National Center for Education Statistics (NCES) highlights a 15% increase in STEM major enrollment over the past five years, with 2024 showing a notable rise in students taking STEM courses at both secondary and post-secondary levels [3].

To attract more students to STEM fields, educators and industry professionals have been implementing innovative strategies, such as workshops, extracurricular activities, and summer camps that provide hands-on experiences and experiential learning in various engineering disciplines [4-5]. These workshops engage students by showcasing the practical application of engineering principles and introducing them to the challenges and excitement of real-world problem-solving. High school plays a pivotal role in shaping students' STEM career trajectories. For those entering the workforce directly, high school is when many solidify career paths, including those in skilled technical STEM fields. For students pursuing higher education, experiences during this formative period help establish their interests and preferences, influencing their choice of major and future careers [6]. Developing initiatives that promote STEM career opportunities for both K-12 and postsecondary students can enhance academic success and pave the way for entry into STEM-related majors and professions [7].

Wentworth Institute of Technology (WIT), located in Boston (MA), has actively participated in numerous outreach initiatives to promote STEM education targeting students of different ages. Girl Scouts is a program that was established in 2014, and participants are girls from 4th or 5th-grade students [8]. Starting in 2016 a STEM program for High School Girls has been offered [9]. In 2020 a new STEM outreach program for first year and sophomore female high school students from a private girls' high school has been initiated [10]. In 2021 our school started a new collaboration with Ron Burton Training Village (RBTV) resulting in a new STEM activity that targets students from 6^{th} to 12^{th} grade [11-12].

This paper presents a STEM outreach program offered at our school for high school students. The program includes a two-week workshop exposing students to various STEM disciplines. This paper specifically focuses on the Electrical and Computer Engineering (ECE) modules conducted over two separate days. Survey data are analyzed and discussed to highlight the strengths and areas for improvement in the designed activities. Feedback from students is used to make recommendations for enhancing the activities, with the goal of increasing interest in pursuing careers or further education in the ECE field.

Workshop

A precollege program was hosted by our university for high school students during the summer. In this program, rising juniors and rising seniors participate in a residential two-week session which introduces the students to our school' majors and campus life. Participants attend lectures, labs, hands-on modules, and field trips similar to those done by our school's Year 1 students. The structure of the program is as follows. Each day, Monday through Friday, students attend a morning session from 9:00am to 12 noon and an afternoon session from 1:00pm to 4:00pm facilitated by faculty members. Social activities are scheduled on most evenings and are typically run by undergraduate students and Admissions staff.

One of the sessions delivered by the School of Engineering faculty is Engineering Exploration. Participants of this session are exposed to each of the Engineering majors or concentrations offered at our university. In Engineering Exploration, students spend one day participating in modules in each of the following: Introduction to Engineering, Civil Engineering, Computer

Engineering, Electrical Engineering, Mechanical Engineering, Biomedical Engineering, Biological Engineering, Electromechanical Engineering, and Robotics. This paper focuses on the Electrical Engineering and Computer Engineering modules.

EE Module

The morning session served as an introductory activity aimed at introducing students to fundamental concepts of electrical engineering, such as voltage, current, and resistance. It also included hands-on instruction on using basic benchtop equipment and building circuits on a breadboard. In the afternoon session, students applied their acquired knowledge to build and test an EKG circuit, enabling them to visualize their heartbeats.

Morning Session

The morning session began with a 15-minute lecture introducing the activity and explaining fundamental electrical engineering concepts such as charge, current, voltage, and resistance. Following the lecture, students were given a booklet outlining the exercises for the morning session and several packages containing all the required components. The session was modular, consisting of multiple independent activities, allowing students to work at their own pace. Initially, students familiarized themselves with basic components such as resistors, capacitors, LEDs, and breadboards. They then began building DC (direct current) and AC (alternating current) circuits, taking measurements with benchtop equipment and recording their results in the provided booklet. The exercises included:

1. Measuring Resistance: Students were given multiple resistors and tasked with measuring their resistance using a digital multimeter (DMM).
2. Measuring Capacitance: Students used an LCR meter to measure the capacitance of three provided capacitors.
3. Performing a Continuity Test on the Breadboard: Students conducted a continuity test using the DMM to understand the socket connections on the breadboard, ensuring they could correctly build circuits.

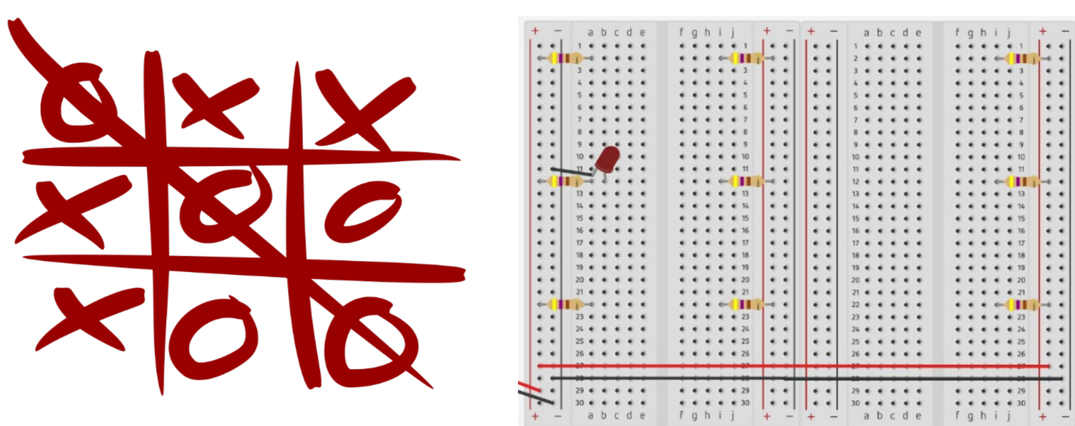

Fig. 1: Tic Tac Toe game

4. Building DC and AC Circuits with LEDs and Resistors: Students calculated the resistor needed to limit the current in an LED, built the circuit, tested it under DC and AC conditions, and reversed the resistor to test it again.

After completing these foundational exercises, a fun and engaging activity was introduced. Students built a Tic Tac Toe game using LEDs and played multiple rounds, as shown in Figure 1. All groups successfully completed the tasks and had time to enjoy the game and play it multiple times.

Afternoon Session:

The afternoon session of the program consisted of a hands-on experience to explore a real-world application in an electronics laboratory. To develop professional skills, one must begin by keenly observing the world around. With the hopes of empowering future engineers to notice the interconnected systems at play in our world, an Electrocardiogram (EKG) circuit for the Electrical Engineering module was developed [12]. The circuit diagram of the introduced EKG circuit is shown in Figure 2 while Figure 3 shows the connection diagram provided to students to build the EKG circuit in the lab. During the afternoon session, students constructed the circuit shown in Figure 2 and Figure 3, evaluated it with a test signal, and then used it to collect the human heart's waveform by connecting the circuit to their body using Biopac electrodes. They utilized the lab's oscilloscope to observe the output signals of the circuit, whether in the evaluation or data collection mode. In the testing mode, the gain of the circuit (amplitude of the output voltage divided by the amplitude of the input voltage) was explored, the EKG circuit in the testing mode is shown in Figure 2. In the data collection mode, the input voltage source was replaced by two connections that were on one side attached to students' right and left forearms via Biopac electrodes, and on the other, to the input terminals of the circuit. One electrode was also attached to the ankle acting as the ground for the circuit. Students took advantage of the capabilities of the advanced oscilloscopes in the electronics lab to apply a low-pass filter to the EKG signal and reduce the noise to obtain a reasonable result.

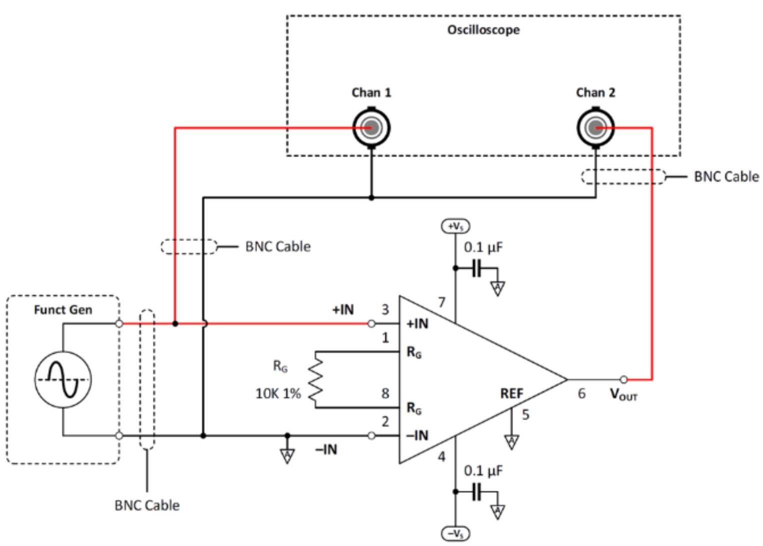

Fig. 2: Circuit diagram of the EKG circuit in the testing mode

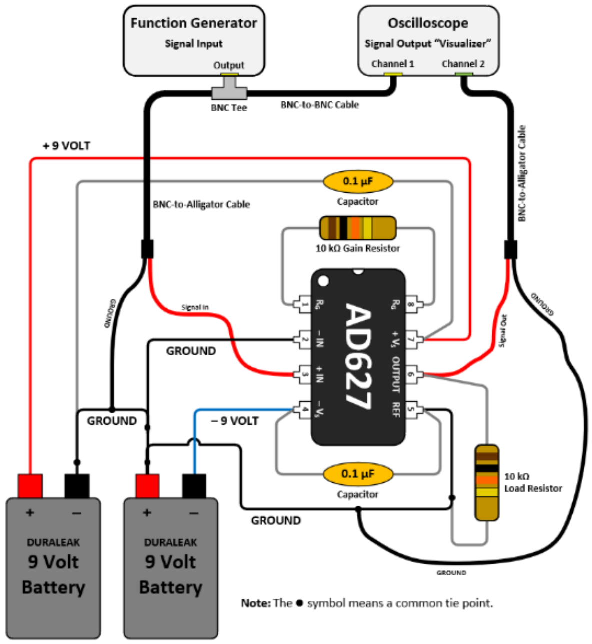

Fig. 3: Connection diagram of the EKG circuit in the testing mode

The experiment introduced students to the concept of sensors and how the activity of the human heart could be captured as an electrical signal (electrical voltage). The experiment also created a bridge between how curiosity as an abstract concept, exploring a human's heart pattern in this case, could be manifested through interconnected physical components. Additionally, students closely observed the challenges that may accompany such a bridging process because making an EKG measurement was challenging and required patience and trial and error.

Trial and error *are* the foundation of *scientific thinking* when any task can be approached as an *iterative* process. It is indeed imperative to educate young minds with the foundations of engineering mindset through hands-on learning of technical systems, before the start of their "higher education" cycle.

CE Module

Computer Engineering focuses on both the hardware and software aspects of a computing system. The field of computer engineering has many key areas including processor design, embedded systems, software design, and computer networking. Because of the limited 6-hour duration, the co-facilitators of the Computer Engineering module used embedded systems, which combines hardware and software to create a specialized system, to present students with a fun and interactive introduction to computer engineering. In this module, students build a sumo robot car or an autonomous robot car.

The goal of the Computer Engineering module is to program a robot car that uses optical sensors to sense its environment. The car will then use this information to stay in the designated area – a dark circular area surrounded by a white border – without human interaction as shown in Figure 4. Students were divided into groups of 3, then each group competed against the others to see which group's car stayed in the designated area the longest. In the second challenge multiple cars were put into the ring to see which cars were bumped out of the area and which remained.

Fig 4: The sumo robot car and the ring

Morning Session

The morning session began with a short 20-minute presentation that covered three topics. First, computer engineering and its different key areas were presented to the students. Then, a summary on self-driving cars that can sense its environment and navigate without human interaction was presented as a current example of real-world research and development in computer engineering. Finally, our scaled down version of a self-driving car, the sumo robot car that uses optical sensors to sense its environment to navigate using a programmed Arduino was presented. The hands-on section of the morning session was broken down into 6 Tasks:

1. Calculating the parameters needed to move the servo motors attached to the car wheels: students used the datasheet characteristics of the servo motors to calculate frequency and duty cycle values needed to move the car forward and backward and to stop the car.

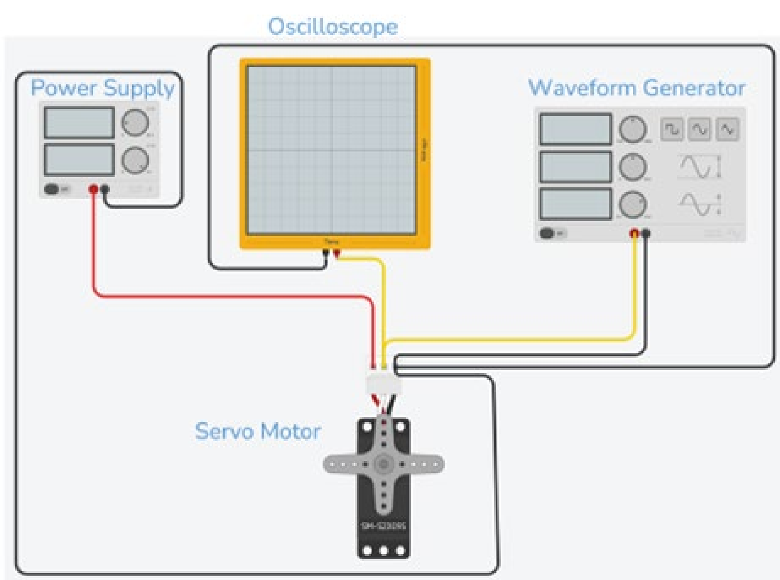

Fig. 5: The connections made in Task 3

2. Generating a square wave: students practiced generating square waves on the function generator and obtained measurements on the oscilloscope to verify the amplitude, duty cycle, and pulse width were set correctly.
3. Determining the duty cycles needed to turn the servo motor clockwise, to turn the servo motor counterclockwise, and to stop, students used the power supply, waveform generator, oscilloscope determine the duty cycle and pulse widths needed to control the motors. The circuit used is shown in Figure 5.
4. Calculating the values needed for Arduino code: students converted the duty cycle values from Task 3 into values that can be used in their Arduino code.
5. Using the Arduino to generate the square wave: students used one of the 5 values from Task 4 to generate a square wave on the Arduino on the robot.
6. Completing the setup of the robot car by connecting the battery packs and writing code for the Arduino: students connected the battery packs and wrote snippets of code that would allow the car to move forward, move backward, stop, turn left, and turn right.

<u>Afternoon Session</u>

The afternoon session focuses on programming and encouraging students to use their critical thinking process. The basic programming was introduced with practice questions in each topic for students to experiment. Then, there is a combination of knowledge in the morning and afternoon sessions where students write a program to control a Sumo robot car. The hands-on section of the afternoon session was broken down into 5 Tasks:

1. The introduction of programming in Arduino: in this section, there was an explanation of how coding in Arduino works, introduction to basic programming including conditional statement, loop. Multiple practice questions were given for students to experiment and solve.
2. Using Arduino to detect environmental information: in this section, students were tasked to write a code to read data from optical sensor and display it on the screen.
3. Controlling a robot car: After students learned how to write a basic programming and be able to detect environmental data, in this task, students were challenged to write a program to control a Sumo robot car. The car must move forward when it detects the black floor and move backward when the floor is white. Then, students were tasked to find a way to make a car follow a white path. The car must be able to turn left and turn right depending on the floor color, so it could stay on the part
4. Function: To simplify the understanding of code, students must put their codes into functions. Four functions were created: turn left, turn right, go forward, and go backward
5. Sumo robot car: The last part is a combination of every task. Students were tasked to write a program to make a given car stay in a ring as long as possible. There was a small competition where multiple cars were put in the ring. Cars bump the other cars. Most of the group, especially from session 2, can complete this project.

At the end of the session, students have to use knowledge from CE module to build an autonomous robot car. The main goal of this autonomous robot car is to make their car stay inside an arena as long as possible.

Survey

At the end of each module, the instructors requested attendees to complete a survey. The purpose of this survey was to assess the success and effectiveness of the STEM activity in enhancing students' interest and confidence in the ECE fields. Additionally, the survey included open-ended questions to understand students' background and their knowledge prior to the activity, to gather feedback on the module and suggestions for improving its design in future iterations. The survey included the following questions:

Q1: On a scale of 1-5, how would you rate your knowledge of the Electrical Engineering field before participating in this program?

Q2: On a scale of 1-5, how much has your confidence in understanding electrical/computer engineering concepts improved after completing this module?

Q3: On a scale of 1-5, how much has this program increased your interest in electrical/computer engineering?

Q4: On a scale of 1-5, how likely are you to pursue a career in electrical/computer engineering as a result of this program?

Q5: On a scale of 1-5, how new were the topics covered in the program to you?

Q6: If not new, please describe the equipment and/or components you have used before:

Q7: On a scale of 1-5, how helpful were the hands-on activities in enhancing your understanding of electrical circuits?

Q8: Which topics did you find the most interesting?

Q9: How could this program be improved?

A high response rate of approximately 93% was achieved, with the remaining 7% attributed to students who left the activity before it ended.

Results

The results of Q1–Q5 and Q7 are presented in the section below, with 5 representing 'strongly agree' and 1 representing 'strongly disagree.' The open-ended responses from Q8 and Q9 are discussed in the subsequent discussion sectionThe results aim to highlight the strengths and successes of this STEM outreach program while also addressing its shortcomings and weaknesses, which will be analyzed further. The objective of the data analysis is to draw conclusions on how to design effective, inspiring, and successful STEM outreach activities.

Figure 6 illustrates the percentage of students versus their ratings on a scale from 1 to 5 regarding their prior knowledge of Electrical Engineering (orange bar) and Computer Engineering (blue bar) fields. The results indicate that most students had limited knowledge of the ECE fields. Specifically, 65% of students rated their knowledge as 2 or lower for the CE

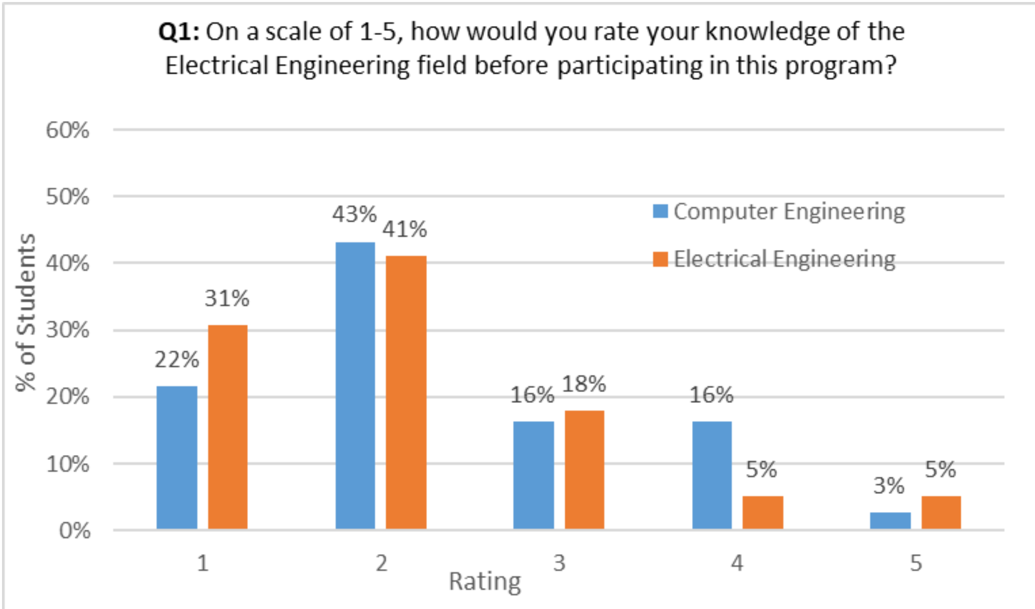

Fig. 6: Survey Results Q1

field, and 72% of students did the same for EE. These findings are supported by Figure 7, which shows that 41% of students stated the CE topics covered in the module were new to them, while 50% of students said the same for the EE topics (rating greater than or equal to 4). This discrepancy between CE and EE knowledge may stem from the greater emphasis on computer science and coding in high schools, driven by the demand for software-related skills in the job market. Platforms for learning programming, such as Python and Code.org, are widely available, low-cost or free, and easy to integrate into classrooms. Additionally, almost 40% of students stated in response to Q5 that they had previously been exposed to programming. In contrast, EE concepts, such as circuit analysis, are often perceived as advanced, abstract, and intimidating

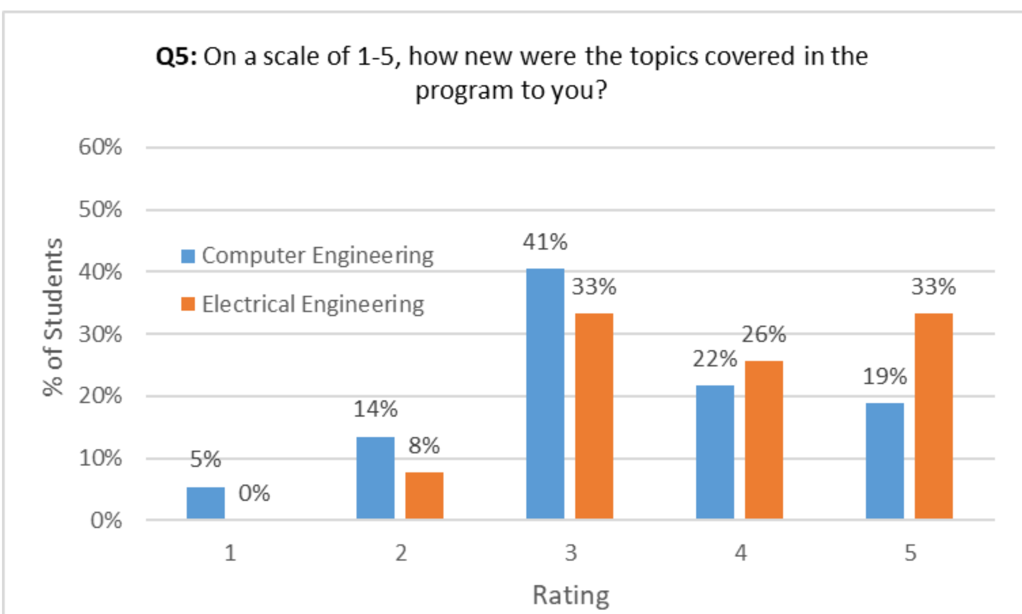

Fig. 7: Survey Results Q5

without a strong foundation in math or physics. As a result, these topics are typically reserved for higher education, leading to less exposure at the high school level.

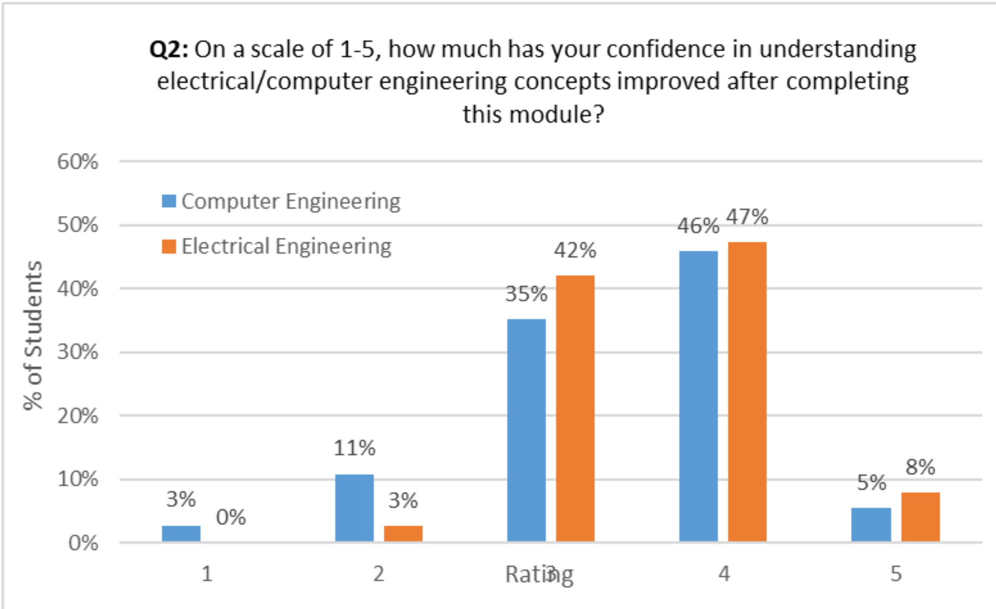

Fig. 8: Survey Results Q2

Figure 8 illustrates the percentage of students versus their ratings on a scale from 1 to 5 regarding their increased confidence in understanding concepts in the fields of Electrical Engineering (orange bar) and Computer Engineering (blue bar). It is evident that students' perception of their confidence in the ECE fields has improved. More than 50% of the students rated their confidence as 4 or higher for both CE and EE in response to Q2. However, 17% of participants indicated that the activity did not significantly enhance their belief in their capabilities. A notable factor to consider is that only 5% of students in CE and 8% in EE gave a

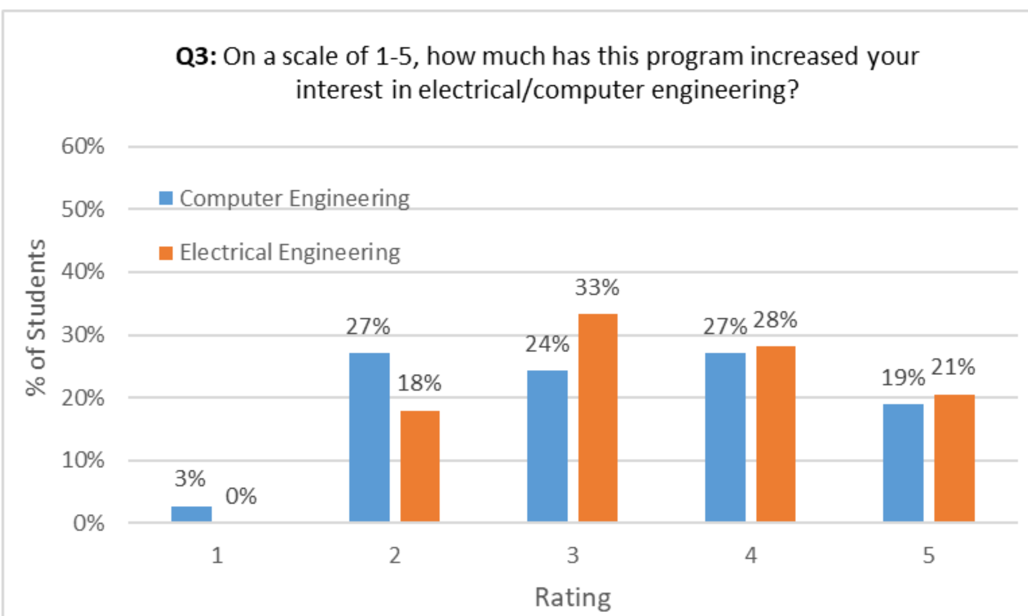

Fig. 9: Survey Results Q3

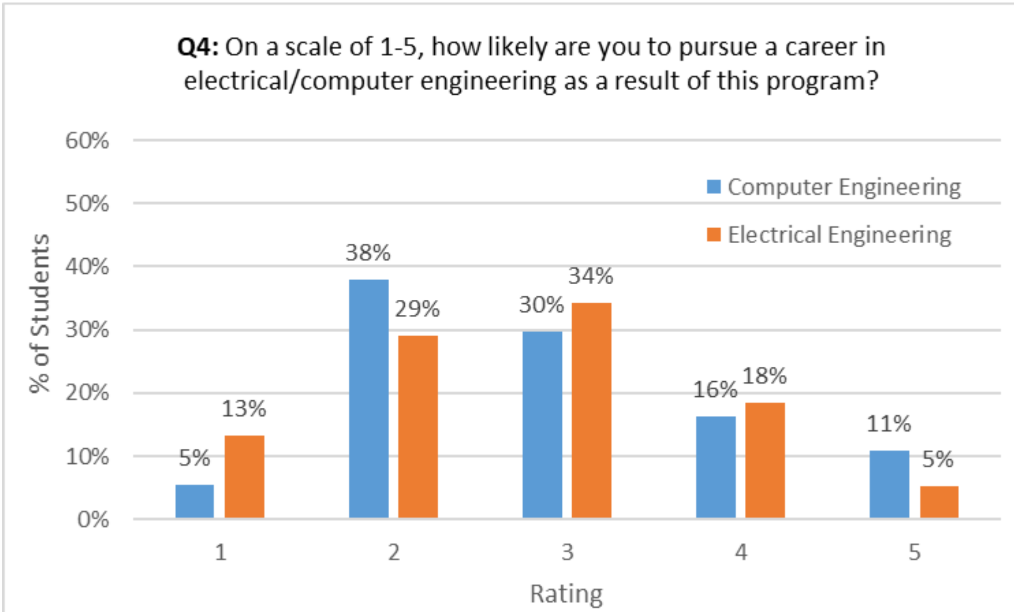

Fig. 10: Survey Results Q4

top rating of 5 for Q2. This may be attributed to a lack of interest in the activity, insufficient engagement, or inadequate guidance and instructions, as reflected in responses to Q9, which will be discussed in a later section. The primary goal of STEM outreach activities is to ignite students' interest in STEM fields and inspire them to pursue careers in ECE, thereby cultivating the next generation of engineers to meet the growing demand for skilled professionals in these areas.

Figures 9 and 10 illustrate the percentage of students and their ratings on a scale from 1 to 5, evaluating their increased interest and the likelihood of pursuing a career in CE and EE after attending the workshop. The results for Q3, shown in Figure 9, reveal that interest in the EE and

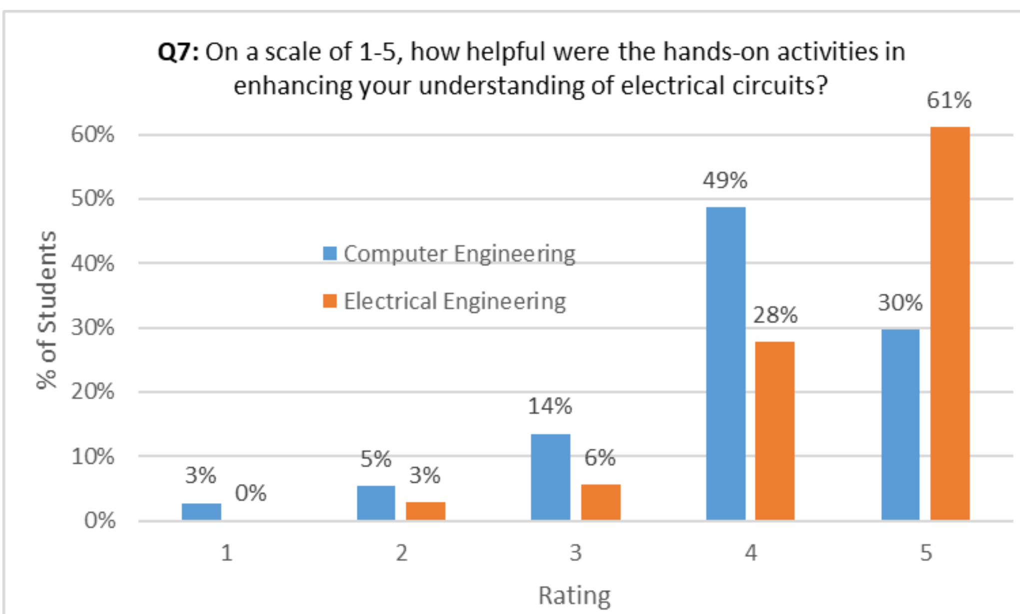

Fig. 11: Survey Results Q7

CE fields increased for 49% and 46% of the students, respectively, who provided ratings of 4 or higher. Notably, a greater percentage of students expressed increased interest in the EE field. However, 30% of CE participants and 18% of EE participants rated their interest as 2 or lower, indicating that the activities did not enhance or instill curiosity or interest for these students. Despite this, the STEM activity successfully sparked interest in nearly half of the participants, demonstrating its potential to inspire future engineers. However, the results for Q4, illustrated in Figure 10, are concerning. While about one-third of the students were uncertain about whether the STEM activity increased their likelihood of pursuing a career in ECE, the majority gave Q4 a score of 2 or less. Specifically, 43% of CE participants and 42% of EE participants expressed no interest in pursuing a career in ECE. This outcome warrants further reflection and analysis. One consideration is the apparent contradiction between the results of Q3 and Q4. While the activity successfully increased students' interest in ECE, this heightened interest may not have been strong enough to translate into a commitment to pursue a career in the field. Another important factor is that students rotated through various engineering programs offered by our school, including mechanical, civil, biomedical, biological, and electromechanical engineering. It is possible that some students were more impressed by or enjoyed another discipline, which

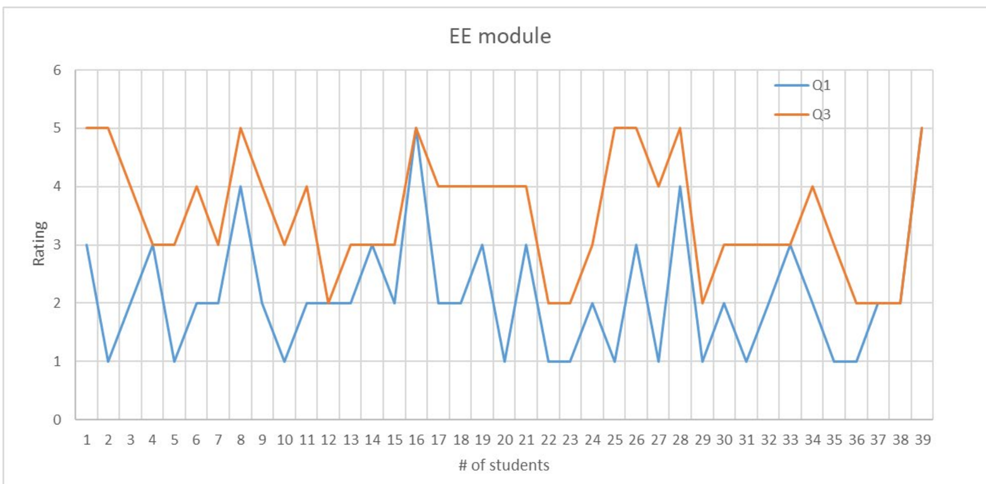

Fig. 12a: Q3-Q1 for EE on the scale of 1 to 5

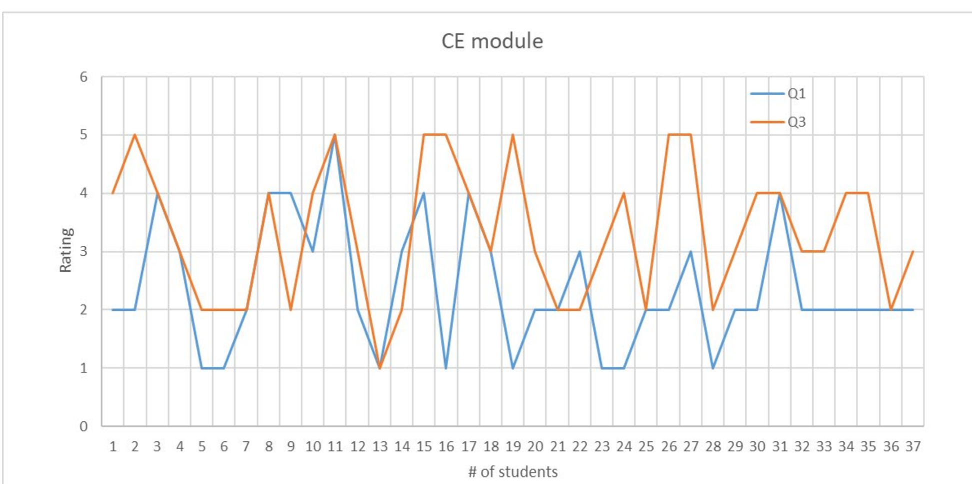

Fig. 12b: Q3-Q1 for CE on the scale of 1 to 5

influenced their responses to Q4. Therefore, even though the STEM activity increased students' interest in ECE, many may still prefer to pursue a career in a different engineering discipline. Figure 11 shows the percentage of students and their ratings on a scale from 1 to 5 on how useful the hands-on activities are in enhancing the understanding of electrical circuits. Results demonstrate that the attendees found the hands-on approach of the STEM activities helpful in understanding the concepts illustrated during the workshop. This successful result aligns with our school mission of providing experiential and practical learning experiences to the students.

To refine the design of future modules, the relationship between students' prior knowledge and their increased interest after the activity was analyzed for both EE and CE. This analysis aimed to determine whether the activity was too simple and easy—causing students with prior knowledge to lose interest—or too difficult and challenging, leading to discouragement and a lack of interest among students new to the field. Figures 12a and 12b illustrate the ratings versus the number of students for Q1 (blue line) and Q3 (orange line) for both EE and CE respectively. The goal of the activity was to enhance students' interest regardless of their prior knowledge or background. The workshops were designed with a modular approach, allowing students with varying capabilities and backgrounds to successfully complete the modules at their own pace. Ideally, the rating for Q3 should be greater than or equal to the rating for Q1, indicating that the activity effectively stimulated curiosity and increased interest in the ECE field, regardless of the students' initial familiarity with the subject. In Figure 12a (EE module), it is evident that the rating for Q3 is consistently greater than or equal to the rating for Q1 for 80% of the attendees. A similar trend is observed in Figure 12b for the CE module. However, 8% of attendees rated Q3 lower than Q1, which occurred among students who rated their prior knowledge as 3 or 4. This suggests that for these students, the activity failed to maintain or enhance their interest, resulting in a decline in engagement.

Discussion

We wanted to know about the efficacy of our efforts and therefore, we collected feedback from students with the hope of finding answers to our research questions (as shown below):

1) If a team could not complete a task, was it due to the complexity of the module or other restrictions? In other words, did we include too much curiosity in our modules?
2) Did our modules benefit our audience in terms of advancing their understanding of and/or increasing their interest in the ECE fields?
3) Did we have to simplify or increase the complexity of our projects to better serve the audience?
4) Will the most complex iteration of our module design be the most effective or is there a balance between simplicity and efficacy?
5) Should we be very detailed in the instructions we provide for our modules or giving too many specifics may decrease the level of creative thinking in the students.

A summary of the most repeated answers for the open-response questions of the surveys conducted at the end of each module is shown in Table I.

Table I: Survey Results, Open Responses

Most Repeated Phrases in the Open Responses	Electrical Engineering	Computer Engineering
Better/Clearer Instructions	18%	19%
Complex Assignment	10%	5%
More Help	15%	0%

Considering the survey results and direct observations from faculty members and student volunteers participating in the activity, the following insights and answers to the previous questions will be considered for future iterations:

1) Results from Table 1 show that 28% of students that attended the EE module and 24% of students that attended the CE module who answered the open-ended questions preferred a less complex assignment and/or clearer instructions. This indicates the need to revise the activity manual to include more detailed information about the activity and clearer step-by-step guidance for the laboratory exercise for the next iteration. The goal will be to improve clarity while maintaining the same level of curiosity and independent thinking.
2) Results from Figure 11 indicate that the designed modules/activities enhanced students' understanding of the ECE field. However, Figure 9 shows that while their understanding improved, the activities did not significantly increase their interest in the ECE field. Therefore, in the next iteration of this STEM outreach program, additional emerging engineering topics will be explored and incorporated into the activities to leverage their interest.
3) The module aimed at encouraging students to apply independent and critical thinking to complete the laboratory activities. However, results in Table 1 show that some students have rated the activities to be complicated. Therefore, the level of complexity of the modules will be re-evaluated and simplified for the next implementation.
4) A complex iteration of a module proved not to be the most effective. A balance between simplicity and efficacy may be more effective in achieving the goal of STEM outreach activities. Future module designs will be restructured to reduce complexity while incorporating some challenging tasks to identify an optimal tradeoff between complexity and efficacy.
5) As shown in Table 1, students expressed a desire for better instructions. However, the goal of these activities is to instill curiosity, while motivating them to pursue career opportunities or further education in the ECE field. In future iterations, modules will be revised to include clearer instructions on using benchtop equipment and components, while incorporating more open-ended and optional questions to spark their curiosity.

Conclusion

Engineering education, which includes the Electrical and Computer Engineering (ECE) fields is evolving to meet the demands of a rapidly changing world. In the 21st century, complex societal problems inevitably involve technology and cannot be addressed by a single discipline. Therefore, it is more essential than ever to train engineering students with creative problem-solving and innovative thinking skills to design a better, more inclusive future [13]. The real-world challenges require curious individuals who are equipped with knowledge and skillsets.

Cultivating curiosity would involve work; processes should be integrated into the ECE curricula to achieve this goal systematically. It should also be noted that it is essential to nurture the correct amount of curiosity as too much of it may lead to anxiety and not enough of it would result in boredom [14]. Our university is a member of the KERN Entrepreneurial Engineering Network (KEEN), we would like to include an Entrepreneurial Mindset (EM) in all our educational endeavors and our STEM outreach activities are no exception. In addition, we would like to apply an iterative approach to our efforts in order to find "best practices" to foster an ECE mindset and also to teach problem-solving early on.

STEM outreach activities play a crucial role in shaping high school students' educational and career trajectories, particularly during the critical period when they are making key decisions about their futures. To address this need, our institution offers a two-week STEM program designed to expose students to various STEM disciplines and foster their interest in these fields. This paper provides an overview of the program, focusing specifically on the EE and CE modules, and presents the survey data collected from participants to assess the program's effectiveness. These engineering modules feature carefully designed laboratory activities aimed at engaging students in hands-on learning and showing real-world applications of ECE concepts, such as autonomous driving systems and EKG signal analysis.

The results indicate that the activities were partially successful in increasing students' interest in CE and EE, with 46% and 49% of participants, respectively, reporting an increased interest in these fields. However, a significant proportion — 43% of CE participants and 42% of EE participants—expressed no interest in pursuing a career in ECE. These concerning findings may be linked to feedback provided by the participants. While students enjoyed the activities and appreciated the relevance of the chosen topics, challenges encountered during the activities affected their overall experience. Specifically, students highlighted the need for more guidance and instruction, as well as additional support during the activities. These obstacles appear to have discouraged some participants, underscoring the importance of evaluating and refining the program to better balance engagement with support.

Future work will focus on improving the design and delivery of the EE and CE modules by incorporating structured guidance and real-time support during activities to reduce frustration and enhance engagement, while still fostering curiosity, critical and independent thinking skills. Pre-activity surveys and assessments will be implemented to measure baseline interest and identify areas for improvement, while long-term follow-up surveys will track participants' academic and career trajectories. These efforts aim to continuously improve the program's effectiveness in inspiring and preparing future STEM professionals.

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