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FREEDM Pre-college Renewable Energy Program: Inspiring Young Adults to Recognize the Value of STEM Careers

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Abstract

The FREEDM precollege program uses renewable (i.e., green) energy as a platform to help high school students realize the value and importance of science, technology, engineering and mathematics (STEM). The program lectures, tours, and activities are designed to inspire secondary school student interest in engineering and encourage them to enter college and study in a STEM major after graduation from high school. In the four-week summer commuter program, the high school juniors and seniors, designated as Young Scholars, learn about renewable energy via four programmatic facets. The class time primarily comprises interactive presentations focused on the topics of electrical energy and renewables. To provide real world engineering examples and to expand the students' familiarity with various engineering branches, multiple tours, such as visiting a power plant, are arranged. Some additional activities, such as a debate centered on renewable energy resources, learning how to solder, and an introduction to engineering computer tools, supplement their learning and provide them with some valuable skills for their future studies. The signature activity is having each student work on an individual project that is related to energy conversion. A weekly oral presentation provides the students the opportunity to share what they have learned during the week and report on the progress of their project. A science fair style poster presentation is scheduled for the last day of the summer program. By comparing the pre-program and post-program survey results for the Young Scholars, the FREEDM precollege program has met its goal of instilling the students with an understanding of engineering careers. Furthermore, students who have participated in this precollege program have stated that they have gained more confidence in their future studies and they believe that they can do well in college.

Introduction

Science, technology, engineering and mathematics (STEM) subjects are essential fields in the United States due to the role they play at multiple levels of society, as well as their enormous impact. Today, the STEM subject scope is expanding into STEAM, in which the A stands for art, and STEMM, in which the added M signifies medicine. The President's Council of Advisors on Science and Technology (PCAST) report:

> "Since the beginning of the 20th century, average per capita income in the United States has grown more than sevenfold, and science and technology account for more than half of this growth. In the 21st century, the country's need for a world-leading STEM workforce and a scientifically, mathematically and technologically literate populace has become even greater, and it will continue to grow – particularly as other nations continue to make rapid advances in science and technology".[1]

Although STEM plays a significant role in today's global society, a December 2014 survey by YouGov for IEEE shows that young adults, especially in the United States, seem to overlook the value of STEM subjects.[2] Table 1 shows the results of that survey which queried more than two thousand adults in each of both the United States and United Kingdom about their opinion of

STEM subjects being taught in primary and secondary schools. It shows that in both countries, the younger millennial generation (18 to 34 years old) does not value the importance of the STEM subjects as much as the older baby boomers generation (51 to 69 years old). Among the four STEM subjects, mathematics was ranked with highest importance and engineering with lowest importance by all cohorts. In the U.S., the number of people who do not consider taking any STEM lessons important more than doubled among the millennials compared with the seniors. Disinterest in STEM by the next generation of adults could lead to the predicament that we cannot meet the demand for skilled engineers in the future.

Table 1. IEEE STEM Survey Results[2]

Survey Respondent Position	United States		United Kingdom	
	18 to 34 years old	51 to 69 years old	18 to 34 years old	51 to 69 years old
Considered science as an important subject to be studied	68%	80%	76%	79%
Considered technology as an important subject to be studied	60%	66%	65%	76%
Considered engineering as an important subject to be studied	42%	46%	46%	51%
Considered math as an important subject to be studied	75%	88%	82%	92%
Do not consider taking any of the four STEM subjects important	7%	3%	4%	1%

Efforts are being made to help the younger generation realize the importance of STEM subjects and attract them to fields such as engineering. The Future Renewable Electric Energy Distribution and Management (FREEDM) precollege program described in this paper is one such endeavor. Other efforts related to power engineering at the pre-university level include workshops for science teachers[3], interactive online applets[4], and a distribution power flow experiment[5]. In 2004, Jeffers et al. compiled an extensive listing of K-12 engineering outreach programs.[6]

FREEDM Precollege Program

FREEDM is a National Science Foundation (NSF) supported Generation III Engineering Research Center headquartered at North Carolina State University (NCSU). The partner institutions include Arizona State University (ASU), Florida State University (FSU), Florida A&M University (FAMU), and Missouri University of Science and Technology (MST). The FREEDM system center has established cooperation with specific middle and high schools in the states where the above universities are located to leverage the students' interests in green energy in order to attract them into STEM subjects. The goals of the FREEDM precollege program include:

- Enhance teachers' engineering content knowledge and pedagogical methods,
- Bring engineering concepts to the classroom,
- Involve precollege students in research, and
- Increase enrollment of diverse domestic students in university degree programs.

This paper focuses on the FREEDM Young Scholars (high school students) program on the Arizona State University (ASU) campus. Other papers have described the research experience for teachers (RET) program.[7]

The ASU FREEDM program has partnered with a Title I high school located in central Phoenix and whose population is 94% Hispanic. Applications to the program are solicited in the spring and approximately ten high school students are accepted into the four-week commuter program each year. The selected students must be completing their sophomore or junior year in the spring with a minimum target GPA of ~2.5/4.0 such that they could reasonably be expected to be admitted into a university engineering program. To encourage his or her participation, each high school student is given a $1,500 stipend.

FREEDM Program ASU Activities

At ASU, the Young Scholars program contains four major parts: class time, tours, activities, and science fair styled projects, as depicted in Figure 1. Table 2 provides an example schedule of the first week. All of these components are aimed to help the Young Scholars to have a better understanding and increased interest in the STEM subjects. The minor-aged Young Scholars are mentored by a least two college students at all times.

Table 2. FREEDM Precollege Young Scholar Program Example Schedule of Week 1

<table>
<tr><th></th><th>1-Jun</th><th>2-Jun</th><th>3-Jun</th><th>4-Jun</th><th>5-Jun</th></tr>
<tr><td>8:00am-
9:00am</td><td>Paperwork</td><td>How to Make a Good Presentation</td><td rowspan="2">Lecture: Overview of Renewable Energy</td><td rowspan="2">Scavenger Hunt</td><td rowspan="2">Young Scholar Project Presentation</td></tr>
<tr><td>9:00am-
10:00am</td><td rowspan="3">Orientation and Program Overview</td><td>Project Selection Time</td></tr>
<tr><td>10:00am-
11:00am</td><td rowspan="2">Lecture: Electricity and Power System</td><td rowspan="2">University Campus Tour</td><td rowspan="3">Lecture: Solar, Photovoltaics</td><td rowspan="3">Lecture: Solar Thermal</td></tr>
<tr><td>11:00am-
12:00pm</td><td rowspan="2">Fire and Safety Training</td><td rowspan="2">Video & Activity</td><td rowspan="2">Trivia on Renewable Energy</td></tr>
<tr><td>12:00pm-
1:00pm</td><td>Food Court Tour</td><td>Lunch</td><td>Lunch</td><td>Lunch</td><td>Lunch</td></tr>
<tr><td rowspan="2">1:00pm-
2:00pm</td><td>Online Survey</td><td rowspan="2">Introduction to Debate</td><td rowspan="2">Select/Assign Projects</td><td>Introduction of the Weekly Presentation & PowerPoint</td><td rowspan="5">Project Research</td></tr>
<tr><td>Icebreaker</td><td rowspan="3">Debate Preparation Time</td><td rowspan="3">Project Research</td><td rowspan="4">Presentation Preparation Time/ Project Research</td></tr>
<tr><td>2:00pm-
3:00pm</td><td>Introduction to MS-Office & Practice</td></tr>
<tr><td>3:00pm-
4:00pm</td><td rowspan="2">Introduction to Projects and Project Research</td><td rowspan="2">Debate</td></tr>
<tr><td>4:00pm-
4:30pm</td><td>Feedback on Projects</td></tr>
</table>

Figure 1. FREEDM Young Scholars program at Arizona State University.

1. Class Time

The class time consists primarily of interactive presentations given by the graduate student mentors, with an occasional guest lecture. The presentations are mainly concerned with the topics of electrical energy and renewables including: electricity and power systems, overview of renewable energy, photovoltaics (PV), solar thermal, wind energy, hydropower, geothermal, biomass and ocean energy, and renewable vs. non-renewable energy. During the lectures, the Young Scholars are engaged by asking them questions and they solve simple exercises to help them retain the material conveyed during the presentation.

A major objective of the class time is to introduce the students to the basic concepts of electrical engineering and different kinds of energy sources. For example, the electricity and power systems lecture provides an introduction to the basics of electricity, with the flow of electricity being explained using an analogous situation, that of water flow in a pipe. Apart from these, this presentation also gives a brief overview of the power system and its major subdivisions of generation, transmission, and distribution. We planned the majority of the lectures to introduce the different sources of renewable energy that are being developed in the world, as well as their ecological, social, and economic impacts. For example, in the wind energy lecture, we cover the information about harnessing wind energy, wind turbines, and wind farms. Details about the construction of wind turbines, advantages and disadvantages of wind farms, and the directions for future development are also discussed. After addressing all the renewable energy sources, we introduce the existing non-renewable resources through lectures, explaining how each resource generates power, and discuss the differences, advantages, and drawbacks of renewable and non-renewable sources of energy in detail. Our purpose is to use these class presentations to provide the students with a foundation from which each can delve deeper into the concepts he/she would need to learn for the science fair project. In addition, they gain familiarity with the subject area and genuinely begin to recognize that they can impact the future, thus encouraging them to take up a career in the STEM domain.

The guest lectures focus mainly on providing other useful information. For example, one guest lecture is about how to make a good presentation. Presentations are widely used in today's college courses. This is significant since the students are asked to give an individual presentation

each week during the program to report their progress. Most of the students then use what they have learned from this guest lecture in their weekly presentation. As this program serves as an impetus for the students to continue their education into college after they graduate from high school, another second guest lecture tackles college admission. An admissions counselor assigned to the specific high school where the Young Scholars attend addresses topics such as: how to apply, when to apply, admission requirements, how to apply for financial aid and scholarships, different resources at the university, and so on. Because most of the students are first generation college bound, they typically have many relevant questions. Anecdotal feedback reveals that they learned a lot about how to apply for college and how they should prepare in the following year.

2. Tours

In order to provide some real world engineering examples to the students and give the students the chance to explore the wide range of activities available on a college campus, as well as help make the summer program more exciting and entertaining, multiple tours are arranged during the program. Since it is probably the first time for the students to visit the university, a campus tour is provided during the first week. The guided tour introduces the students to all the major buildings and venues including a visit to the football stadium. This helps to acclimate the Young Scholars to their new surroundings and makes a large college campus look less daunting and more inviting.

To expand the students' familiarity with other fields besides electrical engineering, we arrange a tour of the School of Earth and Space Exploration. There are two major parts of the tour. The first part is a guided tour that helps students to understand the kind of stellar research being performed including the collaboration between the university and NASA. The second part is a 3-D astronomy show at the theater. The movie takes the students on a journey from the Earth to outer space by introducing the planets and stars. The students have shown great interest in this tour and have said they have learned a considerable amount about space engineering as well as what aerospace engineers do for their study and research.

We broaden the students' exposure to the allied fields of architecture and art. In terms of architecture, a tour is undertaken of the Gammage Auditorium, which is a significant landmark both historically and structurally. On the tour, students learn about the construction aspects and history of the building, as well as how the design by renowned architect Frank Lloyd Wright helps to enhance the plays, orchestra, and musical performances in Gammage. In addition to visiting backstage, they can even sing on the stage to experience the amazing acoustic design of the auditorium. In response to the trend today to expand the STEM subjects into STEAM, we take the students on an art museum tour. During the tour, the guide explains design inspiration and history of different art masterpieces, and the students have shown appreciation for the beautiful specimens at the museum.

The tour that the students enjoyed most is the visit to the Ocotillo Power Plant. This tour provides a valuable opportunity for the students to connect what they learned in the lectures to real world utilization. The Ocotillo Power Plant is a natural gas-fueled power plant with two (old) steam and two (new) combustion turbine units. First, the electric utility staff introduce the history of the generating station, and then give a short presentation on the design concept and working mechanism of the units there. After that, the students are taken on a tour to see the

different parts of the plant, such as the combustion chamber, generator, cooling tower, etc. They even get a chance to visit the control room and ask questions of the plant operators. Because the electric utility's solar technology and research center is also located there, they also have the opportunity to see a real photovoltaic farm and how it works.

Although a trip to a large scale hydropower plant is prohibitive due to the traveling distance, there is a small hydroelectric facility in the local area. In particular, Arizona Falls produces 750 kW from a natural 20-ft drop between two aqueducts. These power plant tours provide a great opportunity for the students to learn what engineers do in their daily work, as well as providing a role model for them to observe, since most of them do not have an engineer in their family. This increases their interest in engineering and their confidence that they are capable of doing well in a technical major in college and perhaps become an engineer after graduation.

3. Activities

Apart from the lecture and tours, there are some additional activities carried out to supplement their learning or provide them some valuable tools for their future endeavors. For example, learning to debate can foster critical analysis skills. It is also an important tool for familiarizing oneself with all the aspects of a particular issue through research and discussion. Two debates are scheduled, one at the beginning and another at the end of the program.

Before we influence their views with information and our opinions, a debate with the topic "Coal or hydro – which is better?" is held before the lectures about coal-fired generation and hydropower are taught. After being split into two teams, they are tasked with researching the question. An objective is for the Young Scholars to establish their own opinion on this topic but that such beliefs need to be based on a holistic understanding of the subject. This topic also shows how we connect the program activities to relevant issues in the state. A case study of the coal-fired power plant in Page, Arizona is introduced to the students after the debate. The Glen Canyon Dam and Powerplant as well as a coal-fired power plant, the Navajo Generating Station, are located just a few miles apart. The coal-fired power plant is under pressure by environmentalists because the pollution and haze it produces are hurting the ecosystem of the Grand Canyon. They are demanding more pollution controls and regulations for this power plant. However, the coal-fired plant is sited on the Navajo Reservation. Even though the coal-fired power plant may be harmful to the environment, the Navajo people still want to keep it there because the plant hires local tribe members (85% of the plant workers are Native American[8]), brings tax income to the Navajo Nation, and uses coal from the Kayenta mine located on the Navajo Reservation (creating even more jobs and tax revenue for the tribe). If the power plant is shut down, they will lose these financial benefits. Aside from that, 24.3% of the fossil power plant is owned by the U.S. Bureau of Reclamation[9], which uses its share to provide more than 90% of the power needed by the Central Arizona Project to deliver Colorado River water to agricultural water users in central Arizona and many of the state's civic water users, including the cities of Phoenix and Tucson. If the plant were shut down, they would need to find an alternative source to power their megawatt size water pumps. On the other side of the debate is the seemingly benign hydroelectric facility. Environmentalists also oppose the dam located there, favoring returning the Colorado River and the canyons to their natural states. However, the water impoundment is vital in the arid Southwest. Furthermore, hydropower is a non-CO_2 emitting renewable energy source. Therefore, the decisions are not easy to make, but such

analyses are consistent with the ABET engineering criteria 3(c), 3(h) and 3(j) that students have the ability to make decisions "within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability", "understand the impact of engineering solutions in a global, economic, environmental, and societal context" and have "a knowledge of contemporary issues".[10] Via this debate and corresponding case study, the students learn how to think outside the box and look at the big picture in its entirety when approaching a problem.

The second debate "Do alternative energy sources stand a chance?" is scheduled at the end of the summer program. As the Young Scholars become acquainted with the topic in general, they can be much more thorough in their research. This debate helps them discover and explore much more than they learn in the lectures.

Knowing how to solder electrical components could be a worthwhile skill for constructing some of the projects. With this in mind, a laboratory session is planned for the students about the basics of soldering, as well as the basics of electronic devices. This aids their attaining a more practical perspective of the theoretical concepts that they have heard. For the practice session, each of the students and teachers is given a soldering kit containing instructions and materials to build a basic 555 timer circuit. This practical work is fun and interesting, given the fact that they all have a working unit of a buzzer and light siren system by the end of the tutorial.

Proficiency with computer software is important in today's world. During various stages of this summer program, students are taught and shown various tasks that can be accomplished through the Microsoft Office tools. One of the major things conveyed is how to select the proper software based on the task at hand. The tutorials and the exercises focus on Word (equations, headers and footers, tables), PowerPoint (slide show settings, clip art, word art, animations) and Excel (equations, mathematical operations, graphs, table tools). The knowledge obtained from these tutorials assists the students in preparing their reports and posters during the summer program, as well as aiding them in their future academic pursuits.

They also participate in a technical scavenger hunt, a fun activity that involves physical exercise and tests their observational skills. Students are split into two teams, each of the teams is given a list of 10 objects (e.g., transformer, solar panel, wind turbine, etc.) to be found in specific locations around the campus. This gives them a chance to connect what they have learned in the lectures with the objects encountered in their daily lives. Another fun activity is lunar survival. Students are divided into two teams with the objective of ranking which of 15 objects would be most useful to have in case of a failed lunar landing from a given list of supplies. This activity tests the logical skills of the students, as well as teaching them how to work in a team. Additionally, they learn some interesting facts about space.

4. Projects

During the four-week program, each student works on an individual project. A list of possible projects is provided to the students with the project topic, description, and difficulty level from which to choose. Table 3 lists the title and description of projects that have been undertaken by Young Scholars. The specific project is assigned to the students according to their preference. During the first two weeks, students are given time to perform online research about their projects and to create a detailed plan and list of materials needed. After that, they have two

more weeks to build their projects. During the construction phase, they often experience difficulties, and need to adjust their original blueprints. As noted earlier, the students provide a weekly oral progress report. At the end of the program, they create a science fair style poster to present their project. The project is a key part of the program. In order to build the project, students need to learn how to search for useful information online to help them understand the theory behind their project and design the device. Besides providing a hands-on experience for the students to actually build something that they have seen in the lectures, they also learn how to troubleshoot if their project is not working properly and make appropriate alterations. Time management is another takeaway for the students in order to finish the project on time.

Table 3. FREEDM Project List

Project Title	Project Description
Solar Powered Radio	Design and build a radio that can be charged using solar energy.
Solar Cooker and Oven	Evaluate various solar cooker and oven designs before fabricating a unit.
Hand Cranked Generator	Build an electric generator that produces a few volts by hand cranking the generator.
LED Lighting from Kinetic Energy	Build a simple motion-powered electrical generator that can power a series of tiny lights.
Energy Harvesting from Piezoelectric Sensor	Use the piezoelectric property of certain crystals to recover waste energy from walking.
Solar Powered Car	Explore and implement a suitable design for a solar car, such that the car is driven with the energy from the sun.
DC Motor	Select from possible designs for building a DC motor using simple materials. Also, improve the constructed model.
Solar Water Heater	Evaluate different designs for realizing a solar water heater and choose the best possible design.
Solar Powered Train	Design a train powered by solar energy. Investigate how the train wheels are rotated by the energy from the sun.
LED Traffic Glove	Build a lighted safety device for officials to direct traffic at night.
Solar Table Fan	Design a simple table fan that is powered by sunlight.
Solar Powered Boat	A motor boat can be propelled by converting the solar energy. Implement a selected design for the solar powered motor boat.
Wind Turbine	Investigate how the wind can be converted into electricity by constructing a home-made wind turbine.
Solar Fan Cap	Build a fan that works using power harnessed from a solar panel that can be mounted on a hat.
Solar Hot Dog Cooker	Construct an appropriate design to realize a hot dog cooker that utilizes solar heating.
Solar Table Lamp	Design a simple table lamp that is powered by solar energy.
Difference in Light Bulbs	Perform comparative studies of LED, CFL, and incandescent lamps.
Homemade Electronic Tester	Build a simple circuit tester and use it to investigate how electricity flows through a household lamp.
Dimming Lights	Build a simple dimmer switch and investigate the relationship between resistance in the circuit and the amount of light produced.
Variations of LED Brightness with Current	Investigate how LED brightness varies with the current harnessed from a photovoltaic panel for different light intensities.
Seebeck Effect	Measure the electricity produced from solar heat using a thermocouple based thermometer. Evaluate its usefulness.
Variation of Output with Changes in Circuit Topology	Connect photovoltaic cells in series or in parallel and measure voltage and current under different sunlight intensities.

Program Assessment

1. FREEDM Precollege Program 2014

A goal of the FREEDM precollege program is to encourage the participants to attend college and study a STEM major after they graduate from high school. In the 2014 summer program at ASU, there were seven young scholars who were entering their junior or senior year in high school. All of them were Hispanic and two of them were female. It is very important to encourage the minorities to pursue a higher education since the nation needs to encourage and cultivate the human capital of minorities who can staff industry needs. With a large number of present employees retiring, there are not enough qualified people to fill the vacancies. This provides an excellent opportunity for the well-educated members of underrepresented groups to obtain a good career in the future. Figure 2 shows the U.S. population composition changes by race from 2014 to 2060. The U.S. Census Bureau projections are that the non-Hispanic White population will fall to less than 50% of the total population in 2044. Furthermore, the Hispanic population will increase to more than a quarter of the country's population, and the Asian population will increase by 50% as well by 2044.

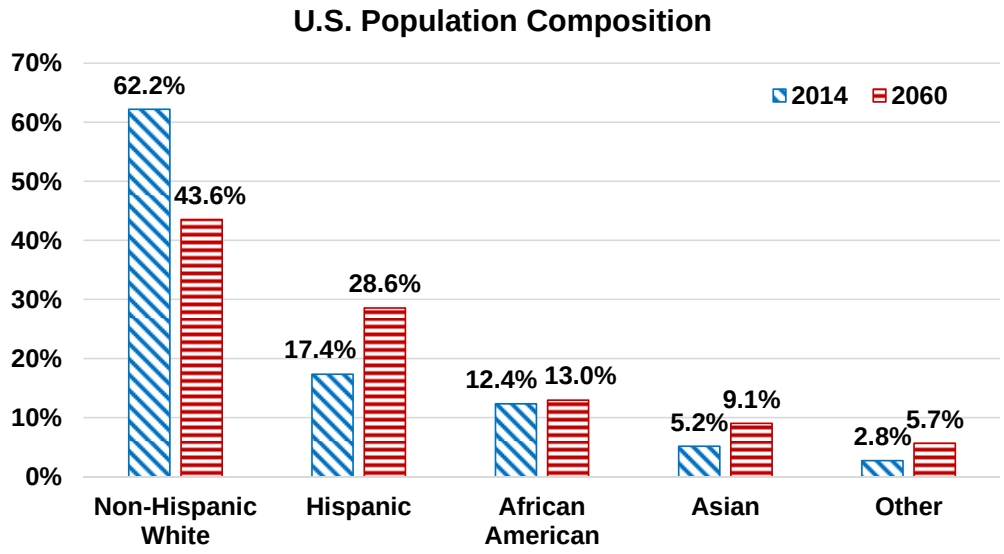

Figure 2. U.S. population composition comparison by race and Hispanic origin, 2014 vs. 2060.[11]

Lacking a college-educated role model, some students may relinquish their education after high school. Six out of the seven Young Scholars would be first generation college students if they enter a college. But the good news is that all of their families expect and support them to go to college after graduation. Three of seven students (43%) have never met a scientist in their life. Even in television shows and movies, there are not very many scientist/engineer characters. This can cause high school students to regard science and engineering as mysterious since they have no idea what engineers learn in college or what their career entails. This program provides them with a good opportunity to meet with engineering students and professors, learn some basic knowledge about engineering, hear what to expect when studying an engineering major in

college, see what engineering students and professors do in their daily lives, and generally ask questions about engineering. Actually, all of the seven students have stated that they want to learn about what engineers do via this program in the pre-program survey, and six (86%) have agreed that their goals for participating in this program were met in the post-program survey.

We want to stimulate their interest in engineering and give them confidence that they could be successful engineers. In the post-program survey, all of them have agreed that this program has helped them understand engineering better and has increased their interest in studying engineering in college. All of them think that it has increased their confidence in their ability to participate in engineering projects or activities after completing this program. This leads to 57% of the students thinking that they will become an engineer in the future, compared with 43% before they started. We hope that the legacy of this continuing program is a gradually increasing rate of graduating engineers. By taking this summer program, all of them have decided to work harder in school so that they will be better prepared for college life.

2. FREEDM Precollege Program 2015

In the summer of 2015, the number of participants almost doubled over the prior year. Among the twelve Young Scholars, one was Black/African American, while the rest were Hispanic. In addition, there was a significant change in the gender composition of participants this year as nine (75%) were female. Females seem to be more attracted to helping professions.[12] As a result, they usually favor careers such as doctors, nurses, teachers, etc. rather than engineers. We used the story of a surgeon vs. an engineer to broaden their view that engineers are actually helping people as well. As the surgeon wrote "*In my more lucid moments I wondered what I had achieved. After all, there were more effective ways to stop people dying than by being a surgeon. On my final helicopter flight I had sat next to a Swedish water engineer who told me about his work, while my body shook with chills. He built filtration plants, and the clean water that he had brought to the refugee camps had preserved probably thousands from death. By comparison I'd saved perhaps a handful of lives by operating to stop blood-loss or gangrene; improved the outcome of injuries in a few more cases where I was able to conserve a damaged limb or clean a wound, and possibly – just possibly – prevented some fatalities through the haphazard distribution of drugs among the refugees.*"[13]

The post-program survey substantiates the girls' desire to help others. All ten Young Scholars who participated in the survey think that it is important for them to do work that allows them to help their community or society. Nine out of the ten students agreed that attending the program increased their interest in studying engineering in college. This outcome also fulfills a goal of the FREEDM precollege program: to attract more students into STEM fields. Nine out of the 10 students plan to go to college after graduating from high school. With this as an impetus, all of the Young Scholars have decided to work harder in school. All of the students feel that energy education should be an important part of every school's curriculum, and they all agreed that they would do more to save energy if they knew how. In addition, seven students entered the science fair at their high school after participating in this summer program.

In the pre-program survey, 73% of the Young Scholars think that they can complete an engineering degree, and only 55% are confident that they can excel in engineering. However, after the program, both figures have increased to 80%. Before attending the program, only 55% of the students believe that they could be a good scientist/engineer one day, which is increased to

80% in the post-program survey. Similar to 2014, all of the participants feel that the FREEDM precollege program experience has met their expectations.

In addition to presenting energy related topics, we teach them some practical things related to their daily life. For example, we require that they ride the light rail to travel to the university. Besides cajoling them to choose a more eco-friendly way for their daily commute compared with driving to school, they learn the life skill of how to get to campus without a car. In addition, the light rail passes by several two-year community colleges that they might enroll in before transferring to the university. Therefore, even if they are not (initially) coming to the university, they know how to reach those institutions.

Conclusion

STEM subjects are playing a significant role in today's society not only in the United States, but also all over the world. The FREEDM precollege program is designed to help young adults realize and appreciate the value and importance of STEM and encourage them to pursue a higher education and engineering career, for example, within the electric power industry.[14] By participating in this four-week FREEDM summer precollege program, the Young Scholars learn about renewable energy resources and how to produce electricity using different resources. In addition, they taste college life and now know what they need to do to prepare for college. The program meets their goal of learning more about engineering. By participating in this precollege program, they gain confidence in their future study and they believe that they can do well in college. All four of the program elements help them to become interested in engineering and encourage them to pursue college studies in a STEM major.

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