

AC 2008-435: SERVICE LEARNING ORIENTED PRE-ENGINEERING PROGRAMS AND THEIR IMPACT ON NON-TRADITIONAL ENGINEERING STUDENTS

Adam Christensen, Georgia Institute of Technology

Willard Nott, American Society of Mechanical Engineers

Douglas Edwards, Westlake High School

Leann Yoder, Jets, Inc.

Christina Ho, Engineers Without Borders

Shannon Flanagan, Engineers Without Borders

Stephanie Hurd, JETS, Inc.

Marion Usselman, Georgia Institute of Technology

Donna Llewellyn, Georgia Institute of Technology

Jeffrey Rosen, Georgia Institute of Technology

Cathy Leslie, Engineers Without Borders

Samuel Graham, Georgia Institute of Technology

SERVICE LEARNING ORIENTED PRE-ENGINEERING PROGRAMS AND THEIR IMPACT ON NON-TRADITIONAL ENGINEERING STUDENTS

Abstract

This paper describes and analyzes a new program implemented by Engineers Without Borders-USA (EWB), JETS, Westlake High School (Atlanta, GA), and the Georgia Institute of Technology that introduces pre-college students to the field of engineering through the use of EWB-focused service learning engineering activities. This initiative differs from other high school engineering programs that emphasize competitions in that it highlights important engineering design concepts by rooting the students' motivation in the desire to help those in need. This emphasis on engineering-themed service projects allows for real-world reinforcement of sustainable engineering practices and promotes the education of ethically responsible and internationally aware students. We postulate that this move away from competition-based motivations and towards community service will be particularly appealing to non-traditional engineering students such as minorities and women.

This paper will examine the case study of EWB-Westlake High School, the first ever high school EWB chapter, which was chartered in the Fall of 2006, and conducted a work trip to Tanzania in July, 2007. The program assessment surveys address which specific activities were effective and which need future refinement, and explore the impact that an engineering service learning program can have on the future goals of the students involved. In addition, two new initiatives will be highlighted; a new national initiative that promotes engineering-focused service learning in high schools, and a local initiative focused on bringing service learning themes into pre-engineering curricula throughout the state of Georgia. This paper will include an alignment of program activities with state and national education standards, and should provide other high schools with the tools to initiate their own programs.

Introduction

The past decades have seen significant growth in the areas of environmentally conscious products, renewable energy sources, and large scale recycling programs within all branches of engineering. These programs have been initiated because of the public's awareness of environmental and social problems throughout the world. Indeed, the public's awareness must now be considered when designing new products so profits will not suffer due to the negative perception of irresponsible manufacturing and implementation^{1,2}. This worldwide movement towards total product awareness must be supported by a shift in how traditional engineering topics are taught, idealized, and approached both within engineering departments and the pre-college (high school, middle school) arena. Without changes to the educational system there is potential for accelerated global environmental impact (i.e. global warming), irresponsible globalization (i.e. exploitation of vulnerable populations), and a shortage of informed product developers among members of the global economy³⁻⁶. To address these ill-effects many university level engineering departments, like those at Purdue, Virginia Tech, and Tufts, are building graduate programs centered on engineering education⁷⁻⁹. These programs exist in order

to develop innovative and efficient pedagogies that result in increasingly aware engineering graduates.

Traditional collegiate engineering programs have been studied by both Haws¹⁰ and Herkert¹¹ and important questions have been raised about how to deliver effective ethical messages. A variety of methods were studied including the reading of humanist authors, engaging in rigorous ethical theory class work, examining case studies, formulating ethical heuristics, and participating in service learning activities. Each of these educational tools is valuable in specific applications, however, Haws concludes that service learning activities have the potential to help students “see the impact of their engineering through the eyes of others”. This altered perspective could help illuminate and solidify necessary ethical ideas that are desired among current engineering graduates.

The seamless integration of engineering design with ethics in service learning projects has enormous potential to engage students intellectually as well as emotionally¹. As a result there has been considerable effort to bring service learning effectively into the university setting. However, there has been limited effort directed towards an authentic service learning experience in the pre-college sector. A discussion of the public’s perception of engineering careers may illuminate why there has been a slow rate of incorporation of pre-college service-learning programs. Hirsch points out that common stereotypes of engineers, ranging from the negative (i.e. “engineers are nerds”) to the unrealistic positive (i.e. “all engineers are geniuses”), can have a negative impact on engineering enrollment¹². She also points out that students may have some incorrect notions of engineering in general, most notably, that “engineering requires no knowledge about business or the environment”. When taken together, these perceptions contribute to the narrow vision of what an engineering career involves, and underscores the importance of teaching engineering concepts at the pre-college level. This problem still exists among university level engineering tracks as they are unable to offer subjects that would accommodate varied interests, in part because of the time requirement to successfully complete the demanding workload. This inflexibility leads some students, even at the university level, to abandon their interest in engineering and to instead pursue other fields.

Herkert’s paper discusses the impact that public perception can have on product success within the framework of technological risk¹³. Similarly, this thesis statement may be used in an educational setting. Herkert argues that when significant and wide-spread attitude changes are necessary there is a need for a meaningful communication path between the lay public and experts. This is true for issues associated with risk as well as those associated with education. By introducing ethical concepts brought out by engineering educators through service learning activities and open discussions with pre-college students it may be possible to reverse some of the common misconceptions associated with engineering careers, thereby increasing enrollment of students who might not normally enroll, and retention of those already in undergraduate engineering programs. Additionally, by addressing ethics earlier in a student’s educational career there is the opportunity for concepts to be retained and later practiced by both the student and their families. It is the hope of the current study that pre-college students not be over looked as important participants in solving issues with global impact.

Recently, there has been an increase in the number of organizations that supply the field of engineering with outlets to practice sustainable and responsible engineering with elements of social activism. Groups such as Discover Engineering (www.discoverengineering.org), The National Service Learning Clearinghouse (www.servicelearning.org), Engineers for a Sustainable World (www.esustainableworld.org), East Initiative (www.eastinitiative.org), Engineers Without Borders (www.ewb-usa.org), and JETS (www.jets.org) are offering programs that include elements of social responsibility and, therefore, are naturally able to engage the students emotionally¹⁰. This emotional engagement leads to the students becoming more aware that their skills are scientifically and ethically meaningful, providing them with a heightened sense of learning purpose and motivation. In addition to these nontraditional engineering resources, large research universities have seen an explosion of student interest in global engineering issues and have formed collaborations with non-profit organizations and non-governmental organizations (NGOs)¹⁴⁻²¹. These programs have also shown promise in recruiting nontraditional engineering students²².

In this paper we discuss and analyze a recently formed collaboration between Engineers Without Borders (EWB), JETS, Georgia Institute of Technology (GT), and an Atlanta area high school, Westlake High School. This collaboration initially formed under the umbrella of a GT National Science Foundation GK-12 program, entitled the Student and Teacher Enhancement Partnership (STEP) program, but has grown to include several other entities with partners on and off campus. With initiatives put forth through STEP, the first official high school chapter of EWB was created at Westlake High School under their Science and Mathematics Magnet program. As the program at Westlake expanded other partnerships were forged between EWB, JETS, and GT that allow for engineering service learning programs to expand into schools outside of the metro Atlanta area. Plans have also been developed for an engineering design competition that includes ethical elements aimed at the high school/middle school audiences. Details of the programs mentioned as well as lessons learned and a study of the impact on participating students is presented in the following sections.

Background

STEP Program/Georgia Tech

The Student and Teacher Enhancement Partnership (STEP) Program started in 2001 and partners advanced Georgia Tech undergraduate and graduate students with metro-Atlanta area high schools in teams that are led by master teacher-coordinators. The program seeks to improve the teaching-related communication and leadership skills of Georgia Tech students and to use the exceptional scholarly expertise available at Georgia Tech to assist in increasing the mathematics and science performance of Atlanta-area high school students. To date there have been 95 graduate level fellows and 41 undergraduate level fellows working in 7 schools; the current year supports 12 graduate fellows and 12 undergraduate fellows.

STEP Graduate Fellows and Undergraduate Interns participate in summer training workshops to familiarize them with inquiry-based learning pedagogy, classroom management and effective teaching skills. They also work with high school personnel to develop a needs assessment and action plan for the school. During the school year they work in teams with their partner school,

choosing activities from a menu of options that includes student instruction, teacher professional development, student enrichment and mentoring, implementation of educational technologies, science fair project assistance, and Georgia Tech lab tours.

Westlake High School

Westlake High School is located in Atlanta, Georgia in southern Fulton County. Accredited by the Georgia Department of Education and the Southern Association of Colleges and School, Westlake has a Science and Mathematics Magnet program that offers classes for students with similar interests. The Magnet program prepares students for collegiate level courses in math, science, and engineering through their special course offerings. The primary goals of the Magnet program are to provide rigorous foundations in STEM subjects, develop partnerships with universities and businesses for internship experiences, and provide academic extracurricular activities to support their student body. All students participating in the Magnet program must make an 80% in all science and math courses and have a minimum GPA of 3.20. Westlake as a whole is composed primarily of an African American population (>99%).

Engineers Without Borders

EWB-USA was started as a result of the concerns and actions Dr. Bernardo Amadei from the University of Colorado in Boulder. In 2001, Dr. Amadei and a team of his students designed and built a water delivery system in the village of San Pablo, Belize at the request of the Belize Ministry of Agriculture. Since most adults worked at a nearby banana plantation, the responsibility for carrying drinking and irrigation water from the nearby Swasey River to the village fell to the young children, preventing them from attending school, and thereby maintaining a cycle of poverty in the community. That project resulted in the first EWB-USA chapter and EWB-USA incorporated as non-profit organization in June 2002²³.

Since then, the organization has grown to over 235 chapters that include over 7000 official members distributed among both university and professional levels at the end of 2007. The organization is experiencing rapid growth and one estimate puts it close to 50% per year. There are over 200 EWB-USA active projects open for assignment in 45 countries. Projects include water supply and treatment, energy, health and safety, education, agriculture, building and bridge construction, micro-enterprise, and sanitation.

JETS

JETS is a national non-profit educational organization that promotes engineering and technology careers to the pre-college audience. JETS provides programs and resources that allow students to explore, assess, and experience engineering first-hand. They provide support for student competitions, assessment tools and career exploration materials. There are more than 40,000 students and 10,000 educators from 6,000 high schools across the country every year that participate in JETS related programs. JETS participants are a diverse group; more than 1/2 are from groups that are traditionally underrepresented in engineering and technology fields, including 1/3 who are female.

Service Learning as a Tool

There exist communities around the world that are in desperate need of basic utilities such as clean water, sewage handling capabilities, and electricity; some of these communities are located within the United States. Since resources are limited in these communities they must rely on engineering knowledge donated by non-profit organizations or other NGOs. In response to this need many universities have set up student organizations that are dedicated to this cause. Schools such as Tufts¹⁷, University of Hartford¹⁹, University of Colorado Boulder^{16, 24}, University of California Santa Barbra¹⁵, Rice University²⁵, and Valparaiso University¹⁸ have worked in areas such as El Salvador, Tibet, Rawanda, Peru, Thailand, Belize, and Mali. Projects have included installing solar panels, digging wells, installing rain water collection systems, and addressing other needs that have been proposed by the community. These programs have had two primary paths of development within the university; those that are purely extracurricular in nature and those that are taken for credit through the students' home department. Some programs have even adopted the service learning concept into their senior design requirement as the projects naturally challenge the students to incorporate interdisciplinary topics (engineering, public health, public policy, environment) into their work^{15, 19}.

In addition to the satisfaction that is derived from helping communities in need there are other motivators that make service learning projects an attractive alternative. Bielefeldt et al. has shown that 50% of the 32 participants in University of Colorado Boulder's service learning project senior design course were women²², whereas only 20.1% of all engineering graduates (baccalaureate level) throughout the country are women²⁶. While social trends such as this are caused by many factors, there is promise that by simply changing the underlying motivational characteristics of a project, underrepresented populations can be drawn into engineering careers. This trend has also been observed in the pre-college programs discussed in this paper and will be elaborated on in subsequent sections.

Evolution of EWB at Westlake

An extracurricular Engineers Without Borders club was formed at Westlake High School through collaboration of the STEP program (GT) and the Science and Mathematics Magnet program. This collaboration was based on service learning ideas that have been deployed in universities and marked the creation of the first official high school chapter of EWB in the United States. In addition to the Engineers Without Borders club project, common themes were incorporated into the curriculum for the "Topics of Engineering" class that is offered to Magnet students. The extracurricular club met three times per week. Two meetings before school were dedicated to project brainstorming and organizational details (fundraising, travel, etc...). One meeting per week was scheduled for after school and was primarily used as construction time. Sub-committees (project managers, financial managers, internal managers, and external managers) were later developed to aid in organization. Typical roles of "president" or "vice-president" were avoided as they were viewed as exclusionary.

The first project that was focused on was a solar powered refrigerator. The motivation behind such a project was that it could be used to store vaccines at low temperatures so they would not

be lost due to spoilage. The raw materials included a small thermoelectric soft drink cooler, a 40W solar panel, insulating foam, a computer heat sink, copper wire, solder iron, thermal grease, and a duffle bag. The project was ideal in that it allowed many physics based phenomena to be explored such as how heat is transferred (Georgia Educational Standards: SP3, SPS5, SPS7), how electric circuits can be connected (Georgia Educational Standards: SP5, SP10), and how thermoelectric materials behave (Georgia Educational Standard: SP5, SPS5). All of these physics concepts were emphasized in addition to asking important public health questions; “How many vaccine doses can we transport?”, “How many people live in a village that would need this type of vaccine?”, “Why is it not possible to fly to a village and deliver the vaccines?”. By asking these questions of the students the motivation for the project was always centered on the service of a community in need. The completed prototype is shown in Figure 1 and was constructed for less than \$500.

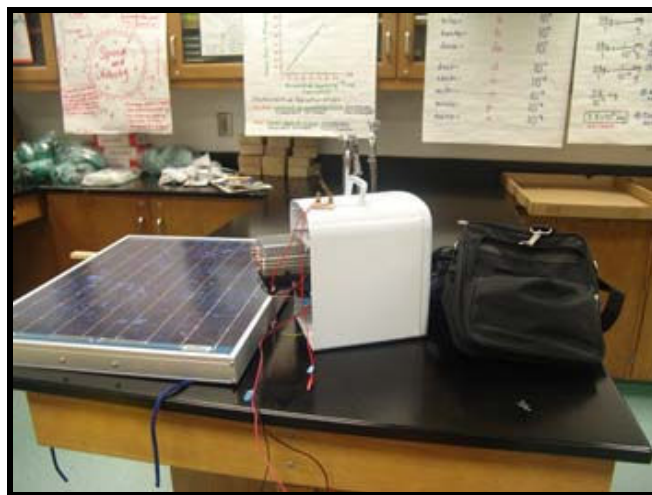


Figure 1: Solar Powered Thermoelectric Refrigerator

The solar powered refrigerator project took one semester to work through. The next project was conceived through a partnership with a NGO based in Arusha, Tanzania called the United African Alliance Community Center (UAACC). It was identified by members of the UAACC that members of Imbaseni Village would benefit from a solar cooker in order to reduce the need for costly fuels used to cook with. Villagers primarily relied on kerosene or wood in order to cook, both of which are very polluting when used indoors and kerosene can be very costly to obtain in Imbaseni as the only roads available require off-road vehicles for access. Students were required to analyze this problem from an engineering perspective as well as a public health perspective. As a result the students had to study much more about the culture of the community in order to assure that the project would be a success. To accomplish all this, the extracurricular club collaborated with the “Topics of Engineering” class as well as an “African History” class. Additional educational standards can be satisfied naturally by incorporating lessons concerning public health, sociology, and globalization into service learning projects (Georgia Educational Standards: SSWG3, SSWG4, SSWG5, SSWH21). Having a connection with a particular village allowed the students to see the impact of their engineering skills, which can be an important source of learning purpose and therefore, motivation.

During the summer of 2007, seven members of the EWB-Westlake club (3 male, 4 female) traveled with chaperones to Arusha, Tanzania to implement their solar cooker design on the grounds of the UAACC. The UAACC offered an ideal location to exhibit the design because of its central location within the Imbaseni Village and their commitment to teaching and informing community members about new technologies. In addition to constructing a prototype solar cooker the EWB-Westlake club members were able to purchase a brick making machine for the UAACC, they helped in the transplant of banana trees, and participated in cultural exchange activities (roundtable forums, town visits, an elementary school tour, and a meeting with the village elder). This visit also offered a unique opportunity for the club to evaluate future projects as well as set up an internet camera that can be used for direct video communication with the members of the community center. The EWB-Westlake club spent two weeks in Arusha, Tanzania and during this time the students kept records of their impressions on a website²⁷. Finances for the trip were raised with efforts from students, teachers, and community members.

EWB Westlake Program Evaluations

A program evaluation of the EWB-Westlake club has been performed in order to reveal necessary improvements and success stories so that future members of the club can continue to benefit in significant ways. The responses collected offer some interesting anecdotal evidence about strong and weak points of the program; however more work must be performed if global trends are to be assessed accurately.

The main group of students that were surveyed under this program evaluation represented the seven members of EWB-Westlake that traveled to Arusha, Tanzania under the solar cooker project. The group will be referenced as the “EWB Group”.

The EWB group consisted of a total of seven students, 3 were male and 4 were female, 6 students were in their senior year of high school and 1 participant was a junior at the time of travel. All students represented a minority demographic, with 6 students being African American and 1 student being Asian-Indian American. In order to assess the impact that the club had on the EWB Group a survey, shown in Table 1, was designed.

Table 1: EWB Group Survey

1	Please list all the engineering or otherwise "technical" clubs that are available at Westlake High School.
2	Why were you interested in the EWB club instead of other engineering clubs at Westlake High School?
3	What other clubs were you a part of at Westlake High School? Please list any leadership roles that you held in those clubs.
4	What were some of the cultural exchange highlights from your trip?
5	What were some of the engineering project highlights from your trip?
6	What do you see as the future of the EWB club at Westlake High School?
7	What do you see as the future of EWB high school chapters within the entire United States?
8	What are your future goals (including both college and career)?
9	Did this trip have any effect on your future goals?

Questions 1-3 aimed to establish the baseline of what a school with a Science and Mathematics Magnet program can offer its students. Not surprisingly there are several extracurricular STEM themed clubs that are available to students, including, National Society of Black Engineers (NSBE), Robotics Club, Digital Design, and a Medical Sciences Club. Most of the students showed an awareness of all the available clubs at Westlake. With club choices available but being limited by time, students must prioritize which clubs they would like to join. Many of the students reported that they were active members of at least two other clubs, often holding leadership positions. When asked why they were active with EWB instead of other clubs responses varied from *“I was interested in this club the most because this was the first one I was introduced to”* to *“Being an engineer has been my dream since I was in elementary school. I love physics and building things.”* However, out of the 7 responses collected 3 of them made mention to the fact that *“EWB actually did projects with a purpose.”* One student elaborated, *“It wasn't engineering for the sake of just doing it; it was designed to help someone. Plus, EWB was hands-on. We actually got to take stuff apart and figure out how it worked. Plus, EWB challenged you to think of creative ways to solve a problem.”* While the sample size is too small to yield conclusive results, it is noteworthy that several of the students were initially drawn to the EWB club because of its service oriented projects.

The purpose of questions 4 and 5 was to quickly understand some of the impressions that were created during the international portion of the club experience. Answers varied among the students and for brevity only a sample will be reported. In response to the engineering project highlights question one student wrote, *“One major highlight from the trip was the amount of teamwork we used to construct the cooker. Usually there is fussing when we are trying to get something done. But on this trip we knew what had to be done and we didn't have any time to spare.”* Another student responded with, *“I especially enjoyed figuring out how to cut the metal sheets for the inside of the solar panel. I knew that we needed pretty precise numbers in order for it to fit together perfectly. It was finding out the lengths and other data for the metal sheets that made me feel like an engineer out in the field.”* The overall sentiment among the students was that the experience was a positive one even if there were some roadblocks that needed to be overcome. In fact, the unique problem-solving environment (a developing country) seemed to further excite others in the group.

While the engineering design part of the trip was the driving force for traveling to Tanzania, it was also important to immerse the students in an authentic cultural environment. This immersion allowed for strong connections on a human level to be built towards the community in which the work was being performed. This connection, while subtle, is critical for drawing non-traditional students into the program to begin with, as highlighted in questions 1-3. In response to question 4 one student commented on the youth forum, a round-table discussion of important world topics such as AIDS, globalization, and the environment; *“The youth forum was definitely the most enlightening experience of the trip. It was cool learning that teenagers from a completely different area of the world were experiencing the same problems that I was going through. I just loved learning about another culture as it relates to people my age.”* While another commented on some of the rituals of Tanzanians, *“I enjoyed the ceremony at the end when we were about to leave. I did not know that anyone in Tanzania performed binding rituals or [gave] gifts to those that have visited them. It was incredibly interesting.”* Still another commented more generally on social interactions observed between village members, *“It was*

great to experience and see how pleasant the Tanzanians were. They were very friendly to us and amongst themselves. Politeness, courtesy and civility are highly valued in this country.” It has been proposed that interactions and observations like these are critical for long-term retention of material and a deeper, more personally relevant lesson²⁸.

Questions 6 and 7 were asked in order to assess the sustainability of a pre-college service program like the EWB club. Since this program was highly dependent on external funding sources a fair assessment would be needed to warrant future trips. It is also critical that the students develop a sense of ownership over the program and help guide the development. On the local level (within Westlake High School) the students’ comments were positive and all 7 responses predicted that EWB would continue to “...grow into something bigger and better than last year.” One student predicted that “...EWB [will become] a larger club at Westlake high school. Because the club is hands on and less talk, it will attract more students. And the idea of being able to implement what you help design will lure them even more.” From the surveys that were collected subtle factors that directly impact sustainability are not identified, however the evidence collected shows positive attitudes toward future developments. Since EWB-Westlake is the first program of its kind within EWB-USA there are initiatives in place to help promote future development in other schools on a national level. In question 7 the issues of national development is probed. Responses ranged from the cautious, “*I think that we will see more EWB high school chapters, but at a slow pace*” to the optimistic, “*I see all of the EWB chapters Across the United States doing AMAZING things. I see all of us coming together to do a major project that will affect the whole world,*” and “*One day, EWB will become the staple club that all high schools have--like SGA.*” All responses hinted at program growth, but warned that the format must be promoted in ways that highlight the hands-on and service aspects. It is interesting that if service-learning programs are presented to students there seems to be no lack of enthusiasm. From observations of active membership and general enthusiasm made during the first semester of the program, prior to the partnership with the Tanzanian NGO, there seems to be only a weak correlation between the organization’s “success” and the possibility of traveling abroad. The definition of a successful pre-college organization can vary widely. Therefore, a working definition of a successful club in this study would be described as one that meets all previously outlined objectives. In summary, those are to 1) increase awareness of what an engineering career involves in a pre-college environment, 2) increase awareness of social inequities in the world, 3) show that engineers can make a direct impact on the quality of life of an individual, 4) inspire non-traditional students to consider engineering as a career, 5) solidify some of the foundations that are needed in order to continue studying engineering in a college setting. When comparing these goals with the survey responses it is can be seen that without an international travel component all of the goals can be satisfied. Not surprisingly, there exists the impression that the travel component provided a more profound impact when compared to work performed locally. The added human connection and hands-on experience of working in an international setting during the students’ pre-college years is hypothesized to affect long-term personal goals. In order to illuminate the details of how an international experience affects personal goals a longitudinal study would be necessary and is suggested as future work.

Two of the main goals of this program were to spark interest in engineering and show that engineers have a direct effect on the quality of life of an individual. The last two questions were asked in order to measure the ability to achieve these two goals. All students in question 8

suggested that they were interested in going to college in programs that ranged from law, medicine, engineering, management, and architecture. Most students made mention that they were interested in pursuing advanced degrees. Responses to question 9 were interesting when compared with the previous responses. One student responded in question 9 that, “...before the trip I was focused more on a major in business, but now I'm more interested in engineering.” Other students that mentioned an interest in engineering in question 8 discussed the possibility of entering a service based career in the responses to question 9. In one particular example one student replied, “I have been considering starting my architecture firm in Tanzania, or somewhere in Africa.” While another student mentioned, “...the trip showed me that it is possible to care about the environment while at the same time continue a passion for engineering.” One student participant was not involved with the Magnet program at Westlake prior to the trip. Upon return the student “...really buckled down on grades, joined the Magnet program and even basic skills, like organization, [had] improved.”

EWB/JETS Project Organization

Based upon the work performed at Westlake High School, EWB and JETS partnered in order to help promote service-learning projects among pre-college students. The EWB/JETS Design Challenge was launched October 1, 2007 and aims to provide projects that emphasize sustainable engineering practices and engineering ethics. The vehicle for distribution is primarily through the JETS monthly newsletter and their website. The program is promoted in two formats for different levels of incorporation in an educational environment. The first format is presented as a classroom activity. The second format is presented as an annual design challenge.

The classroom activity has been designed with input from the New York chapter of EWB. The initial activity was created to provide educators with tools that can be used in order to easily incorporate engineering and ethics principles into their daily lessons. This activity is centered on the idea that a dam needs to be repaired in Cambodia. Activities have been developed for Pre K-2, Grades 3-5, 6-8, and High School in order to appeal to a range of potential audiences and have been designed in alignment with the Massachusetts standards for technology/engineering. One of the key motivational sources for students when working on these handouts is that the project is actually an active EWB-NY project. A message board is provided for interaction between the EWB-NY chapter members and any students/teachers that choose to adopt these activities.

The annual design challenge has been developed on work that was performed with the EWB-Westlake club while in Tanzania. In addition to the trip being an implementation trip, it was also used as an assessment trip. Other projects were identified and researched throughout the community and later compiled into a database of needs. From this database, several projects were selected for their urgency, construction complexity, and feasibility to be presented to the JETS/EWB audience. This year's projects center on four major design challenges and are purposefully left open ended in order to encourage creative solutions from the participating JETS clubs. Since each of the design challenges is a need in Imbaseni Village the proposed solutions will be judged by members of the UAACC as well as JETS and EWB for their technical merit and creativity. The deliverables of the competition can then be proposed to the UAACC and local Tanzanian community members as a solution to their need. At this point the community has the opportunity to adopt the solution. With this type of design competition, the students

benefit from participating on an active problem in a community in need, which addresses issues of project ownership and motivation. The community is also able to obtain interesting engineering solutions to their needs at little cost to them.

EWB/GT Project Organization

Institutions of Higher Education have a vested interest in promoting K-12 STEM programs and activities that are likely to attract students into the STEM pipeline, and to provide a supporting infrastructure. Within the pre-engineering field, the activity of choice is often a form of robotics, as there are well defined and well advertised robotics competitions in many locations that can serve as the culminating activity for engineering or robotics clubs. These robotics competitions ensure that the club or class focuses on a long-term goal, and that the students actually design and build something. In our experience, however, it is difficult to attract enough girls to make up more than about 25% of the robotics participants, or enough under-represented minorities to reflect their population numbers, since a sizable fraction of the potential engineering students are not attracted to robotics.

As part of the EWB initiative, the College of Engineering at this university is implementing a “Young Engineers Day” that challenges engineering clubs and technology classes to design projects with a social consciousness theme, and to present their designs, in the context of the societal issue they are addressing, to university and industry engineers and to each other. Teams are encouraged to use the cases put forward by JETS and EWB, but may also present solutions to other socially relevant problems. Particularly well designed projects will be awarded funds to enable the team to create a working prototype, with encouragement for the organization to officially become an EWB chapter.

It is the contention of the authors that this type of engineering challenge, rooted as it is in service learning and social relevance, will attract a higher percentage of girls and minorities than do traditional robotics competitions. Data will be collected as this program grows, to determine whether this is the case.

Conclusions and Future Work

In this work a pre-college program was established which centered on concepts of service-learning. Partners included Engineers Without Borders, Westlake High School, Georgia Institute of Technology, and JETS. Out of these partnerships grew programs that provided some interesting anecdotal evidence about how non-traditional pre-college students can be motivated to consider engineering as a career. Future work that needs to be completed includes longitudinal studies of pre-college EWB clubs, investigation of efficient program marketing strategies, and development of standardized survey tools for nationwide program assessment.

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