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Integration of Engineering Education and Research with Community Service

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***Abstract* — The strong interaction between teaching and research encourages faculty members to inspire, motivate, energize, stimulate, and promote their students towards the real goals of engineering education. Due to the need for education process improvements, integration of teaching and research with community service is necessary for the advancement of society. The efforts invested for the engineering education, the scientific research, and the combination of teaching and research with community service are not only essential for industrial development, but are crucial for our life, nature, and to enhance the technological and intellectual level of our society. This paper presents the benefits associated with incorporating teaching and research into several community services while also discussing the establishment of such a mechanism in engineering education through CAUSE Program.**

***Keywords*—Community Engagement, Service-Learning, Engineering Education**

I. Introduction

Engineering students possess the innate characteristic of finding solutions to problems by applying scientific knowledge, mathematics and ingenuity. Through community engagement programs, students are involved in undertakings that address local needs, while increasing their academic skills and commitment to their communities. Students also develop a sense of responsibility towards society and learn cultural tolerance.

CAUSE (Community Activities by Undergraduate Students in Engineering) Program was initiated in May 2006 at Ajman University of Science & Technology (AUST). Since then students have been working in groups, targeting different sectors of the society, researching and developing solutions to make their society a better place. The objectives of this program are as follows:

- Develop technical depth and multi-disciplinary breadth
- Experience planning, organizing and executing a project
- Acquire professional and interpersonal skills
- Create products and awareness that have a significant impact on their community
- Grow as individuals, engineers, and good human beings

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These benefits of CAUSE were outcomes that the engineering education community was seeking in the early 1990s [1–4]. With continual effort and by integrating time and context into other aspects of the curriculum can lead to further innovations that provide outcomes that the engineering education community seeks for the coming decades [5, 6].

II. Overview of CAUSE

A. *Motivation*

The engineering curricular structure in United Arab Emirates has no allocated credits for community service projects. Hence, the students are motivated to take up such projects by introducing national-level community service project competition. This competition requires engineering students to chose a project, plan, organize, develop and deliver in a span of one year. The contribution and impact is evaluated by a panel of esteemed judges and the students' efforts are acknowledged and rewarded.

CAUSE was created as a result of discussions in the early 1990s about the state of engineering education [1–4]. The engineering education community demanded graduating students who had strong technical backgrounds but few of the other skills needed for successful careers. The consensus was that students, to be ready for the future, would need:

- Professional skills, including the ability to work in a team environment
- Effective writing skills, presentation skills and verbal communication
- Understand the needs and propose tailor-made solutions
- Aawareness of the many issues affecting any engineering project, including ethical, legal, and environmental issues
- The ability to work with people from many different backgrounds and in different social settings.

B. *Challenges*

The key challenge faced by students and faculty was to accommodate community service projects additional load to the engineering program course load. Doing extra projects for community service is quite difficult to teach or develop in a traditional engineering curriculum. Hence, students were encouraged to choose their capstone projects aligned with community service. Junior students were encouraged to assist senior students and act as mentors to students of high-school.

At the same time, community service organizations were facing a future in which they must take advantage of

technology to improve, coordinate, account for, and deliver the services they provide. Their challenge was to find the long-term, low-cost, customized technical assistance that they required.

C. *Benefits*

CAUSE program was created out of the realization that these mutual needs created a unique opportunity to form long-term partnerships between the university and the community [7]. The vision was that the partnership would provide two benefits:

- Engineering students perform research, create awareness and develop real-world design projects that benefit the community.
- Access for the community partners to the low-cost technical expertise they needed to improve their capability to serve the community.

This combination of challenging community service projects and long-term service to the community has proven to be extremely successful. CAUSE teams are learning both the technical and professional skills they need. The products they develop and deliver to their community partners are being used every day in the community.

III. Themes

When we consider the impact of CAUSE on our students, two themes have emerged as key: C*ontext* and *Time.*

A. *Context*

The long-term community partnerships have created a compelling context for projects that can engage students and hold their interest and commitment over the course of several semesters and years. Because the projects are defined by needs identified by the community, the students know that, if the project is done well, it will in fact be put to use. This adds the very important dimensions of responsibility, accountability, and commitment. Together these dimensions of CAUSE projects help the students mature as individuals, as engineers, and as good human beings.

The learning via real projects also allows exploration of start to finish design, including problem definition, development of specifications, version control, design/coding standards, and rigorous testing. As the projects will be used by the specific sector of the society, it adds many dimensions to the design criteria including design for reliability, usability, maintainability, safety, aesthetics, and manufacturability.

B. *Time*

It is a challenging task to cleanly fit real-world projects into 17-week semesters or 34-week academic years. One of the most significant aspects of the CAUSE program is that it enables project teams to bridge the gap between the privileged and under-privileged. Teams therefore have the time to deliver well-designed, well-tested projects to their partner; gather feedback from their partner and improve on their design; and work with their community partner to identify new opportunities.

From the students' perspective, their extended participation on a team provides time to learn both disciplinary depth and multidisciplinary breadth. It also provides time to gain a sense of the role of engineering in society, self- and team-awareness, and professional skills. Assessment data has shown that the time spent in CAUSE has indeed allowed students to develop these skills [8].

The long-term participation of advisors, as well as students, provides many opportunities for mentoring in all of the areas listed above. One of the greatest rewards of advising a team is getting to know the students and watching them develop throughout their academic careers.

IV. Examples of CAUSE Projects

The CAUSE teams consist of five members each. The teams are usually vertically integrated, that is, composed of freshmen, sophomores, juniors, and seniors. The projects are chosen after performing survey, identifying the problems and then addressing the concerns that require immediate attention and action [11]. Some of the projects carried out by the CAUSE teams are described below.

A. *Student Mentors for Awareness Raising Tasks (SMART)*

The main focus of this project is to motivate and encourage school students to take science subjects in their studies and help them understand the significance of engineering in shaping the modern world. Considering the effectiveness of peer-to-peer communication, the message is readily conveyed to school students and there is noticeable impact of SMART project in spreading the awareness about science and engineering.

The SMART team at AUST has visited a several primary and secondary schools. A typical visit includes a power-point presentation explaining the significance of science and engineering, the role of engineers in developing new technologies, and a brief introduction to various engineering disciplines. This is followed by a demonstration of simple projects developed by AUST engineering students. Finally, a question-answer session is initiated student mentors answer the questions with further explanation about the engineering profession.

The SMART team also plays an important role during the visit of high-school science students to AUST. They act as guides during the laboratory visits and help them understand various issues concerning engineering education. Special emphasis is placed on encouraging girl students to select an engineering discipline for their university studies.

(Cont..d)

B. Vision – The art of seeing things invisible

This project was initiated to learn from and educate the visually impaired individuals in the society. The Blind Association in UAE was approached and several organizations serving the blind were chosen for offering volunteering service by AUST engineering students.

It is a long term project and its full impact will be quite obvious not only over next few years but also through the coming generations. Its implementation has made significant contributions in raising awareness and bridging the gap between visually impaired and visually sighted and encouraged individuals to interact and cooperate more with each other. In addition, it boosted the self-confidence of the members of TAMKEEN. They gained knowledge and also discussed opportunities for placement in society with suitable jobs.

The Vision Team members gained a lot in terms of enhancing their planning skills, organization skills, communication skills, and leadership skills. Also, it raised their knowledge of Braille language and the equipment used by visually impaired people and the latest technology and supporting software programs on that field. Also attending audio movie sessions and training seminars has boosted the Vision Team confidence in communication with people having some physical disability with various age groups and helped us to strengthen other sensation like touching and listening. Moreover, it has raised the team confidence and provided a sense of contribution towards the community bringing immense satisfaction and pleasure.

C. CARE – Community Activities Rendered by Engineers

The project focuses on educating and empowering children with special needs and applying engineering knowledge to build simple projects to aid their day-to-day life.

The CARE team pays regular visits to schools catering children with special needs. Under the supervision of their staff, the CARE team contributes in training and educating the physically challenged children to develop their vocational skills. In addition to that, the engineering students developed a voice recognition system for the special needs school to help challenged children in performing simple tasks. In 2 years, the CARE team contributed in training over 50 children of which six challenged children eventually found jobs as telephone operators, data entry operators, musician and vocalist for advertisements.

D. Social Volunteering Project

This was a multidimensional project to train, educate and help individuals in leading a safe and healthy life. This project targeted many sectors of the community, namely, children with special needs, elderly, single mothers, abuse victims, diabetes patients, school children, etc. AUST students went through vigorous training by professionals of various organizations for specific tasks, in order to assist the organizations staff in serving the community. The key contribution is listed below:

Diabetes Awareness: The objective was to enlighten the society with the problems involved with this disease and how to overcome or fight these problems. Certain tests such as blood glucose test were conducted free of charge for the ones who were willing to check up if they suffer from any such disease or have a potential to be diabetic.

Dubai Walk: This event is a part of the Community Development Authority organized by the Dubai Sports Council. This event was held in Mamzar Beach, Dubai. The goal of this event was to demonstrate the importance of physical activities and to highlight the role of sports in avoiding or controlling certain diseases, for instance diabetes. This event helped in removing UAE from the top ten countries suffering from diabetes (according to the Community Development Authority).

Fifth Championship "ALPUCCI" with Down Syndrome: An event held under the patronage of Her Excellency Mariam Khalfan Al Roumi, Minister of Social Affairs. The event took place in UAE Down Syndrome Association , Dubai. The aim of this event is to persuade down syndromes to contribute in life activities and to help them communicate confidently with the society.

Community Police with the Ministry of Interior: This event was held in the Community Police, Ajman. The purpose of this event is mainly to deal with the public safety issues such as crime, social disorder, and fear of crime; thereby, it supports systematic use of partnerships and problem-solving techniques.

Electrical Safety: A significant event held in Fatima Al-Zahra Secondary School, Ajman. The focal aim of this event was to convey basic knowledge about electrical engineering to the high school students and presenting previous engineering projects to demonstrate the aptitude of electrical engineers.

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