A Research Based Assignment in a Course on Communication System to Infuse Technology Applications in Humanitarian Action

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Abstract

Innovative use of Information and Communication Technology supports effective and efficient humanitarian action. This paper presents a research based assignment for electrical engineering students taking an elective course on "communications systems". Students were assigned to research on recent and novel application of communication technology in humanitarian action. Along with summarizing their research, they were assigned to prepare a report describing the engineering system and its suitability for use in disaster or developmental situations. Student survey at the end of the course revealed that this research project enabled them to understand the system design aspects along with how innovative use of telecommunication technology infrastructure was able to contribute to the improvement of quality of life and provide improved access for humanitarian action. The survey also indicated that they became more aware of the use of technology for public good and that it promoted a sense of volunteerism.

Keywords

Telecommunication Technology for Humanitarian Action, Communication system, Research assignment, Project based learning

Introduction

Traditionally engineering courses have emphasis on academic rigor along with simulation and laboratory exercises. In recent times it has been complemented with experiential learning and service learning in order to instill both, a moral and social responsibility among students. However, community development activities that are relevant to the discipline specific engineering curricula are not often easily available locally for such a transformational education to be implemented. Student clubs in several institutions such as "Engineers without Borders" provide volunteering opportunity in community development activities either locally, nationally or globally. To engage in such efforts that may not be available locally, students travel to places that require their services. However, only a few students are able to participate in the available club activities that take place during summer or other short breaks. A few other students engage in product development that improves quality of life in the developing world through the capstone course that is taken in senior year. While only some students benefit by engaging directly through club activities or by designing technology for humanity, others gain ethical and social responsibility required for professional practice from a course that satisfies the ethics requirement in the ABET criterion. Strategies to teach engineering ethics with the goal of encouraging engineers to serve as effective volunteers are presented by Kevin M. Passino[1].

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In order to give students an experience of technologies that serve the needs of communities in developing countries and to improve the quality of life, a multi-disciplinary course titled: "Appropriate Technology for Developing Communities" was created at Rose Hulman Institute and presented by M.M. Payne et al[2] at the 123rd Annual Conference of ASEE in 2016. Findings from a survey of students in this course indicated that "they were able to get a real-world glimpse into the opportunities and challenges of practicing engineering in developing communities" and that "they expressed interest and joy in learning the content and its focus on humanitarian engineering context".

Another study by Bielefeldt and Canney[3] presented the differences between disciplines and institutions on humanitarian aspiration for engineering students. A survey was conducted by the authors to study if the students felt that an ability to help others was a central message in their major. Findings from their survey indicate that while 73% of students in Civil Engineering major are in agreement, only 45% of Electrical and Computer engineering majors say the same. The study also indicated that Christian institutions were among the highest to respond positively to this survey question. Clearly these studies indicate that whenever possible it would be expedient to incorporate technology applications for improving quality of life of the underprivileged into the courses and more so in Electrical and Computer engineering majors as fewer students in this major feel the ability to help those in need as central message in their major.

Effective response in humanitarian crises has been made possible through innovative uses of Information and Communication Technologies (ICT). Through the use of software application in mobile devices several novel resources have been created for benefitting the impoverished and disadvantaged as described in the blog on 'Mobile Money: Getting banking services to the poor[4]. Ellis et al[5] described that in software engineering courses, humanitarian education was infused by engaging students in a project on creation of open source disaster management software. The humanitarian aspect to this project was listed as one of benefits to the students.

It has been suggested by Kevin M. Passino[1] that in order to encourage volunteerism it is essential to give assignments that explore and promote it even if they were entirely "paper studies". The reference further supports research based assignments – "students could be asked to research and then provide a survey of current volunteerism projects that clearly require engineering skills".

The Jesuit University Humanitarian Action Network (JUHAN)[6] at Fairfield University together with Universidad Central Americana (UCA) and Georgetown University agreed to jointly explore the following three-part question ("The Big Question") - What is human suffering and why does it exist in the world today?, what are individual and collective responsibilities for humanity?, and; what can we do about it? A group of faculty members from different disciplines were selected to form a Faculty Learning Community (FLC) to examine these questions as well as understandings relating to humanitarian action and infuse them into the curriculum. The FLC met several times over a semester. As a participant of the FLC, the author's work with students on the course Communication Systems' is presented titled 'in this paper.

This paper presents an approach to infusing the relevance, significance and effective use of telecommunication technology solutions in humanitarian action in an elective in Electrical engineering major – "Communication Systems". A research project based assignment was used for this purpose. Although this project gives a theoretical background of technology solutions for

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humanitarian action, it has been used as an effective strategy to encourage volunteering amongst students along with gaining knowledge of their engineering principles of operation.

Teaching Methodology

The semester long elective course in "Communication Systems" was offered to both graduates and undergraduates. The topics covered in the course include Analog modulation and demodulation techniques (amplitude modulation (AM), frequency and phase modulation (FM and PM); Digital Modulation and demodulation techniques (ASK, FSK, PSK, QPSK, QAM, PCM, and delta modulation). It discusses information measure, source coding, and some error correcting codes. Additionally, it discusses Gaussian Noise, Signal to noise ratio, Noise Figure of cascaded system and communication link design, application of Shannon's Channel capacity theorem. Students taking this course should have satisfied the pre-requisite courses on Signals and systems and Probability theory.

A good communication technology infrastructure is an important resource for various agencies working in humanitarian action to provide better services during the time of disaster or crisis and for effective aid management[7]. It is also essential to set up new communication links quickly whenever and wherever need arises during emergencies. This was the basis for introducing a research based assignment on humanitarian action within this course.

To introduce the topic of humanitarian action, during the first meeting students were posed the three part questions and were given few minutes to discuss as a group. The Institute of Electrical and Electronic Engineers (IEEE) website[8] was shown and students were asked to focus on the words below the logo "Advancing technology for Humanity". The students were asked to reflect on these words and discuss in a group what their reflections were on this phrase. Students were then asked to discuss ways in which technology could alleviate human suffering.

The educational use of video on campus is rapidly increasing in all fields. A video[9] (3 minute duration) on the installation of VSAT for the purpose of humanitarian action during the Nepal earthquake by, "Emergency Telecom Clusters", was used for providing further discussions on the student assigned research project. This video and the related discussions set the stage for the research based assignment.

Students were guided to relevant abstracts on the IEEE Xplore digital library on "Global Humanitarian Technology Conference" and resources from the website of CDAC[10] – 'Communicating with Disaster Affected Communities'. The students were provided with their research based assignment along with sample references[11-14] and another video[15] on the concept of *M-Pesa* that showed the impact of communication technologies. The research question is as below.

Research Questions –

Part A: Identify any one paper from the publication on the IEEE Global Humanitarian Technology conference available in the library or any other source that you may find from open resources that is relevant to using communication systems for supporting humanitarian action.

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Cite the reference and summarize in your own words the humanitarian action that was provided through communication technologies in three pages. If possible suggest any extension to the work that you have summarized.

Part B: Assume that you were using any two of the following communication technologies in humanitarian action - ham Radio, VSAT system, cellular mobile systems, mobile satellite systems, and microwave systems. Prepare a report explaining why the system you chose was appropriate for the humanitarian response in the given situation. Additionally, the report shall address the following – the block diagram of the system, the frequency band the system operates in, information on the type of modulation that is used in the transceivers of these systems, the complexity of the system; also mention one or two key players that manufacture these systems, the installation requirements of the system in terms of infrastructure such as power, size (area), other issues that are particular to the system – for example - antennas etc., whether these communication systems enabled data and the maximum data rates that is possible. Identify the regulatory bodies that approve or license the installation of such systems.

The deadline for completing the research assignment was set as two weeks prior to the final examination. Students were encouraged to work in groups to enable them to discuss among themselves and to explore options for solutions. They were allowed to interact with the instructor – the author, on questions and guidance relevant to the project. The engineering skills required for the project was covered during their coursework.

The course covered a number of topics in terms of theory without an associated laboratory component. Most of the class room instructions were based on lectures and problem solving. Hence, to enable better understanding of concepts a laboratory demonstration of tone modulated AM, FM and PM (analog modulated) signals was performed using a spectrum analyzer with projection capability. Students were allowed to use the equipment after class meetings to learn the basics of using the equipment and spectrum measurement of analog modulated signals that were demonstrated. Literature[16] indicates the need to include Matlab simulation for students to understand the systems aspect better and thus emphasize the academic rigor. Matlab codes to perform analog modulations was provided to students and discussed in class. Additionally, Matlab simulations using communication system toolbox; that calculated the bit error rate and showed the eye and constellation diagram of digital modulation systems – BPSK, QPSK in the presence of channel noise were demonstrated.

Student grade evaluation was based on newly introduced research based project that infused technology applications in humanitarian action along with other standard assessment methods which include, tests, homework, Matlab simulation project, Multisim simulation project simulation or a demonstration of a communication circuit in laboratory and a final examinations.

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Results and Discussion:

Student comments in the survey at the end of the course:

- Project was interesting and learned new ways to help people in need technically
- Good work to learn technology with humanity
- Helped to learn more about humanitarian actions
- More aware about human suffering and need to eradicate them
- Helped me to think and contribute something to the world
- Learned different kinds of communication systems used during hazards
- Got to know about humanitarian projects
- It showed the impact technology can have on the world
- It was interesting change from normal engineering homework
- An opportunity to learn apart from books
- One more step towards a better world
- It was interesting, you should incorporate "Engineers without Borders" as well
- Helped me understand how technology can be used in rural places

The survey among the 17 students participating in the course suggests that all of them believe that technology is meant to help and alleviate human suffering, with 15 of them feeling that they have a stronger sense of responsibility for using technology to advance humanity after the project work in the course. The remaining two were unsure. Four more were unsure if they would have felt that way, if they had not participated in the course.

All but one of the seventeen students in the course believe that they will be able to respond individually and collectively with solutions for global public good based on the learnings in the course. Fifteen of the participants feel that homework assignments and the videos as well as weblinks in the blackboard (BB) contributed to their learning and have assisted them in carrying out the research project.

Further, all but one in the class responded that they are now more likely to volunteer their technology skills and knowledge for work in the field of humanitarian action and that the course and the project have been helpful in this regard. Fourteen out of the seventeen responded that their being a part of the project contributed to their learning; the remaining three who felt otherwise however in their narrative comments confirmed the usefulness and interesting dimensions of the project.

Overall, it is clear that students have gained insights to the contributions that telecommunication technology can make for advancing response in humanitarian crisis.

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Biography

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