GP186/abs017

What do Students understand by the term 'Humanitarian Engineering'?

Simon Hill (hills10@coventry.ac.uk), Dr. Elizabeth Miles (aa7679@coventry.ac.uk)

Coventry University, England

Abstract: *Several Higher Education Institutions have educational groups whose titles include the term 'Humanitarian', such as the 'Humanitarian Centre' at Cambridge University or the 'Humanitarian and Conflict Response Unit' at Manchester University. Many engineering departments across the UK are engaging with a charity known as 'Engineers Without Borders', an international development organisation seeking to remove barriers to development through engineering. Coventry University is in the process of embedding 'Humanitarian Engineering' at the heart of what the Engineering and Computing Faculty delivers to its students. There were many reasons for this approach, ranging from a desire to increasing student retention rate and enhancing graduate employment prospects, through to preparing engineers to operate in a more global and international context. As part of the change process to facilitate this embedding it was vital to understand exactly what is encompassed by the term 'Humanitarian Engineering'. Once an understanding had been gained, developments in the marketing, curriculum and pedagogy of the courses could be implemented, in order to further Coventry University's reputation as a centre for engineering excellence. This paper presents the results of questionnaires, focus groups and workshops that were conducted at Coventry University and externally via the Global Dimensions for Engineering Education Project. The paper discusses recent literature around the term 'Humanitarian Engineering' and highlights the perception of the term and will conclude with how Coventry University has decided to interpret the term, and the impact that this will have on the future of the curriculum in the Faculty.*

Introduction

The word Humanitarian has gained increased popularity in recent times with Cambridge and Manchester Universities creating "The Humanitarian Centre" and "The Humanitarian and Conflict Response Unit" respectively, as just two examples. This emergence of the term within higher education has seen specific growth within engineering departments, and more specifically in relation to the term Humanitarian Engineering, with thirteen universities participating in the Engineers Without Borders Challenge. Yet when reviewing the meaning of the term, the only thing that is clear is that there is no clear definition agreed upon by key individuals in the topic area. Therefore the problem arises that if there is no consensus on the meaning at national or international level, then the value of the term is reduced within curriculum and pedagogic practice in Higher Education, when students are introduced to the term Humanitarian Engineering. Herder recognized humanitarianism as being "a commitment to the advancement or perfection of the human race" (Mitcham 2010)

This paper documents a small research project aimed at gaining an insight into the understanding and connotations of 'Humanitarian Engineering' from students who have little or no

prior knowledge of the term, compared with those who have experience in the field, either through higher education or extra-curricular activities. Highlighting current student understandings of Humanitarian Engineering will potentially enhance the design of appropriate teaching strategies; that will in turn interlink with Coventry University's work in the area. As a result of work (as yet unpublished) by a member of staff who was awarded a 'Vodafone World of Difference Award', Coventry University decided to review the impact initiatives such as engagement with Engineers Without Borders UK (EWB-UK) had on students' career progression, career perception and employers' perceptions of the abilities of the resulting graduates. This work showed that students engaged with EWB-UK (on any level from general engagement with a student society through to going on international placement) have a deeper understanding of the practical aspects of engineering, a broader understanding of global and international issues in engineering and a stronger understanding and definition of their own personal professional engineering identity. Further, it is known that the UK has the lowest percentage of female engineering undergraduates in Europe, with an 85:15 split (Beraud 2003) yet engagement with EWB-UK appears to have a gender split of 60:40 (M:F). The overall implication is that 'Humanitarian Engineering' in its broadest form, could potentially be a vehicle to address many of the documented challenges within the engineering curriculum today.

Literature Review

The term *humanitarian engineering* is difficult to find in traditional engineering academic texts. From a broader search of journals and recent pedagogical literature, the term reveals it to be a nascent area of study with a number of conspicuous authors that are at the forefront of this development, including Baillie, VanderSteen, Mitchem and Munoz, amongst others.

Research into the meaning of humanitarianism and its connection with engineering (Garrett 1999) makes it clear that there are numerous definitions for the term depending on the nature, culture and personality of the individual involved, as well as the context in which the individual finds themselves. One of the most popular current discussions is whether humanitarian engineering is solely connected with disaster relief, or whether there is a broader connection with solving social issues, wherever they may exist. Garrett felt that this was dependent on a number of factors including country, religion, gender, situation, political perspective and cultural differences. As a consequence the meaning can only be very broad. He also noted that amongst all of these factors there is also the emotional impact that is often attached to humanitarian engineering and the motivating influences that this has on an engineer, to utilize their engineering knowledge in solving these problems.

Reed (Reed 2002) argued that Humanitarian Engineering has its core in emergency disaster relief, to handle and solve issues brought about by conflict as well as natural disasters such as drought and earthquake. Reed rightly highlights the need for the technical and problem solving skills of engineers within disaster scenarios, yet when comparing these views to the work of VanderSteen (VanderSteen 2009) there are conflicting views that need to be considered. VanderSteen focused on humanitarian engineering placements in local communities, and demonstrates a softer approach to the use of engineering solutions as a tool to solve social problems that are much more frequent than larger natural or man-made disasters. Therefore taking these two views from respected academic perspectives, can lead to confusion in the minds of students who may see disaster situations as being too big an issue to handle within an engineering class, whereas designing a water pump, could be a typical case study within a higher education engineering module such as fluid dynamics. By understanding students' understanding of humanitarian engineering, it can be embedded with greater depth and tailored to the needs of graduate employers.

As was highlighted by Mitcham and Munoz, there is a logical progression from an interest in Humanitarian Engineering to an interest in Humanitarian Engineering Education. Skokan *et al* (Skokan, Gosink 2005), provide a clear starting point in the design of humanitarian engineering classes. One of the key points put forward within their paper is the need for engineers to be

"sensitive to social contexts, committed and qualified to serve humanity by contributing to the solution of complex problems at regional, national and international levels." (2005).

This statement highlights two key points in regard to humanitarian engineering. Firstly humanitarian engineering should not be restricted to specific geographic locations, as noted by Vandersteen. However as previously stated some academic perspectives put more emphasis upon humanitarian engineering as exclusive to work conducted in developing countries or disaster areas.

The second key point in Skokan and Gosink's paper is the need to educate engineers at the foundation layer of education in order that they apply this knowledge and skills from the outset. This point of view will lead onto further research in future, but here indicates the need for humanitarian engineering to form a part of all engineering curriculum areas.

The views of Skokan conflict with those of Amadei and Sandekian (2010) which indicate that humanitarian engineering education is and should be based predominantly within the developing countries.

The opposing views from different academic aspects highlight a potential need to further research and define the role of humanitarian engineering from a global perspective; no matter how close to home that may be.

Humanitarian placements have been seen as a particularly beneficial technique for enhancing the learning experiences of engineers, yet VanderSteen et al (Vandersteen, Baillie et al. 2009) suggest there are key factors that should be considered when evaluating the value of humanitarian engineering both in the field and classroom. Whilst humanitarianism, they argue, is considered to be a global necessity, the use of placements as an educational and career enhancing tool is not always effective, citing "attitude, communication skills and cultural awareness" as significant factors that can make or break a placement experience.

Differing styles of engineering education from both a pedagogical and content standpoint, have the potential to provide a variety of benefits to both the students, in terms of higher grades and engagement, and institutions in terms of improved retention rates and levels of employability (Felder et al. 1998). By bringing in the humanitarian aspect of engineering, higher education institutes could empower students further; as seen with the use of the EWB-UK Challenge, currently being run at thirteen institutions across the UK.

Vandersteen (VanderSteen, Hall et al. 2010) has also conducted research into the relative benefits and drawbacks for engineers involved in humanitarian projects in local communities compared to internationally based projects. By looking at this academic research it is possible to see links between Humanitarian Engineering and the needs of engineering courses to meet accreditation guidelines.

On review of the requirements listed in the UK-SPEC for engineering courses, terms such as sustainable development and social skills connect well with outcomes from "humanitarian engineering" (Engineering-Council 2011). There has been anecdotal evidence to suggest that some universities are using humanitarian engineering based content in order to meet the accreditation needs set by the Engineering Council.

By comparing these considerations with those of previous definitions of humanitarian there appears to be a significant proportion of the cognoscenti that believe humanitarian engineering to be a global force that can be used within a variety of communities, from local to developing in order to solve social problems, as well as within the developing world.

With this in mind Coventry University decided to conduct a small research project to gain a better understanding of exactly how our broad range of students interpreted the term 'Humanitarian Engineering' before embarking on major change initiatives to the engineering curriculum around this agenda.

Methodology

In order to gather as much information as possible four basic research methods were used:

- A paper based questionnaire
- An online questionnaire
- An informal workshop
- An informal focus group

Paper Based Questionnaire Design and Implementation

Coventry University is made up of 4 main Faculties;

- Engineering and Computing (E & C)
- Business, Environment and Society (BES)
- Health and Life Science (HLS)
- Art and Design (A & D)

Utilizing a random sampling strategy, students from all four faculties participated in the research, in order to expose potential differences in thinking between a variety of course areas. With participants selected at random, the research gained insight into how both academic and non-academic (media, family, etc) elements influenced partipants' understanding of the term.

In selecting an appropriate sample size Cohen *and Manion* (Cohen and Manion 2000).suggests that in order to be effective in statistical analysis a minimum of thirty respondents are required. Whilst the total number of respondents was higher than this (254 in total), it was ensured that the sample sizes from each faculty were both similar and adequate. One issue that arose in this work was that, whilst every care was taken to allow inter-faculty analysis, the multiplicity of courses within each Faculty made it very difficult to ensure that students from a broad range of courses within each Faculty were surveyed. It was not felt to be a critical issue in this particular case. By targeting the general student population in this research, it was anticipated that a minority would have knowledge of the term humanitarian engineering, and the responses given would appear as anomalies, within the data. In hindsight, greater care would be taken in future to identify participants that might skew the data in a smaller sample size.

The questionnaires were constructed so as not to give any leading questions and embedded the key question of "What does Humanitarian Engineering mean to you" within a selection of other questions. These other questions formed a part of currently un-published work within the field of humanitarian engineering, which is irrelevant to this area of research. To make the questionnaire straightforward, a series of five terms were give for participants to choose from, followed by the opportunity to input any other meanings that came to mind. These terms were selected from the range of definitions of the term 'Humanitarian' highlighted by the authors' literature review summarised in an earlier section of this paper.

The response options selected for the questionnaire are shown below:

- Ethical
- Environmental
- Solving Social Problems
- Sustainability in Developing Countries
- Poverty Reduction

No restriction was placed on the number of options that could be selected. Participants were chosen at random to ensure that the data collected was reliable but every effort was made to gain a good cross section of cultures and gender balance. On review of the data collection methodology, further data on gender could benefit the final conclusions of the work and further inform the reasoning behind the greater gender equilibrium found within the humanitarian engineering sector. Another key learning outcome from the use of this data collection strategy was the need to identify what experience (if any) the participant had had with the term "Humanitarian" and "Humanitarian Engineering".

Due to the collection method employed for this data the majority of students were UK resident undergraduates.

On-line Questionnaire Design and Implementation

As the research was primarily interested in the understanding of engineering students of the term 'Humanitarian' it was decided to use an on-line questionnaire to widen the type of engineering students responding to the survey. The on-line questionnaire was developed using the same questions and responses as the previously used paper questionnaire but was targeted specifically at International Masters level engineering students with in the E&C Faculty. By altering the segmentation strategy, it was possible to gauge the difference by age and ethnic origin, on the understanding of the term "Humanitarian".

Informal Workshop

The researchers were offered the opportunity to gather data from student attendees of the 'Changing Course - Global Dimensions Engineering Education' Conference held at UCL. All student attendees of this event were familiar with the term 'Humanitarian Engineering' and so it was felt inappropriate to reuse the questionnaires used to gather the previous data. Instead the authors developed an hour long semi-structured workshop. Participants were initially asked to 'voice' their own thoughts on the meaning of 'Humanitarian Engineering' as an individual 'mind map' or note taking. This was then followed by a discussion combining their thoughts with the other members of the group to develop a fuller definition, with little input from the workshop leader. Although from a smaller sample of 14 students, these workshops enabled greater detail to be gathered from individuals that had had some involvement with and knowledge of humanitarian engineering.
Following the main workshop the results of the previously conducted questionnaires at Coventry University were released to the workshop members for discussion and feedback.

Informal Focus Group

Several key members of Coventry University Engineers Without Borders Student Chapter formed an informal focus group whose key objective was to discuss each member of the group's perception of the term 'Humanitarian Engineering'. The discussion was not led and no key words were provided, the group consisted of 16 members, but the results are still felt to be pertinent to this particular study. It should be noted that all the students were undergraduates (from level 1 through to Masters level) from the Department of Civil Engineering within the Faculty of E & C.

Results

The following section presents the results of the research methodologies outlined in the previous sections of the paper.

Paper and On-Line Questionnaire Results

Figure 1 shows the number of respondents from each Faculty across the University. From this is can be seen that the researchers struggled to obtain the required 30 respondents in the Faculty of A & D. It was felt that this was primarily due to the method and geographical location of implementation of the questionnaire but after analysis it was decided to still include the results in

this paper but to treat any conclusions drawn about this particular Faculty with caution.

Faculty	Respondents
Engineering and Computing	77
Business, Environment and Society	108
Health and Life Sciences	54
Art and Design	15

Figure 1: Number of Respondents from each Faculty

Figure 2 represents the responses of students on the paper questionnaire (keeping in mind that students could select multiple answers)

Faculty	Ethical	Environmental	Solving Social Problems	Sustainability in Developing Countries	Poverty Reduction
Engineering and Computing	23%	14%	**44%**	29%	6%
Business, Environment and Society	23%	22%	**42%**	33%	7%
Health and Life Sciences	26%	20%	37%	**52%**	11%
Art and Design	20%	**53%**	33%	33%	33%

Figure 2: Paper Questionnaire Participant Responses

Figure 3 shows these results in graphical form. Data for the Faculty of A & D has been excluded due to the small number of responses causing misrepresentation of the data on the graph.

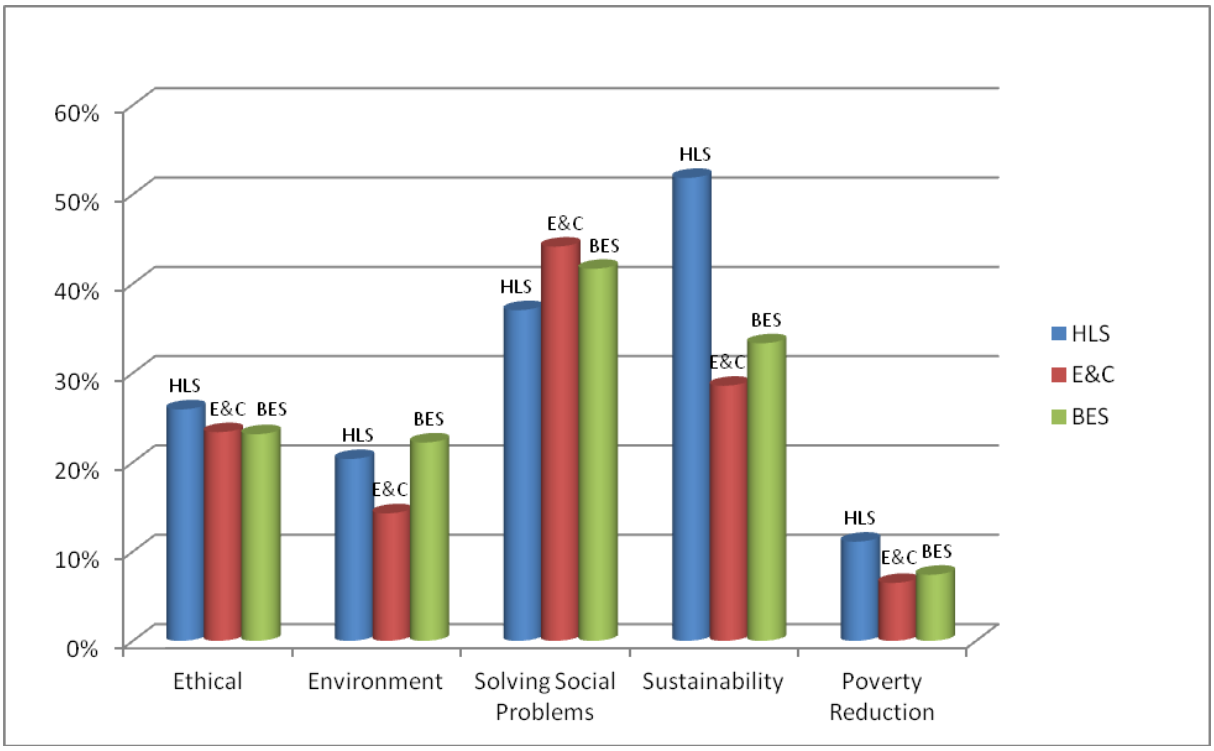

Figure 3: Graphical Representation of Paper Questionnaire Results

Figure 4 represents the responses of students to the paper questionnaire (keeping in mind that students could select multiple answers) 97% of the respondents to the on-line questionnaire were international students and there were a total of 39 respondents.

	Ethical	Environmental	Solving Social Problems	Sustainability in Developing Countries	Poverty Reduction
Online Survey	29%	29%	**82%**	37%	32%

Figure 4: Online Survey Results

Workshop Findings

When the individual responses from the workshop were reviewed the following is a list of the most commonly used words by the participants in the session when asked to describe what 'Humanitarian Engineering' meant to them.

- Inter-Disciplinarian
- Altruism
- Sustainable Development
- Holistic

- Social Development
- Poverty Relief
- Appropriate Technology

Once the participants had completed this on an individual level there followed a discussion regarding the most pertinent of the presented words and the two key areas that were agreed up on were 'Inter-Disciplinarian' and 'Poverty Relief'. When further clarification was sought from the workshop leaders as to exactly what the group meant by the term 'Inter-Disciplinarian' it was indicated that in the participants experiences of actually participating in 'Humanitarian Engineering' projects they felt that the best results were obtained when engineers of different disciplines combined forces and worked together.
When presented with the same options as the questionnaires used in the earlier work there was a unanimous response that 'Humanitarian Engineering' in its most basic form related to the use of engineering to elevate poverty with a focus on developing countries.

Focus Group Findings

The group quite quickly came to the conclusion that 'Humanitarian Engineering' was the use of engineering to solve social problems and to help elevate poverty but then the debate took an interesting turn as the students debated the geographical context of the subject and came to the conclusion that in fact they felt that the term 'Humanitarian Engineering' was equally applicable to social problems and poverty evident in their own local community as it to issues encountered in a developing country.

Analysis & Discussion

What can clearly be seen from Figures 2 and 3 is that students from both E & C and BES felt that the most important issue addressed by 'Humanitarian Engineering' was the solving of social problems, whilst those students in HLS indicated that they saw the most important issue addressed as that of sustainability in developing countries with A & D citing their area as environmental issues. It needs to be kept in mind that all students had the option to select all of the 5 areas and to indicate that they felt all were of equal value but very rarely did any students select more than three areas and even the number that selected two was extremely low.
What was clear from these results was that students felt strongly that there was one clear issue addressed by the term but exactly what this one issue was varied depending on the Faculty that the students were from.
Hence these results back up the point cited at the start of this paper;

> '*'the only thing that is clear is that there is no clear definition agreed ''*

When the analysis was broadened out to include the second most important issue raised by the term the results became even more interesting in that both E & C and BES felt that sustainability in developing countries was a close second to the solving of social problems with HLS indicating their second most important issue was solving of social problems and A & D had an even split of 33% for each (solving of social problems and sustainability in developing countries).
So across all Faculties it was agreed that the two most important issues raised by the term 'Humanitarian Engineering' were the solving of social problems and sustainability in developing countries.

Only 20%-25% of students in any Faculty felt that 'Ethics' was of relevance to this agenda and across E & C, BES and HLS only 14-20% of students felt environmental issues were covered by 'Humanitarian Engineering'. One plausible explanation of this phenomenon suggested by the authors is that over the last decade both 'ethics' and 'environmental issues' have been introduced in higher education curricula as individual topics, especially in Faculties like E & C where the Royal Academy of Engineering have produced and promoted their own codes of practice in these fields. It is therefore feasible that both of these areas were familiar to students and as such were

not linked by the students to the 'Humanitarian Engineering' agenda. It could be said that this theory is further evidenced by the fact that the A & D students, who have not had such an inclusion in their curriculum over the last decade hence then cited such topic areas as relevant to 'Humanitarian Engineering'.

Across all Faculties the issue felt to be least relevant to 'Humanitarian Engineering' was that of 'Poverty Reduction' with below 11% selecting this area in E & C, HLS and BES with this number rising to 33% in A & D, although this is one of the A & D comparisons that must be treated with caution as a result of the low number of participants from this Faculty. The lack of acknowledgement of 'Poverty Reduction' is relevant and interesting because it is in direct contradiction to the results of the Workshop conducted and the literature reviewed, both of which put a deep emphasis on 'Poverty Reduction' being at the heart of any 'Humanitarian Engineering' initiative. One possible explanation of this discrepancy could be that all of the participants of the workshop and authors in the literature are practicing humanitarian experts who have spent time in the field delivering 'Humanitarian Engineering'.

All of the above findings were mirrored but with increased percentages in the On-line survey with the International Masters E & C students indicating that their most significant issue would be that of solving social problems (82%) closely followed by sustainability in developing countries (37%) with both ethics and environmental issues being the third most important issues at 29% and again 'Poverty Reduction' being the issue least associated with 'Humanitarian Engineering' with only 32% of students indicating it an issue at all.

The results of the both the Paper and On-line questionnaires analyzed in the above sections appear to support the findings of Skokan and Gosink who put forward the point that;

"[Engineers need to be] sensitive to social contexts, committed and qualified to serve humanity by contributing to the solution of complex problems at regional, national and international levels."

In addition the work of Garrett (Garrett 1999) supports these results as their paper indicates that the term 'Humanitarian' means different things to different people, organisations, cultures and carries with it a 'significant emotional impact'.

When analysing the results of the workshop it could clearly be seen that the group generally tended to agree with the findings of authors such as Reed or Amadei and Sandekian all of whom discuss 'Humanitarian Engineering' as a response to a natural disaster or emergency or issues based predominantly in developing countries. Whilst they did not agree with the basic findings of Skokan and Gosink who suggested that 'Humanitarian Engineering' should not be based on geographical location the one area they did agree with these authors was in the need for 'Humanitarian Engineers' to be understanding and knowledgeable of inter-disciplinary nature of such projects and that 'Humanitarian Engineering' was relevant across all engineering disciplines.

The final set of results from this work to be analysed was the focus group and the key issue that was highlighted of the application of the term 'Humanitarian Engineering' to social problems and poverty evident in local communities and not just in developing countries. Whilst these issues has been touched upon by several authors (Garrett 1999, Skokan and Gosink 2005) this particular view point is one supported by VanderSteen who conducted research into Humanitarian Projects within local communities commenting on their success and a need for the understanding that the numbers of such social problems are far higher than the number of disasters per year. It should also be noted that VanderSteen and Baillie conducted further research in to this topic and did conclude that there was a potentially negative impact on the educational value of the placement itself if conducted in a local community, namely a lack in development of cultural awareness by the placement students.

Conclusions

The conclusions to this initial research into the understanding that students have of the term 'Humanitarian Engineering' are as follows;

Students within a particular Faculty could agree on one key issue that the term 'Humanitarian Engineering' addressed no one issue was agreed on across the Faculties.

Across the Faculties there was agreement on the two key issues that the term 'Humanitarian Engineering' addressed which were;

Solving of social problems
Sustainability in Developing Countries

Generally the issues of 'Ethics' and 'Environment' were only seen to be marginally relevant to the agenda.

According to all Faculties the least relevant issue to the agenda was 'Poverty Reduction'.

Students with experience of humanitarian engineering cited their most relevant issues to be those of 'Poverty Reduction' and a need for engineers to understand the inter-disciplinary nature of work.

Students engaged in the EWB UK Chapter at Coventry University highlighted a need to engage in social and poverty reduction projects within their own regional communities.

Overall this research has affirmed Coventry University's move towards expanding humanitarian engineering. The research gathered shows a need to further develop these topics in order to create a consensus view of humanitarian engineering, but more importantly how studying it can enhance a students future career, and therefore also the reputation of the institution itself. Developing the role of Humanitarian Engineering within curriculum can highlight the role of the engineer in providing solutions to social problems and poverty reduction, in both local and developing country contexts.

References

AMADEI, B. and SANDEKIAN, R., 2010. Model of Integrating Humanitarian Development into Engineering Education. *Journal of Professional Issues in Engineering Education & Practice,* **136**(2), pp. 84-92.

BERAUD, A., 2003. A European research on women and Engineering Education (2001-2002). *European Journal of Engineering Education,* **28**(4), pp. 435-451.

ENGINEERING-COUNCIL, 2011-last update, UK-SPEC [Homepage of Engineering Council], [Online]. Available: http://www.engc.org.uk/ecukdocuments/internet/document%20library/UK-SPEC.pdf [06/03, 2012].

FELDER, R., FELDER, G. and DIETZ, E., 1998. A Longitudinal Study of Engineering Student Performance and Retention. V. Comparisons With Traditionally-Taught Students. *Journal of Engineering Education,* **87**(4), pp. 469-480.

GARRETT, S.A., 1999. *Doing good and doing well an examination of humanitarian intervention.* Westport, Conn.: Westport, Conn. : Praeger.

COHEN, L. MANION, L, 2000. *Research methods in education.* London ; New York; London ;: London ; New York : RoutledgeFalmer.

MITCHAM, C.M.,D, 2010. *Humanitarian Engineering (Synthesis Lectures on Engineers, Technology, and Society).* Morgan & Claypool Publishers.

REED, H., 2002. *Demographic assessment techniques in complex humanitarian emergencies summary of a workshop.* Washington, DC: Washington, DC : National Academy Press.

SKOKAN, C. and GOSINK, J., 2005. Gender participation in humanitarian vs. traditional multidisciplinary senior design projects, *ASEE Annual Conference and Exposition, Conference Proceedings* 2005, pp. 6785-6793.

VANDERSTEEN, J.D.J., BAILLIE, C.A. and HALL, K.R., 2009. International Humanitarian Engineering. *IEEE Technology & Society Magazine,* **28**(4), pp. 32-41.

VANDERSTEEN, J.D.J., HALL, K.R. and BAILLIE, C.A., 2010. Humanitarian engineering placements in our own communities. *European Journal of Engineering Education,* **35**(2), pp. 215-223.

VANDERSTEEN, J.D.J., 2009. *Humanitarian engineering in the engineering curriculum*, ProQuest Information & Learning.

Copyright statement