Serie *Investigation*

ICT, INNOVATION IN THE CLASSROOM AND ITS IMPACT ON HIGHER EDUCATION

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(Editors)

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The accelerated progress of technology in society nowadays, means that the way of carrying out formative activities in the different fields of knowledge is constantly being rethought in order to obtain more efficient, effective and innovative methods. This avalanche of changes also invades the educational environment and forces society to pose a series of questions regarding all areas of teaching. This influence in the educational field is not only limited to the impact that the deve lopment of new applications and programs has on the teaching-learning process, but also to the impact that the incursion of new technologies, techniques and software has on the curriculum, since these modify the skills required for pro fessional practice.

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Content

Chapter 5

Humanitarian Engineering: a proposal to articulate engineering education with social issues[1]

María Paula Flórez[2], Diana María Duarte[3], Luis Alejandro Ángel[4]

Abstract

The academy has focused on theoretical discussions that distance themselves from real social and economic issues of the communities. Aiming to create synergy between engineering education and low-income communities, the School of Exact Sciences and Engineering of Sergio Arboleda University has focused on Humanitarian Engineering. This study seeks to establish the first model used in the design of the first academic offer of this approach: a course where students must face challenges of communities and design artifacts, systems or engineering processes under social, environmental and technical constraints. A framework is established for Humanitarian Engineering, followed by a case study where the proposed course model is analyzed through students and teachers' perceptions after its implementation. The proposed changes for a second version of the course are concluded.

Keywords

Humanitarian engineering, education, communities.

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1. Introduction

The role of academia and universities in particular in education processes has been a topic of philosophical, political and scientific discussion since its inception. There is a gap in the theoretical and academic conversation regarding the social and economic issues of communities directly impacted by this knowledge (Arango, 2004). Should not we consider that the generation of professionals who are capable of taking an active role in the construction of more egalitarian societies with a better quality of life is a fundamental task of education?

Engineering, by definition, is any application of the physical, chemical and mathematical sciences, industrial techniques and, in general, of human creativity, to use and invent matter (Law 842, 2003). It refers to an activity that transforms knowledge into something practical. This must be aligned with community interests, since it is useless knowledge if it can only be applied to solving theoretical issues, rather than helping solve real problems with their social, economic, and environmental constraints (Lucena, Schneider & Leydens, 2010). Engineering should be oriented to designing solutions within real environments that allow students to identify the constraints of their context. The schools and faculties of engineering are challenged with creating propitious environments and active methodologies to improve the student competences that allow them to attend the needs of the society. Many students graduate without being prepared to design under real conditions, that is, with economic, social, and environmental constraints (Lucena, Schneider & Leydens, 2010). The academy is training engineers to design, yet without deepening the importance of learning to identify and evaluate issues from different areas of knowledge. This causes a lack of humanism in engineering and prevents forging a society. Therefore, engineering education must rethink changes to ensure that professionals can meet the needs of society.

Emphasizing the need to incorporate these approaches in engineering education, Colmenares & Celis (2016) state that, despite the considerable amount of studies that have been conducted on changes in engineering in the last decade, research on strategies to achieve successful changes, as well as evidence to evaluate the impact of curricular changes made

in engineering programs are scarce. This study proposes a course model that favors the inclusion of community work approaches in traditional engineering programs promoting changes in engineering education. This chapter shows the design of the "Humanitarian Engineering" class at Sergio Arboleda University, based on the implementation of a pilot class and the analysis of its results. The class seeks, through interdisciplinary groups, to generate symbiosis between the university and the community, and thus ensure preparation to meet the needs of society through the design of devices, systems or sustainable engineering processes.

The objetctive is to answer the question: what could be a course model that incorporates the community in traditional engineering programs? This chapter is structured as follows: (1) proposals for change made by theorists for engineering education and defines what Humanitarian Engineering is; (2) synthesis and analysis of three referents of engineering courses with a community approach; (3) description of the methodology used to carry out the proposed model of a Humanitarian Engineering course at the Sergio Arboleda University; (4) results obtained; and (5) conclusions.

2. Theoretical framework

2.1. Changes proposed for education in engineering

One of the proposed changes for engineering education is based on the ability to design through participation. Verharen, Tharakan, Middendorf, Castro-Sitiriche & Kadoda (2013) propose engineering courses in which interdisciplinary teamwork is promoted when designing, taking into account the contribution from different disciplines. The authors argue that a positive change in the designed technology could be achieved, considering the proposal of Shields, Verga & Andrea (2014) to incorporate sustainability into the engineering curriculum, since one could learn to design under real restrictions (social, economic and environmental) when working with interdisciplinary groups. Nazzal & Zabinski (2014) propose to introduce sustainability in the different subjects of the engineering curriculum and then create modules or specific subjects that cover the relationship between engineering and sustainability. According to Besterfield-Sacre, Cox, Borrego, Beddoes & Zhu (2014), creating a shared vision of these

changes in the curriculum is relevant, and needs the support of faculties and teachers, as well as the implementation of policies that allow rewarding teaching innovation.

Based on international experience, Colmenares & Celis (2016) establish that the changes proposed for engineering training not only aim to be more grounded and articulated to the master's degree, but that those who apply for a license should have previous professional experience aiming to actually being qualified for obtaining it. According to them, the professional license should not be assumed only as a matter of theoretical knowledge, but as the certification of professional skills and experience necessary to develop projects with impact and social responsibility with solvency.

2.2. Humanitarian engineering

Another change in engineering education has been to encourage the development of projects with social and environmental impact. Humanitarian Engineering is a peaking approach in several programs worldwide, and is recognized as a specialty that encourages the development of communities through the design of technologies, systems and processes. Passino (2015) defines the term: "Humanitarian engineering is the creation of technologies that help people". Lucena, Schneider & Leydens (2010) state that Humanitarian engineering refers to the development of communities, ergo, a student that specializes in Humanitarian Engineering has the following profile.

Humanitarian Engineering and similar programs have been incorporated in different American Universities such as: Colorado School of Mines, University of Canterbury, Arizona State University, Villanova University, Rochester Institute of Technology, University of Wisconsin-Madison, Carleton University, University of Michigan and Purdue University; in Mexico: Monterrey Institute of Technology and Higher Education, University of the Valley of Mexico; and in Latin America: National University of La Matanza in Argentina, Catholic University of Argentina, University of Chile, Pontificial Catholic University of Chile, Universidad del Desarrollo in Chile; University of the Valley, Universidad of La Salle, University of the Andes and Universidad Minuto de Dios.

2.3. Referents in Humanitarian Engineering

The skills and abilities acquired by a student depend on the design and methodology of the course. In order to understand some basic characteristics of a Humanitarian Engineering course, three referents are analyzed, considering aspects such as the audience to which it is directed, the type of course, the weekly time assigned, the theoretical and the practical component, and evaluation (Table 1).

There are several similarities among the three Humanitarian Engineering courses analyzed. All courses have a theoretical component and a practical component. The student receives the tools to develop the practice in the former while, in the latter, the execution of a project or the resolution of a challenge takes place. It is common in all cases that the practice requires a team effort.

The practical component is not always focused on finding solutions to local problems. The social system to be analyzed depends on the context and the possibilities of each place.

A Humanitarian Engineering course does not necessarily have to be made up of engineers, and therefore it is important that all students learn techniques and know how to apply participatory methodologies for working in multidisciplinary teams.

The three courses analyzed are elective, since, regardless they approach matters relevant for the training of professionals, specially for engineers, the issues addressed are not necessarily interesting to everyone. Students are expected to be fully committed, since behind the problems addressed lies the human being.

Each course has different pedagogical strategies, however, all three courses demand a final project. In addition to the grade obtained in the project, other activities are carried out to evaluate theoretical knowledge. In none of the cases are exams performed.

Table 1. Examples of referents in Humanitarian Engineering

Course / Aspect	**Engineers without borders Colombia (ISF-CO)** *Los Andes University (Los Andes University, 2017)*	**Community Based Research** *Colorado School of Mines (Colorado School of Mines, 2017)*	**Humanitarian Engineering** *The Ohio State University (The Ohio State University, 2017)*
Target group	Course for engineers.	Course for engineers.	Course not exclusive for engineers.
Type of course	Elective course.	Elective course.	Its a mandatory course to minor in engineering, as well as elective for other degrees.
Time	4 hours weekly.	3 hours weekly.	3 hours weekly.
Theoretical component	The topics are focused on the development of the concepts related to the criteria of the ISF-CO projects: socially inclusive, viable, environmentally responsible, engineering, innovative, technically possible, high impact. Speakers are invited to the course to give talks oriented to the criteria of the ISF-CO projects.	Oriented to the development of topics such as: qualitative research, ethnography, participatory observation, collaborative design, community-based cartography, interviews, and the importance of listening. Speakers are invited to some of the classes to enrich some of the course topics.	Oriented to topics such as: poverty, underdevelopment, sustainability, culture, social justice, strategies for development, engineering for community development, analytical methods and participatory development of humanitarian technology. Discussions are held in class regarding different topics.

Course / Aspect	**Engineers without borders Colombia (ISF-CO)** *Los Andes University (Los Andes University, 2017)*	**Community Based Research** *Colorado School of Mines (Colorado School of Mines, 2017)*	**Humanitarian Engineering** *The Ohio State University (The Ohio State University, 2017)*
Practical component	Students throughout the course should seek solutions to a challenge in a participatory manner with the community. This community may be vulnerable or with development potential. The challenge that the students must solve is chosen by the teachers. The Ocdio context is used to address the challenge. Field laboratories are conducted in which students know the area and interact with the actors involved with the problems. The practical component is developed in groups.	Students throughout the course must answer a research question related to a group that is part of the University community. The group and the research question are proposed by the students. Students are taught different tools for working with communities, especially tools for participatory observation. Students should conduct participatory research activities with the actors involved with the research question outside the classroom. The practical component is developed in groups.	Students work on a final project in which they must select and develop appropriate technology to solve a real problem, in addition to assessing their environmental and economic impact. Students are taught different tools for the participatory design of technologies. Students are taught ways to model and simulate the impact of proposed solutions. The practical component is developed in groups.

Course Aspect	**Engineers without borders Colombia (ISF-CO)** *Los Andes University (Los Andes University, 2017)*	**Community Based Research** *Colorado School of Mines* *(Colorado School of Mines, 2017)*	**Humanitarian Engineering** *The Ohio State University* *(The Ohio State University, 2017)*
Evaluation	Queries are performed to assess the comprehension of the readings assigned for class. Workshops are approved in which students apply some of the tools seen in class. The students record advances in relation to the challenge in portfolios. Each portfolio synthesizes and documents the information collected in at least one phase of the oCDIO context. At the end of the course, they make a presentation, where they expose their proposal in front of experts.	Attendance and participation in class is qualified. The application of the tools as interview guides, interviews, participative observation, and participative research activity are qualified. Students analyze the assigned readings. Students do a final project with conclusions regarding results found in the research.	Queries are made on the assigned readings and class comments that the teacher makes through videos. Students must submit tasks consisting of solving problems from the text guide (Humanitarian Engineering: Advancing Technology for Sustainable Development, 3rd Edition). Some tasks must be solved in Matlab programming software. Students submit a report of the final project and sustain it at the end of the course.

Source: own elaboration.

3. Methodology

The methodological proposal used to define a model course in Humanitarian Engineering was tested in the Industrial Engineering program of Sergio Arboleda University as a strategy to include new perspectives to its traditional approach:

An initial model course in Humanitarian Engineering was designed for Sergio Arboleda University, taking into account references in Humanitarian Engineering.

1. The initial designed model was implemented.
2. The students evaluated the course through anonymous surveys, and the teachers gave their insights regarding the model.
3. The initial model was redesigned, based on the results obtained in the surveys and the teachers' perceptions.
4. This chapter concerns the initial course model in Humanitarian Engineering for Sergio Arboleda University, taking into account references in the matter.

3.1. Initial proposal of a course model in humanitarian engineering at Sergio Arboleda University

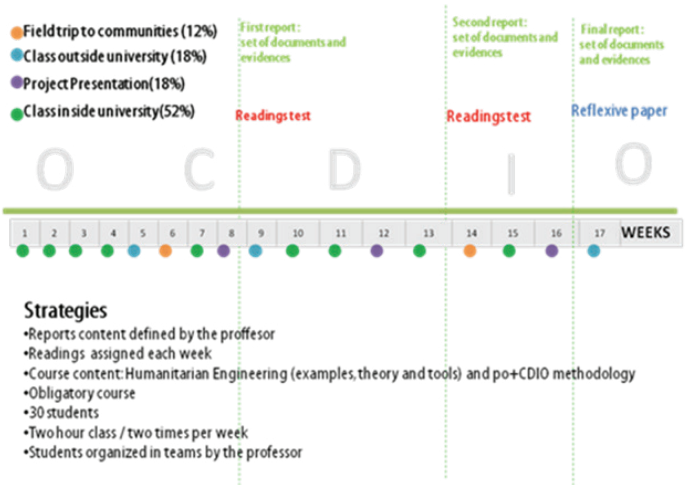
The Humanitarian Engineering course was designed to achieve the following objectives:

- Create synergy between engineering and other college programs and form interdisciplinary groups to design artifacts, systems or engineering processes, under social, environmental, technical, and economic constraints;
- Create synergy between low-income communities (in Bogota and its surroundings) and the University, through the co-creation of engineering solutions;
- Train students in skills and competencies based on the humanist-scientific approach.

With this scope, the course was defined as mandatory for all industrial engineering students (in this pilot phase) to approach the role of the engineer in community projects. These types of experiences help develop design skills under economic, environmental, and social constraints, necessary to acquire a complete professional profile in any sector contemplated in the 2030 agenda for sustainable development.

In accordance with the established objectives, the course required a methodology of practical approach. The course model was aligned with an innovative proposal made by Distancia Cero, a social enterprise with the mission of reducing the gap between reality and academia, promoting an educational strategy called '*Aprendizaje basado en retos*[5]'. Distancia Cero provided the course with a portfolio of challenges published by different social organizations. The course was designed around these issues, where groups of students had to offer solutions, using the po+CDIO methodological framework proposed by Ingeniores sin Fronteras Colombia, an adaptation of the CDIO framework created by MIT.

Figure 1. Initial proposal of the Humanitarian Engineering course model at Sergio Arboleda University



Source: own elaboration.

[5] "Learning based on challenges".

Figure 1 shows the course model that was implemented for the first time in the second semester of 2016. The aspects considered in this model are related to the general characteristics in which engineering courses with community emphasis are usually focused.

4. Results

Students completed an anonymous survey in which they were asked about their perception of the initial model of the course at the end of the semester. The priority was to understand, from the student's point of view, whether the course was effectively adding value to the educational experience. The main results obtained are:

General perception:

- 20% of students indicated that the course seemed relevant to their engineering training; 60% considered it relevant; 20%, little relevant.

Regarding evaluation:

- 30% of the students said they spent more than the minimum time necessary for the evaluations; 50%, only the time needed; 20%, less than the necessary time.
- Students stated that the course should be more flexible in terms of the design process, requesting that it not be too methodical.
- Although literature was related to the course, students perceived a lack of relation to the challenges, which were the course's main objective.
- Some tests had no direct connection with the challenges, but rather assessed literature review. Students considered there was no added value, and the course as a "waste of time".

Regarding methodology:

- 55% of the students perceived that the methodology was very innovative (they had not had a similar course yet), while 33% considered it innovative.

- 88% of the students considered the experience of working with real challenges as very valuable for their learning.
- About 95% of students said that it was clear how to apply the methodological framework po+CDIO.
- 55% of the students showed interest in continuing to work on the challenges, because they considered that working with communities was an important experience for them.

After the course was evaluated, and according to the results, the implementation of the 'Learning based on challenges' methodology was defined as the most valuable aspect. In the Faculty of Exact Sciences and Engineering of the Sergio Arboleda University, this approach proved to be innovative for the educational experience. However, there were some aspects that did not work properly and that should be corrected to respond effectively to the educational offer. Challenge development requires a significant amount of time, therefore, it is necessary to minimize the evaluations or exams that are not directly related to them, and to minimize theoretical content in order to center on the out-of-classroom experience.

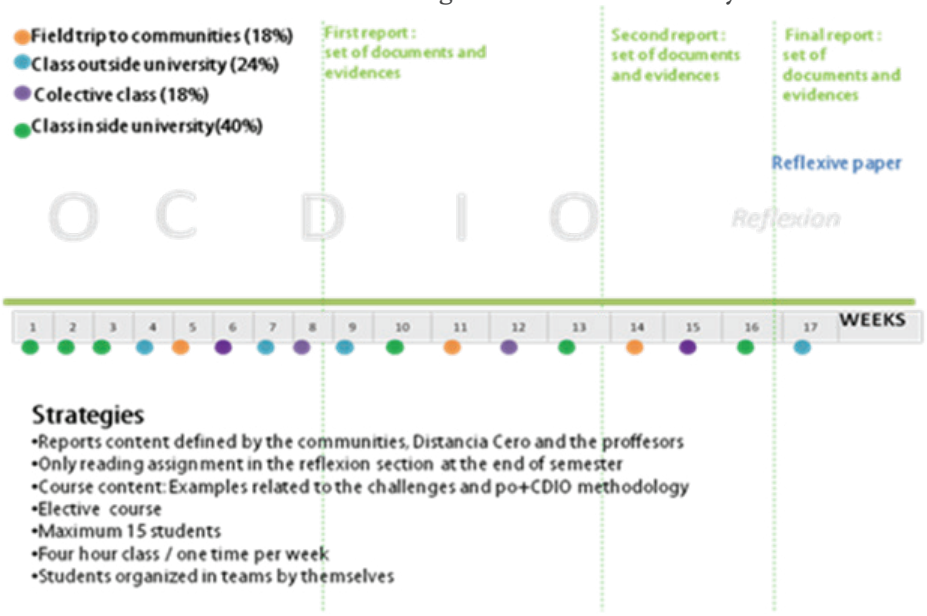
Humanitarian Engineering is an open and complex field that needs to provide experiences and examples that are related to the challenges so that students can connect this information easily with their practical experience throughout the course.

The assigned literature and its evaluation throughout the semester did not contribute efficiently to the learning process. On the other hand, the reflective article and the methodology given to develop it (po+OCDIO) did help students reach personal conclusions about the design process.

5. Conclusions

After result analysis, and considering that both the theoretical and practical components are relevant, some changes to the Humanitarian Engineering model were included, which were implemented in the first academic semester of 2017 (Figure 2).

Figure 2. Proposal for a Humanitarian Engineering course model at Sergio Arboleda University



Source: own elaboration.

The percentages vary from Figure 1 to Figure 2. While time devoted to field visits and of classes outside the university increases by 6%, the opposite occurs with decreased time of classes in campus. This is to ensure that students dedicate more time to practical experiences outside the classroom and to face the challenges together with the communities.

This new model seeks that all class evaluations are focused on the challenges, given the amount of time that students dedicate to them is sufficient to achieve the learning objectives, including decision-making on the design process, considering economic, social, and environmental restrictions.

A reflective exercise at the end of the semester is valuable so students can assess their experience, using literature related to Humanitarian Engineering. This way, they can reach their own conclusions.

Regarding its impact, evaluations should be defined at the beginning of the semester in a negotiation between communities and professors (not just instructors), supported by organizations such as Distancia Cero. The teachers have the role of facilitators in this strategy, and the immediate impact on the communities is assured.

The course must be elective and not mandatory. Although professors think that Humanitarian Engineering is key to the development of design skills in students, working with communities is not transversal and is not for everyone, since it requires great commitment. A course with many students would not be necessary; working with few students facilitates personalized accompaniment in the development of solutions to challenges.

The po+CDIO should be used as a framework and not as a methodology. Students should be able to define how to use it, taking into account that they are the basic steps in a design process, but also considering its flexibility.

This new proposal, although based on analysis of the results obtained by implementing a first model, will also be evaluated after its implementation to improve and update it if necessary.

References

Arango, G. M. (2004). *La educación superior en Colombia. Universidad Nacional de Colombia*. Recuperado de: http://www.colombiaaprende.edu.co/html/investigadores/1609/articles-73081_archivo.pdf

Arias, L., Rámirez, C., Duarte, D., Flórez, M. y Sanabria, J. (2016). PoCDIO: A Methological Proposal for promoting Active Participation in Social Engineering Projects. *Systemic Practice and Action Research*,1-25.Recuperadodehttps://link.springer.com/article/10.1007/s11213-016-9370-y

Besterfield-Sacre, M., Cox, M. F., Borrego, M., Beddoes, K., y Zhu, J. (2014). Changing engineering education: Views of U.S. faculty, chairs, and deans. *Journal of Engineering Education*, *103*(2), 193-219.

Colmenares, J. S., y Celis, J. (2016). Hacia una formación más fundamentada y flexible en ingeniería civil. *Revista Educación en Ingeniería, 11*(21), 4-8.

Colorado School of Mines. (2017). Humanitarian Engineering Program. Recuperado de http://inside.mines.edu/HE-Program

Ley 842 de 2003. Por la cual se modifica la reglamentación del ejercicio de la ingeniería, de sus profesiones afines y de sus profesiones auxiliares, se adopta el Código de Etica Profesional y se dictan otras disposiciones. Diario Oficial No. 45.340. Congreso de la República de Colombia, 14 de octubre de 2003.

Lucena, J., Schneider, J., y Leydens, J. (2010) *Engineering and Sustainable Community Development*. Morgan & Claypool Publishers series. Recuperado de https://isfcolombia.uniandes.edu.co/images/documentos/lucena.pdf

Nazzal, D., y Zabinski, J. (2014). Introduction of sustainability concepts into industrial engineering education: A modular approach. *IIE Annual Conference Proceedings,* 948-954. Recuperado de http://search.proquest.com/docview/1622299468?accountid=48417

Passino, K. M (2015). Engineers' Role in Humanitarianism. En (2da ed.) *Humanitarian Engineering*. (pp. 51-68). Ohio: Bede Publishing. Recuperado de https://hebook.engineering.osu.edu/sites/hebook.engineering.osu.edu/files/uploads/Edition2/humanitarian-engineering-2ndedition.pdf

Shields, D., Verga, F., y Andrea, G. (2014). Incorporating sustainability in engineering education. *International Journal of Sustainability in Higher Education*, *15*(4), 390.

The Ohio State University. (2017). *Courses on Humanitarian Engineering*. Recuperado de https://hecourse.engineering.osu.edu/humanitarian-engineering/spring-2017

Universidad de los Andes. (2017). *Ingenieros Sin Fronteras Colombia*. Recuperado de: https://isfcolombia.uniandes.edu.co/index.php/proyecto-intermedio-2017-10/presentacion-2017-10

Verharen, C., Tharakan, J., Middendorf, G., Castro-sitiriche, M., y Kadoda, G. (2013). Introducing survival ethics into engineering education and practice. *Science and Engineering Ethics, 19*(2), 599-623. DOI: 10.1007/s11948-011-9332-9