International Journal of Engineering Education Vol. 38, No. 3, pp. 584, 2022
Printed in Great Britain
0949-149X/91 $3.00+0.00

Guest Editorial

Ethics, Social Responsibility and Sustainability in Engineering Education

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In recent years technical universities have started to include Ethics, Social Responsibility and Sustainability in their elemental requirements for engineering education. For example, in its statutes the Universitat Polite'cnica de Catalunya (UPC) defines itself in as a ''knowledge-generating and transmitting entity, that must promote the protection of the environment and sustainable development, both in terms of training and research activities and institutional ones'', acknowledging ''importance of the social and environmental impact of scientific, technological, humanistic and artistic activities, as well as the ethical problems raised by any of these activities, and that UPC must offer courses related to these issues in the framework of the curricula. This mission statement is instantiated on specific courses that merge sustainability, social responsibility and ethics in engineering degrees [1], the incorporation of sustainability and social responsibility as competences or soft skills within the curriculum [2], creation of knowledge bases for lecturers to integrate the skills in the courses [3], its application in final degree and masters projects [4], multi-university initiatives [5], and even out of the box thinking involving Star Wars engineering projects [6].

The IEEE/ACM Computer Science Curriculum 2013 [7], identifies social issues and professional practice as one of the key knowledge areas that computer undergraduate students must learn. These guidelines state ''the education that undergraduates in computer science receive must adequately prepare them for the workforce in a more holistic way than simply conveying technical facts. Personal attributes (such as risk tolerance, collegiality, patience, work ethic, identification of opportunity, sense of social responsibility, and appreciation for diversity) play a critical role in the workplace''.

This special issue we asked for communications about research, innovations, and best practices on how to teach the dimensions of ethics, social responsibility, and sustainability. We have selected 15 communications that provide a good perspective on the state of the art.

Three of the papers present initiatives of teaching Ethics, Social Responsibility and Sustainability in engineering degree courses. Gaganpreet Sidhu and Seshasai Srinivasan present ''Integration of Ethics, Sustainability, and Social Responsibility Components in an Undergraduate Engineering Course on Finite Element Analysis'' which introduces various real-world engineering ethical issues directly related to the technical topics presented in the class when teaching the fundamentals of Finite Element Analysis, which is used to do engineering and performance analysis of designs. The lecturer establishes a background for each instance and outlines the underlying micro- and macro-ethics challenges. The same tasks are given to students in two distinct cohorts. Following an analysis and self-reflection, the students in the first cohort write an individual commentary. Following a comprehensive conversation among peers, the students in the second cohort produce a commentary in groups. The findings imply that students in the second cohort had more advanced and rich commentaries based on the study of the two cohorts' commentaries.

''Assessment of ethical, environmental and professional responsibility training of Civil Engineers.'' by Ester Gimenez-Carbo, M. Esther Gómez-Martín and Ignacio Andrés-Doménec, analyses how the generic outcome ''Ethical, environmental and professional responsibility'' is achieved in the Bachelor degree in Civil Engineering at Universitat Politècnica de València (Spain). The research of activities and evidences generated when assessing this outcome, interviews with responsible lecturers for courses generating this generic outcome, and perspectives from final year students all contributed to the analysis. The study's goal is to see if the activities students participate in during their Bachelor's degree ensure that they are well-prepared to attain the two levels of proficiency for this generic objective.

Marie Decker, Ann-Kristin Winkens and Carmen Leicht-Scholten present ''Teaching Topics of Respon-

sibility and Sustainability in Large Engineering Classes''. Every year, roughly 500 engineering students from RWTH Aachen University in Germany attend the lecture ''Engineering and Society.'' The lecture, which complements the highly technical engineering content in these study programs, is designed to familiarize engineering students with central theories and subjects in the field of science and technology studies, as well as sustainability and responsibility. The authors constructed a detailed teaching idea to make these issues more accessible to students, which is reviewed in this work. The study suggests this strategy for teaching sustainability and accountability to engineering students in a big mandatory bachelor's course, as well as boosting awareness of their personal responsibility while keeping the lecture focused on the academic material.

The next two papers present experiences on Masters courses. Sarah Hitt's ''Embedding Ethics Throughout a Master's in Integrated Engineering Curriculum'' covers the ethics interventions in NMITE's MEng curriculum and will give autobiographical and self-reflective data from a pilot study of trial learners that contributed to an iterative improvement process and served as a decision-making guide. Engineers will be able to promote social responsibility and sustainability, fulfill their public duty, and engage in lifelong learning and reflection thanks to NMITE's rigorous and robust approach to incorporating ethics into and throughout its Master's in Integrated Engineering.

Ann-Kristin Winkens and Carmen Leicht-Scholten present ''Teaching Essential Competencies for Social and Sustainable Engineering Design – Case Study of a Research-Oriented Master's Seminar'' about RWTH Aachen University's master's seminar ''Competencies for Social and Sustainable Engineering Design'', which is part of the Environmental Engineering, Civil Engineering, and Industrial Engineering study programs. This course covers, teaches, and reflects important competences for socially responsible and sustainable engineering design, with a focus on Education for Sustainable Development (ESD). ''Which competencies are regarded relevant by future engineers in the context of sustainable and socially responsible engineering design?'' was the study topic addressed with a research-oriented approach. The goal of this paper is to demonstrate this method and, based on the seminar, to explain how engineers can acquire needed abilities for socially responsible and sustainable engineering design.

We have received also interesting papers about the views of faculty about the topic of introducing Ethics, Social Responsibility and Sustainability in their courses. Paul Gannon et al. present ''Exploring the Relationship Between Students' Trait Empathy, their Attitudes towards Sustainability, and their Reflections on a Workshop on Sustainable Design faculty's views on ethics Teaching'' presenting an online survey instrument was distributed to engineering faculty and instructors at a medium-sized land-grant university in the United States. The whole survey is published here, together with statistical analysis of the previously summarized data and a discussion of open-ended question replies. Engineering faculty support for both engineering education research and sustainability education was effectively measured using the survey instrument. The survey topics also included questions about climate change beliefs, teaching practices and curriculum, and the use of research-based pedagogies.

Mohammad Alsager Alzayed, Elizabeth Starkey and Rohan Prabhu present ''Exploring the Relationship Between Students' Trait Empathy, their Attitudes towards Sustainability, and their Reflections on a Workshop on Sustainable Design faculty's views on ethics Teaching'' investigating the association between students' individual differences – especially, trait empathy and attitudes toward sustainability – and their views on a sustainable design workshop in relation to a semester-long design project. In order to do so the authors carried out a study with 40 first-year engineering students from a public university of the United States. The study's shows that participating in the sustainable design workshop had a beneficial impact on students' attitudes and aspirations toward sustainability, as well as their reported positive experiences with the workshop. These findings may help to guide future attempts to develop pedagogical interventions that promote a sustainability-focused mentality among engineering students through engineering design education.

Two interesting papers present study cases. Alicia García-Holgado et al. present ''A Case Study in Brazil and Spain about the Students' Perception of the Gender Gap in Computing'' which focuses in a lack of gender and race diversity in the engineering and technology fields. Despite differences from one location to the next, this problem exists in all of the world's regions. In terms of the gender gap, governments and organizations are working to close it in engineering and technology through initiatives aimed at attracting more women to these fields, preventing dropouts during STEM education, and assisting women in entering the workforce. In this regard, we've created a project to integrate gender into this framework and promote

diversity in computer engineering. The project's two main goals are to equip students to include diversity and inclusion into software development processes and to create work environments that adhere to diversity and inclusion ideals.

Yousef Labali, Christian Matheis and Vinod Lohani. present the second study case ''Imagination and Moral Deliberation: A Case Study of an Ethics Discussion Session'' which focusses on the importance of imagination in our moral decision as a key issue that has been disregarded in engineering education literature. The neglect of creative rationality in dealing with moral difficulties is exacerbated by a lack of attention to one's ideals, background, and experiences, seeing mind and body as two separate beings, and downplaying the role of imagination as merely an emotional regulator. As part of the professional development activities in a National Science Foundation Research Experiences for Undergraduate (NSF REU) program, the authors planned and implemented an ethics debate session in which they stressed imagination as a fundamental aspect of moral thinking and deliberation. As results of the study the authors present theoretical ideas, a new ethics curriculum and evaluation methodologies.

Other works describe more specific applications of the special issue main topics. Laura Fernandez-Robles et al. present ''Analytical Framework to Investigate Ethics, Social Responsibility and Sustainability in Engineering Project Management'' that examines how two commonly used project management standards, Project Management Book of Knowledge (PMBoK) and Individual Competence Baseline for Project, Program, and Portfolio Management, treat ethics, social responsibility, and sustainability (ICB). The authors create an analytical framework to conduct desk research in accordance with these two project management requirements. They specifically count the number of appearances, present any definitions, determine the appearance in different knowledge areas and process groups for PMBoK and in different competences for ICB, and identify the proposed ethics, social responsibility, and sustainability management techniques or tools. The results of the study show that ICB goes deeper into the three ideas than PMBoK.

Other interesting application is the presented by Manuela Pires Rosa work entitled ''Experimental Education of Collaborative Design – The case of an Inclusive Bus Stop for a Tourist Transportation Hub''. It deals with the idea of designing infrastructures for social sustainability in a universal and inclusive design way. The paper is carried out in the context of the project ''Accesibility for All in Tourism'' and explore a pilot focused on the development of an accessible, smart, and sustainable bus stop located at a tourist transportation hub. It involves professionals from several fields in a co-design process considering all type of possible users of the tourists. The work shows the collaborative approach applied with the students of Civil Engineering at the Institute of Engineering at the University of Algarve (Portugal) and the students' perceptions of topics related with social responsibility.

The issue of gender gap and inclusivity has got a strong foothold in current times and the moral and ethical issues that it presents have already entered this special issue with Alicia García-Holgado paper. There are other two additional papers dealing with gender gap and inclusivity. ''Integrating Inclusive Content and Sustainability for Civil Engineering Courses'' by Kauser Jahan et al. presents the ''Our CEE goes GREEN'' initiative, which began in 2004. This effort enabled civil engineering courses to incorporate sustainability concepts and material. Faculty training, presenting case studies, rewording course syllabi and difficulties, assigning team projects, and establishing extra credit projects were among the tactics covered in the course. Course evaluations, focus group answers, and senior exit interviews are used to assess the integration's performance. Early evaluation data indicates that the tactics for changing course content are working, as student responses for all courses across the border are quite favorable.

Hong Yang presents ''Team-Based Learning to Improve Diversity and Inclusion of Environmental Engineering Students: A Mixed Methods Analysis'' a work that deals with the use of team-based learning (TBL) in engineering education to increase diversity and inclusion. The effect of TBL on the diversity and inclusion of Chinese and British students in the Environmental Engineering program at one UK university was investigated using a mixed methods approach, which included a combination of quantitative (questionnaire) and qualitative (interview) approaches. Nearly 70% of Chinese students rated their interactions with British students as favorable or extremely positive. Around 64% of students said they learned the most while ''discussing and planning group seminar work/presentation together in library/classroom/other places.'' Chinese students prefer learning with British colleagues for two main reasons: ''enjoying a diverse culture'' and ''learning from those with different educational backgrounds.''

The paper ''Stereotype Threat and Faultlines Based on Cultural Diversity in Engineering Education in Germany'' by Edwin Semke and Wanda Theobald focusses on the issue of cultural diversity. The purpose of

this study is to assess cultural awareness and its effects on student life at two German technical universities. The authors want to know if diversity is widely accepted or if it requires additional attention. During the interviews, it was observed that most students, especially German students, have a low self-perception of cultural variety. Furthermore, the authors discovered that there appear to be disparities in stereotype danger and faultlines between universities in small and major cities. To lessen stereotype danger and faultlines among student groups, interaction and confrontation are critical approaches. Faculty and institutional stakeholders must focus more on strengthening and empowering cultural diversity awareness as a vital talent for future economic success.

''Leveraging Sustainability to Teach About Social Justice in Civil Engineering Curricula'' by Tom Siller, Rebecca A. Atadero and Christina H. Paguyo argues that sustainability and social justice should be included in engineering curricula so that future engineers are prepared to understand both the societal and technical implications of their work, while acknowledging the difficulties engineering faculty may face in conceptualizing social justice or social sustainability. We then discuss how new sustainable design rating systems, such as Envision and The Living Building Challenge, incorporate inclusion and social justice into their ratings, and how these rating systems can assist engineering faculty in incorporating social justice into their classrooms in ways that are relevant to engineering content.

We don't want to close this editorial without making a remark about the use of the term: ''social justice'' we see in the title of the last-mentioned paper. Since the usage of the word ''justice'' may imply a call to action for ''social justice warriors'' and the creation of hierarchies of moral standing among young engineering students. Like we can see on the ramifications of the ''Woke'' movement [8] specially in the United States of America, and increasingly in the rest of western countries. This movement and its incitation from part of faculty has been heavily criticized by several authors, like Minowitz on ''Rescuing Diversity'' from affirmative action and campus activists'' [9] and J Haidt and G Lukianoff in the book ''The Coddling of the American Mind: How Good Intentions and Bad Ideas Are Setting Up a Generation for Failure'' [10]. We, the editors, prefer the term ''social responsibility'' which centers the responsibility in the decisions the engineer must take, and cannot be misread as a moral crusade.

Acknowledgement: The guest-editors want to thank Professor Ahmad Ibrahim, Editor in chief of International Journal of Engineering Education, for the opportunity of editing this special issue.

We are also grateful to all reviewers, for their excellent work and the constructive feedback sent back to authors.

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