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Insights into the integration of the SDGs in engineering program curricula as seen through the prism of the perceptions of engineering students and educators

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Abstract

In this paper, we offer insight into how the UN Sustainable Development Goals (SDGs) are being integrated into engineering programs. We investigate the question : "what opportunities and barriers should we take into consideration in order to better integrate the SDGs into engineering programs ?" We undertook two exploratory focus group studies with engineering students and academic participants that explored their perception of SDGs' integration into their programs. Our results show significant differences between the perceptions of students and academics, and this indicates the need for a more comprehensive and balanced integration of the SDGs into engineering curricula. We particularly recommend a transdisciplinary teaching approach involving a close relation between technical and human disciplines.

Keywords : sustainable development education, Engineering education, SDGs inclusion

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Introduction

Education for sustainable development has become a major theme in engineering education. It is generally agreed that engineers will need to play a key role in helping society to meet the challenges set forth in the "2030 Agenda for Sustainable Development" established by the United Nations in 2015. However, even if sustainable development education is now seen as vital, there is little consensus on how to integrate the SDGs and sustainability education into engineering programs (Beagon et al., 2019). In this paper, we would like to contribute to an emerging discussion about the integration of the SDGs into engineering education in the French context. We will consider the opportunities and barriers that we should take into consideration. We aim to do this not by investigating how to incorporate the SDGs into engineering education, but rather via the exploration of the perceptions of the different stakeholders involved in training engineers. Our purpose is to provide guidance which will facilitate the work of those engaged in reforming current curricula in order to better integrate the SDGs.

Theoretical background

Sustainability is a complex concept, with various and often highly politicized interpretations. Yet generally speaking, it is agreed that training engineers for sustainable development will require training them to take into account the environmental, economic and social dimensions of engineering activities. There is no doubt that integrating the SDGs into engineering education will demand a similarly holistic-thinking oriented pedagogical approach. At present, sustainable engineering education is focused primarily on considering the environmental dimensions of engineering projects - in particular energy efficiency and the mitigation of negative environmental externalities (Arsat et al., 2011). This focus can be explained with reference to history : engineering education has traditionally focused on technical problems, leaving aside or ignoring the social. Conversely, Sinaku et al. (2018) who investigated humanities educators have suggested that many academics in the field of sustainability education predominantly focus on the social and economic aspects of the SDGs. These results reveal a divergence between the views of academics in the applied sciences and the humanities.

Concerning the presence of the SDGs in engineering curricula, a recent study by Sánchez-Carracedo et al. (2019) analysed ten engineering degrees in Spain and concluded that there was only a moderate (52%) integration of the SDGs in engineering programs. In addition, there were significant differences in the ways in which SDGs were integrated into these programs, which indicates the lack of consensus on a strategy for the integration of the SDGs. In other words, each of the degree programs defined their own strategy which resulted in an unequal and asymmetric implementation of SDGs among the programs.

According to Mesa et al. (2017), there are clear differences in how sustainability is integrated into engineering programs. Generally speaking, they isolate two approaches :

1. SDGs are integrated in the curriculum via existing courses (55%), generally into common basic engineering courses or
2. integrated into specific or dedicated courses (45%) in most of the cases stand-alone courses used as technical electives.

The latter option, the curriculum integration approach is widely considered to be an effective learning approach where students move progressively into sustainability topics. The majority of these courses (66%) apply an interdisciplinary approach. Tejedor et al. (2018) suggest that schools need to go further in the development of integrated transdisciplinary engineering programs which foster close collaboration between technical and non-technical (Human and Social Sciences) teachers. Molderez and Fonseca (2018) argue that the implementation of alternative learning activities such as real-world experiences or service learning could be an effective way to enhance student sustainable development competencies.

Applied methodology

For our study, we employed a qualitative approach to the analysis of two focus group studies (Parker and Tritter, 2006). The participants in these groups were engineering students and academics. For the student focus group, we selected nine engineering student participants pursuing degrees ranging from Bachelor to Masters. This selection process was assisted by the BEST (Board of European Students of Technology) student association. For the academics focus group, we selected seven participants from diverse disciplines and academic positions.

As this study was part of a larger A-STEP 2030 Erasmus + European project, we followed a standardised and collectively agreed upon process for undertaking the focus groups. In order to facilitate discussion, we undertook all focus groups in French (the participants' native language). The focus groups were digitally recorded and transcribed with only selected passages being later translated into English.

As the focus group methodology involves human participants, we applied for ethical approval from the Ethics Committee at TU Dublin. Before participating in the focus groups, all participants received written information about our research project and the objectives of our study, as well as statements regarding confidentiality, data storage and the possibility of withdrawal. They were also asked to sign a written consent form.

The data analysis was carried out by two senior researchers which facilitated a deep discussion about the group dynamics and group interactions during the analysis process. The analysis was completed following a standardized and collectively accepted common thematic analysis framework based on the principles of the General Inductive Approach (GIA) defined by Thomas (2006).

Results

The students and academic participants revealed that SDGs were taught to varying degrees in their engineering programs. Student focus group participants identified 14 SDGs that were present in their programs at various levels of integration. Academics, to the contrary, insisted that all of the SDGs were covered in their engineering programs.

In the student focus group there was general agreement that the SDGs should be integrated into their programs in a more comprehensive way.

> "The technical teachers are closest to the profession which we will have and they do not talk about it at all. Humanities teachers, they do not necessarily know what the work of an engineer means, they try to adapt their project [....]. We do not have the opportunity to link the two."

They considered the lack of cooperation between teachers of different disciplines as a principal barrier to the inclusion of SDGs. They also explained the need for more student feedback regarding the development of the curriculum.

> “Even if we want to change the way to do things according to our perception, teachers do not agree. ……… I said that I would like to change things - they will tell you that it is good but they will not push in this direction. They train us to do the same thing they did.”

They also highlighted their technical teachers’ lack of knowledge and awareness relative to themes associated with sustainability. As one of them explained :

> “Because our technical teachers were not born into it, they never have been educated with the concept of sustainable development while we are...”

In addition, they pointed out the need for a balanced approach that mediates between the three pillars of sustainable development, to create a holistic integrated approach for the SDGs instead of focusing on one particular pillar.

> “Decent work and economic growth [SDG goals] was included in it because our study program was focused on economic development…”

Students consider that the SDGs could be integrated not only into the formal curricula of their engineering programs but into the informal curriculum, for instance in the form of extra-curricular activities. The value of such an informal approach has been highlighted by Ramirez-Mendoza et al. (2020).

For the participants in the academics focus group, we observed divergent opinions regarding the integration of the SDGs into engineering programs. Technical teachers explained that in their engineering modules they are mainly focusing on technical questions and sustainability questions are not typically considered.

> ‘…however, I have to be honest, in my case it is based on a technical approach and not a sustainable practical approach….’

Human and social sciences teachers have a very different opinion as one of them witnessed :

> “…for me all SDGs are covered in our engineering program. However, it is a question of communication and presentation because we cover all these subjects but it is not promoted, as it is natural for us….so there is work in it to make it more visible.”

They expressed their engagement and underlined the importance of the SDGs in their teaching approach. They also highlighted the lack of modules dedicated to sustainable development and noted that the divergences between specializations was a barrier to including the SDGs within the curriculum. As one teacher argued :

> “…we have a lot of different things everywhere but there is no dedicated module with dedicated teaching hours…it creates a problem of justification and visibility… “.

The academic participants considered lifelong learning and the implementation of new programs applying ‘learning by doing’ in a real situational context as excellent opportunities to include the SDGs within the curriculum in a more comprehensive way.

Conclusion

Our findings show noticeable differences between the perceptions of students and academics. Our results agree with those of Sánchez-Carracedo et al. (2019) in finding that students perceived an unequal implementation of SDGs within their engineering programs. Student respondents call for a more comprehensive and interdisciplinary approach with the collaboration of technical and humanity teachers. This reform has been suggested by Tejedor et al. (2018) who advocates for the development of integrated transdisciplinary engineering programs.

The academics, on the other hand, thought that one of the main barriers to the integration of the SDGs was a lack of dedicated courses. However, this is a surprising finding as an integrated approach to the SDGs within the entire curriculum is broadly considered to be more effective than stand-alone courses (Mesa et al., 2017).

A conclusion of our study may be that reformers need to do a better job of communicating to faculty the need for a comprehensive and holistic approach to implementing the SDGs. A secondary conclusion is that in order to do this, existing educators will need to develop transdisciplinary teaching practices and will need to become adept at creating synergies between technical and non-technical fields.

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