Sustainable Development Competencies for Achieving the SDGs: Engineering Students and Industry Requirements

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SUSTAINABLE DEVELOPMENT COMPETENCIES FOR ACHIEVING THE SDGS: ENGINEERING STUDENTS AND INDUSTRY REQUIREMENTS

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ABSTRACT

This paper will provide an insight into how French engineering students and employers perceive the competencies needed to meet the UN Sustainable Development Goals (SDG). It draws on the findings of two exploratory focus group studies carried out in the context of the A-STEP 2030 European Project. Our results indicate significant differences in the awareness of sustainability goals among respondents, but a relatively high level of convergence around the skills and competencies that appear most necessary for attaining sustainable development. The respondents considered that technical knowledge and skills were adequately included within French engineering school curricula, yet they felt that achieving the SDGs would demand that more emphasis be placed on the development of transversal skills. According to our results, engineering schools need to more comprehensively integrate transversal skills and competencies. Our findings also suggest that this may best be achieved via

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interdisciplinary teaching and an increased use of project-based education (PBE) and learning carried out in a real work context.

1 INTRODUCTION

Sustainablity education is definitively a crucial element in addressing the ‘2030 Agenda for Sustainable Development’ established by the United Nations in 2015. Engineers in particular will play a central role if the 17 Sustainable Development Goals (SDG) are to be met. Consequently, engineering schools ought to prepare engineering students to meet these challenges. This implies that they are able to address the kind of complex and wicked problems that sustainable development presents. Nevertheless, and even if sustainability education has gained a considerable institutional momentum over the past few years, there remains ambiguity regarding which competencies are needed for future engineers. In this study, we investigate how this question is answered by engineering students and industrial organisations currently on opposite sides (supply and demand) of the employability market in France.

2 LITERATURE REVIEW

It is widely recognised that the engineering profession has a major impact on society and that it will play a central role in addressing the SDGs. Engineers working towards achieving sustainability have to be creative and innovative. They must also adopt a future-oriented way of working and thinking [1]. During the last two decades, we have witnessed a transition from the traditional role of engineering which involved supporting industry and providing technical solutions to industrial problems towards a new and more inclusive role within society. This new role embraces not only technical approaches but also recognizes human and social factors [2].

This evolution of the role of the engineer requires the integration of new competencies in sustainability into the engineering curriculum. Based on a recent literature review [3] carried out in the context of the A-STEP 2030 project, even if sustainablity competencies are considered as critical for graduate engineering students, there is a lack of consensus in the educational literature regarding the relevant competencies.

Following Wiek et al. [4], one can distinguish between ‘regular’ competencies and ‘essential’ competencies. We consider technical competencies (including technical knowlegde, skills, aiblities, capabilities, capacities and other related concepts) that are systematically included in engineering academic programs as regular competencies. As a matter of course, engineering schools are putting emphasis on these competencies, which are considered as the core competencies of the engineering profession. Transversal competencies such as anticipatory thinking [5], integrated solutions [6], social participation [7], sustainable entrepreneurship [8] and normative or action competencies [9] are essential for meeting the sustainabilty challenge. However, these competencies are not entirely integrated into traditional academic engineering programs and are thus by and large neglected by engineering schools.

3 APPLIED METHODOLOGY

For the data collection of our exploratory study, we opted for the focus group method, a widely used and popular data collection method in qualitative research. This allowed

us to inverstigate our research question by generating debates which were informed by group dynamics [10].

This method, which involves human participants, requires ethical considerations to be taken into account. We thus sought ethical approval from the Ethics Committee of TU Dublin before beginning the data collection. Focus group participants received written information about our research project, focus group study objectives, confidentiality and the possibility of withdrawal. They were asked in advance to give written consent. We completed two focus groups with engineering students and corporate representatives. For the student focus group, 9 participants from bachelor to master level were selected with the help of the local BEST (Board of European Students of Technology) student association. For the corporate focus group, 8 participants from diverse industries (electronics, automotive, energy, naval,…) were selected with the help of a local Alumni association.

As this study was part of the A-STEP 2030 European project, we carried out the focus groups in a very standardized way, following a collectively agreed upon Focus Group Handbook. Focus groups were undertaken in French as it was the native language of the participants and thus facilitated discussion. We undertook the following procedure:

1. At the beginning, participants were asked about their awareness of SDGs.
2. As a second step, they were asked to consider the skills needed for engineers to meet SDGs and to present their choices in a brainstorming session.
3. The third step consisted of a deep discussion about their choices and reasoning.

The two focus groups were digitally recorded and transcribed. Only selected citations were translated into English.

For the data analysis we also followed a standardized and collectively approved thematical analysis framework. The qualitative data analysis process was carried out by two senior researchers. This allowed us to discuss the group dynamics and to include group interactions in our analysis [11].

4 RESULTS

Our findings show a particularly low level of SDG awareness among professional participants. The most surprising finding was that students' awareness of the SDGs can be described as moderate, which was lower than our expectations.

Concerning the competencies needed for achieving the SDGs, participating students defined the following requirements illustrated in Table 1 below:

Table 1. Unordered list of student participants' perception of competencies needed for SDG's

Competencies – Student focus group in France		
Technical skills	Holistic thinking	Open mindedness
Economic skills	Stress management	Agility
Digital skills	Creativity	Adaptability
Multidisciplinarity skills	Global Awareness	Emotional Intelligence
Decision making skills	Social Responsibility	Perseverance/Grit
Communication: Listening skills	Sustainability Awareness	Ethical Conscience
Critical thinking	Environmental Awareness	Personal engagement & agency
Life cycle thinking	General Knowledge	
Analytical thinking	Respect for others	

First, they outlined the importance of fundamental technical skills and digital skills complemented with economic skills. They were unanimous that technical skills are currently well-covered within the curriculum, arguing "all that is technical knowledge, we currently have it." They highlighted the need for economic skills, as "we are living in an economic world, we must have economic skills…that allow us to perceive the world today... especially for innovations". Surprisingly, they referred to relatively few application skills like multidisciplinary skills or decision-making skills.

Non-technical skills and competencies were considered by student participants to be vital for future engineers. They pointed out the importance of communication skills, and most particularly listening skills and ways of thinking (such as critical thinking, lifecycle thinking, analytical thinking or holistic thinking). However, they cited numerous attitudinal competencies related to their world views (a sense of social responsibility, environmental awareness, general knowledge or global awareness). They also highlighted character traits like adaptability, open-mindedness, perseverance/grit, respect for others, personal engagement, agency and ethical conscience.

Corporate focus group participants outlined the following required competencies for SDGs in Table 2:

Table 2. Unordered list of corporate paricipants' perception of needed competencies for SDG's

Competencies – Employers focus group in France		
Digital skills	Inter-cultural skills	Challenging the status quo
Mathematics skills	Collaboration	Social responsibility
Economics skills	Communication: Foreign languages	Respect for others
Design Skills	Respecting Diversity	Open-mindedness
Interpretation skills	Teamwork	Agility
Innovation	Creativity	Ethical Conscience
Project management	Convergent thinking	

For professional participants, similarly to students, “technical competencies are well taught in engineering schools;…this is their principal mission”. They pointed out that “digital skills are important, engineers need to know how to process information, how to protect it, how to use software even without being specialized in that domain” regarding a “strong and practical knowledge in applied mathematics” as equally important. For the application skills, they highlighted the relevance of innovation capacity and design skills as critical to the innovation process.

They put a particular emphasis on the non-technical competencies like intercultural skills, collaboration, teamwork, respect for diversity and “project management with multicultural partners who understand each other…and work together with people who do not have the same culture. When working in a team and everybody has good ideas and we get better results”. Related to these multicultural concerns, they called attention to the importance of “practical knowledge of foreign languages…this is much more than a basic knowledge of the English language”.

Similarly to student participants, they found attitudinal competencies important but were less focused on character. This is an interesting finding. Concerning ethical conscience, they highlighted the significance of “intellectual honesty that means not stealing others’ ideas” which was evoked several times. This finding demonstrates that industrial companies and organisations have a strong interest in innovation and creativity and their applicability for developing and protecting industrial patents. Comparing the results of students and employer focus groups, there is agreement regarding the fact that the technical competencies are well taught in French engineering schools. From these technical competencies, they single out digital skills as particularly important to engineers. As a matter of fact, technical skills should be combined with economic skills to provide a solid understanding for future engineers to face the challenges of SDGs. Concerning the non-technical competencies, creativity was outlined as an important skill for fostering innovation. We observed a strong convergence relative to attitudinal competencies such as social responsibility, respect for others, open-mindedness, agility and ethical conscience. Among these attitudinal competencies, the significance of social responsibility and ethical conscience were accentuated.

5 CONCLUSION

The main conclusion that can be drawn from our study is that there is a growing need for non-technical or transversal competencies, especially for all kinds of competencies related to the attitudes of future engineers. Our findings are broadly consistent with previous research available in the literature suggesting emphasis on “competencies considered essential for sustainability that have not been the focus of traditional education and therefore require special attention” [4, pp. 204]. The engineering students suggested the integration of these essential competencies into the curricula in a transdisciplinary way within the traditional technical education through an increased use of project-based education (PBE) carried out in a real work context.

The principal limitation of our study, in addition to the general limitations of qualitative studies, is its restriction to one engineering school. Within the framework of the A-

STEP 2030 project, future research involves the comparison of participating countries at a European level.

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