Integrating Sustainable Competences and Green Skills in the Hungarian Environmental Engineering Education

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ABSTRACT

Engineering plays a crucial part in responding to the biggest challenges of our era, including the transition toward a green economy by meeting the Sustainable Development Goals by 2030 and by achieving net-zero carbon emissions by 2050. Engineering education could be the leading actor in preparing engineers for these complex tasks and spread the necessary green knowledge, interdisciplinary skills, and competences to pursue a sustainable future. Hungary's education system has improved significantly in the last decade, considering the Central Eastern European region. A new national higher education strategy in 2014 set new directions for its development in many aspects, including an emphasis on soft skill development in the curricula. The Hungarian higher education system was characterized for decades by memorizing facts and figures; therefore, the effective integration of soft skill development is a slow process. In our study, we first provide a systematic review of the international and national literature to identify fundamental sustainability skills and competences for engineering. We also examine the Hungarian higher education frameworks and the skill-related output requirements in the environmental engineering programs. In the second part of the research, we present a qualitative study of in-

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depth interviews with Hungarian experts with different academic profiles and a focus group study with environmental engineering students about their views on green skills. Our results show that the concept of green skills is slowly spreading in environmental engineering university communities in Hungary; however, the effective implementation into the curricula will require some more time and work.

INTRODUCTION

1.1 General Introduction

Pressing actions are needed to reach the targets set by Sustainable Development Goals by 2030. Sustainability and climate change-related goals are complex issues where conventional answers are not adequate enough. New skill sets and toolkits are needed to face these challenges successfully. As per target 4.7 of the Sustainable Development Goals (SDGs), all learners need to acquire the knowledge and skills to promote sustainable development by 2030. Education has a crucial role in the green transition as it allows students to improve their competences and collect the necessary knowledge, skills and attitudes to take action for sustainability (1). Education systems worldwide need to integrate sustainability skills and competences into their agenda to accelerate the transition to a fairer, greener economy and society.

Environmental and Sustainability Education (ESE) has been in the highlight for the last decades. The need to include sustainability education in the educational curricula is now widely recognized globally. UNESCO dedicated a decade for Education for Sustainable Development between 2005-2014 followed by the Global Action Programme (GAP) on Education for Sustainable Development (2015-2019) (2). As part of the Green Deal, the European Commission issued the European Sustainability Competence Framework – GreenComp in 2022, serving as guidance for both learners and educators (3).

Engineering plays a crucial part in solving sustainability challenges and fostering the implementation of sustainable transition. It has also been in the focus of ESE research, among others in the Barcelona Declaration from the Engineering Education for Sustainable Development Conference in 2004 (4). The much-needed shift towards sustainability in engineering has been acknowledged theoretically; however, the implementation is not an easy task - the mindset of university leaders, professors, and those of students needs to be changed.

1.2 Research Background and Research Questions

The current paper is built on previous quantitative research from 2021 conducted in Polish and Hungarian universities (5). The research sought to answer whether green skills development appears in the environmental engineering undergraduate programmes, and if yes, how. It also examined the main barriers of implementation. A questionnaire was compiled about the integration possibilities of green skills in the environmental engineering BSc programs separately for students and professors reaching a total of 257 people in January 2021.

Both lecturers and students were open to green skills development based on the answers. They identified environmental awareness, professional knowledge, and practice as the most important green skills. Soft skills (flexibility, adaptability, creativity, group work, communication skills, empathy, etc) were less often classified as green skills by respondents.

Since the European Commission issued the GreenComp in 2022 identifying the main sustainable competences for all, we considered conducting a qualitative study to ask the opinions of both professors and students about green skills. The aim of the research is to examine how sustainable competences could be integrated into the environmental engineering programmes. Our hypothesis is that even though non-technical skill development is a legal requirement in the Hungarian environmental engineering programmes, there has not been enough emphasis on its successful implementation. The main research question we formulated is: How can we integrate sustainable competences and green skills into the curricula of environmental engineering programmes?

2 METHODOLOGY

The first step of the research project was to conduct a brief literature review in the fields of the usage of the words: ‘sustainable competences’ and ‘green skills’ and to see the legal requirements for learning outcomes of the Hungarian Environmental Engineering BSc programmes.

Environmental engineering programmes were chosen since they can be considered the closest to the topic of sustainability, and maybe the most open for the integration of sustainable competences. Students and professors for the research were chosen from the Budapest University of Technology and Economics (BME), since that is the oldest and most prestigious engineering university in Hungary.

In the practical part of the research, semi-structured interviews were conducted within the framework of qualitative research. The discussion was based on a pre-compiled thematic questionnaire, which was handled freely during the discussion. The selected academics for the in-depth interviews play important roles in the Environmental Engineering programme: directors of the entire programme or one of the specializations, and actively teach the students. The interviews were conducted in January 2021 and in April 2022, the first one online, the second one in person. Both interviews took around one hour, and they were recorded, and later on transcripted.

We also conducted a focus group with a group of students from the Specialisation in Environmental Management of the Environmental Engineering BSc programme at BME. Seven students participated in the focus group discussion in the framework of the course Complex Environmental Management Practices in April 2022.

General inductive approach (11) was used as the qualitative research analysis. The raw data (the transcripts of the interviews, and the notes from the focus group discussion) was read several times by both authors, and the emerging themes were

identified and conclusions drawn as a results of several discussions between the authors.

3 RESULTS

3.1 Literature Review

In the respective literature, several terms are used to describe the necessary abilities for sustainability: green/sustainable and skills/competences. "Green" is a term that is derived from the green economy concept, and it is mostly used in relation to employment and employability (6). The term sustainability is widely used in both job and education relatedly. The difference between skills and competences is that usually, skills represent only a part of competences since competences include knowledge, skills and attitudes – as per the educational definition. However, green skills or skills for sustainability are often used instead of competences in policy and scientific works (7). Higher education institutions should implement sustainability competences into their agenda to prepare their students with the necessary green skills to be employable for green jobs.

The European Commission's science and knowledge service, the Joint Research Centre (JRC) published GreenComp - The European Sustainability Competence Framework in 2022. It defines sustainability competences as a group of skills, attitudes, and knowledge. It provides a common understanding of these competences both for students and educators. The report identifies four main competence areas and 3-3 competences within each area (Table 1).

Table 1. Competence areas and Competences of GreenComp (3)

GreenComp competence areas			
1. Embodying sustainability values	**2. Embracing complexity in sustainability**	**3. Envisioning sustainable futures**	**4. Acting for sustainability**
Valuing sustainability	Systems thinking	Futures literacy	Political agency
Supporting fairness	Critical thinking	Adaptability	Collective action
Promoting nature	Problem framing	Exploratory thinking	Individual initiative

In the Higher Education System in Hungary, the document ‘Shifting of Gears in Higher Education Mid-Term Policy Strategy’ (8) is the first policy to provide guidance in Hungary for universities on the actual application of practical education for the 21st century. It emphasized the importance of transversal skills that increase employability, such as entrepreneurial skills, digital skills, and foreign language proficiency. It also

highlighted the competences that describe general characteristics such as the competences of critical thinking, independent but cooperative problem-solving, civic knowledge, digital literacy, etc. Some of these fields can be connected with the GreenComp competences such as critical thinking and problem solving correspond to the competences from embracing complexity competence area, and the active citizenship characteristic corresponds with the acting for sustainability competence area. This strategy paved the way for universities to introduce education innovations and practical education.

The learning output requirements for environmental engineering programmes are defined by law (18/2016) with detailed information of the expertise, professional abilities, attitude, autonomy, and responsibility areas. The following general skills are mentioned as a requirement for environmental engineers: environmentally conscious behaviour, demand for lifelong learning, good communication skills using technical terminology, ability to solve professional problems, digital capabilities, and openness to cooperation (9). The introduction of these learning outcomes is a significant development in the Hungarian higher education system (10).

3.2 Interviews

Throughout our interviews and focus group discussion, we focused on the possibilities and barriers of the implementation of sustainable competence development in the higher education institutions. We identified four main themes of the discussions, presenting the results around these topics.

The concept of sustainability has become widely used in the last decade.

One of the professors highlighted that the spread of the sustainability concept resulted in the word entering everyday vocabulary on a rhetorical level without people knowing exactly what it meant. Often only the environmental aspect is understood by it; there is no complex understanding of the concept sometimes even at academic level. According to the other interviewee, even though the concept of sustainability is widely spread, it is not integrated in engineering programmes except for the environmental engineering training. Both professors mentioned the concept of saving as an example – it is a fundamental concept of sustainability, still the teaching programmes do not convey that. Both professors highlighted the students' often experienced inadequate knowledge in natural sciences – without which it is hard to discuss these complex issues.

Sustainable Competences/Green skills in the environmental engineering programmes

Both professors brought examples from their teaching practices regarding practical education tasks that support green skills development during their courses. These tasks work well because they reflect on a real-world problem, such as representing an issue the local municipality or simply discussing simple everyday actions from a sustainability point of view. One of the professors mentioned that lately other professors started to see that specific skills could/should be implemented in the everyday teaching practices. Professors already have to identify the skills, knowledge,

and attitudes as the output requirements for each course - unfortunately, this task is experienced by most university lecturers as a considerable burden. There is no energy to redesign lessons unless it is mandatory (eg: redistribution of classes).

Both professors agreed that certain soft skills could be a booster for sustainability, e.g., the art of debate, good communication, and networking abilities. These are more and more present in the courses but typically as part of the assessment – these skills are not taught.

According to one of the interviewees, integrating sustainability skills should not be through separate sustainability courses but built-in elements of all courses, even in mathematics, physics, and statistics as topics of certain tasks.

Multidisciplinary and interdisciplinary education

Both professors agreed that the introduction of multidisciplinary and interdisciplinary projects is very much needed in the environmental engineering courses. However, both found it too hard to implement - it would take too much energy to compile a challenge-based interdisciplinary course.

Encouragement for university professors to integrate sustainability skills

Both professors emphasized the importance of training and guidelines about innovative pedagogical methods that could support professors to move away from the frontal teaching. Lecturers need to be educated about green skills in an engineering context. One of the professors highlighted the importance of thematic calls as an incentive for researchers and lecturers to deal with green skills development. The other professor emphasized the role of networking. The implementation of green skills is currently more a characteristic of the younger generation. Having opinion leaders network with highly respected older generation of academics could support the sustainability initiations within the university.

3.3 Focus Group

We invited seven students from the Specialisation in Environmental Management of the Environmental Engineering BSc programme at BME to take part in the focus group study. Out of the seven students there were 1 female and 6 male participants. 4 of the students already worked beside their studies (as chef, manager, or intern). First, we were interested in how much they live a sustainable lifestyle by asking questions about their everyday sustainable habits. The whole group tries to avoid plastic waste and waste generation in general, and they collect waste selectively. Only 4 out of 7 students try to reduce printing, avoid using cars and buy second-hand products. The least spread actions were reducing eating meat and the usage of smart appliances in their homes. In this regards, this group can be considered better than average.

The first question was about the current teaching program's ratio of engineering and non-engineering skills / knowledge. The group agreed that currently, the non-engineering skills take about 30%-40% of their training. There was a small debate since some students thought the ideal would be around 50%, but others argued that 30-40% is also ideal.

The second question was whether it is the task of the environmental engineering bachelor's and master's programmes to support the development of green competences? Most of the group agreed that, yes, it is because the student's ultimate goal is acquiring these competences for their future jobs. In the management specialization, they feel that it is more typically present, but the technology specialization should not be neglected either.

The third question focused on how useful they find gaining sustainability knowledge during their engineering training. The students found it useful because it covers many areas as a horizontal issue. Engineers shape the physical environment and technologies; therefore, this knowledge is becoming more and more important nowadays, and it is needed for a deeper understanding of complex issues.

For the fourth question we asked the students to provide ideas based on the sustainable competences of the GreenComp on how their training programme could support these competences, and how they could improve these outside the university.

According to students, universities could support the skills and knowledge development as they teach sustainability as a complex system. Sustainability could also be represented by educators from different background fields, and through the appropriate use of resources, research work, case studies, and practical experience. Some students highlighted that universities could only inspire the attitude, but it ultimately depends on the individual student to utilize it. Both groups agreed that it is the students' responsibility to develop these competences for example in their extracurricular activities. They identified programs such as attending events, lectures, conferences, reading scholarly articles and journals, watching videos, and joining and supporting NGOs to improve their sustainability skills. Some of the students emphasized that the Environmental Engineering programme could benefit from more interactive courses, up-to-date knowledge and materials, and the development of pedagogical skills of the professors.

4 CONCLUSION

As a conclusion, we can say that our original hypothesis was right. Even though higher education laws in Hungary prescribe non-technical skills development in environmental engineering education, the interviews and the focus group study showed that these regulations are not fully implemented in many cases. There is a lack of training and a lack of resources and examples – many Hungarian educators are not prepared for the shift from traditional knowledge-centred frontal education. The redesign of university courses and giving place to pedagogical experimentation is not easy to implement.

The introduction of good educational practices into undergraduate education is a complex, systemic problem. It depends on many factors, such as the approach of the university management, the incentives given for curricula development, but also the instructor's personality, their economic situation, etc. The work with the student group, however clearly showed that the demand for this shift is real. Students had a clear

view that sustainability skill development is a key factor for environmental engineers, and they expect the university to offer these to them.

To promote improvement both bottom-up and top-down approached are needed. The easiest, most effective ways as per our recommendation are to develop teachers' / lecturers' trainings, pedagogical guidelines, but also raising awareness through students' competitions. The institutional strategy in this respect could also support the transition. Furthermore, to understand better the local needs, we plan to do further research in the labour market in Hungary in the form of an alumni and labour market survey to better understand employer needs of green skill / sustainability competence.

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