

2023

Certificate-Based Good Practice To Motivate Engineering Students To Learn Sustainability Skills

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Recommended Citation

Barna, O., & Szalmáné Csete, M. (2023). Certificate-Based Good Practice To Motivate Engineering Students To Learn Sustainability Skills. European Society for Engineering Education (SEFI). DOI: 10.21427/0Q5G-DW07

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CERTIFICATE-BASED GOOD PRACTICE TO MOTIVATE ENGINEERING STUDENTS TO LEARN SUSTAINABILITY SKILLS (PRACTICE)

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Conference Key Areas: *Engineering Skills and Competences, Lifelong Learning for
a more sustainable world, Innovative Teaching and Learning Methods*

Keywords: *sustainability skills, environmental economics, environmental
management, certificate, best practice*

ABSTRACT

Engineering plays a crucial role both in addressing sustainability challenges and in helping to achieve the sustainability transition. However, tackling the complex problems of sustainability needs a broader understanding of these issues from non-engineering perspectives as well. The Department of Environmental Economics and

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Sustainable Development of the Budapest University of Technology and Economics (BME), Faculty of Economics and Social Sciences (GTK), has developed a unique method for a uniform certification of studies in the fields of sustainability, environmental economics, and environmental management for engineering students. The so-called green certificate is provided after the successful completion of at least five elective courses such as sustainable business models, green economic development, smart and sustainable digitalisation-related solutions, sustainable rural or urban development, sustainable energy management or climate change oriented courses etc. The certificate can be obtained either in the framework of a bachelor's or master's degree programme, and it is available both in Hungarian and in English, even for incoming mobility students. By achieving the green certificate, the engineering students gain a complex vision, a sustainability mindset and a truly green attitude. Our study analyses the green certificates' data quantitatively, focusing on the engineering students' profiles and the most frequently chosen courses. Our results can help further refine our methods to reach even more engineering students, and it can serve as a good practice to follow for other universities.

1 INTRODUCTION

1.1 General Introduction

Engineering plays a crucial role both in addressing sustainability challenges and in helping to achieve the sustainability transition. However, tackling the complex problems of our time requires expertise from multiple disciplines, as social, environmental and economic challenges are often not only impossible to understand but also impossible to solve using a single perspective or knowledge framework due to their complexity (James Jacob 2015). Engineering practice has also become more and more multidisciplinary in the last decades (Lattuca et al. 2017). Engineering education, therefore, needs to be complemented with knowledge from non-engineering disciplines to address complex problems, and a holistic pedagogical approach has to be applied (Kövesi et al. 2021). The main aim is to train students who are sustainability literate (Sterling and Thomas 2006) and have the competences needed to solve sustainability challenges (Bianchi 2020). As university curricula are structured by disciplines, the application of inter-, trans- and multidisciplinary approaches is not a clear and easy process, especially in engineering education. Even though these methods share the same fundamental ideas, there are major differences between them. Interdisciplinary education requires multiple disciplines to create a synthesis of their knowledge and methods, transdisciplinarity constructs an intellectual framework that is unified beyond disciplinary perspectives, while multidisciplinary is a more individual approach where the joint efforts involve the juxtaposition of different disciplinary viewpoints (Stock et al 2011; Marques 2008). These methods encourage the capacity to comprehend complicated issues and take appropriate action, which is consistent with the aims of education for sustainable development (Annan-Diab and Molinari 2017). Sustainable practices are often integrated into engineering programs by either creating or offering stand-alone courses added to the curricula or by integrating them into one of the already existing courses (Mesa et al.2017). These approaches are essential in reshaping engineering education to complement the engineering skillset with competences from other disciplines, such as management and social sciences thus preparing the engineering students to understand and solve complex problems from different perspectives.

1.2 Green Certificate

The Green Certificate is a great example of providing complex sustainability knowledge in a multidisciplinary learning experience for students of engineering and natural sciences. It is an initiation of the Department of Environmental Economics and Sustainability at the Budapest University of Technology and Economics Faculty of Economic and Social Sciences (BME-GTK).

The Green Certificate is not an accredited diploma, it is a supplementary verification of completed sustainability management courses. It has more than 30 years of history starting in the early 90s. Former students asked the department about the possibility of some kind of recognition of their sustainability-related studies to be

used in the labour market. The department developed the green certificate as a response to this request. To obtain a green certificate the students have to complete at least five of the courses advertised and taught by the Department of Environmental Economics and Sustainability during their studies as elective courses. This can be done either during the bachelor's or master's degree course or during the two courses together. The courses are available in both English and Hungarian, therefore international students can also participate. The completion of English courses can be a good preparation for Hungarian students as well to support the preparation for studying abroad or for multilingual jobs (multinational companies, EU institutions). There is a broad portfolio of subjects available including the fields of corporate environmental management, climate change, sustainable regional development, sustainable business models and EU environmental policies, etc.

Students from all educational programmes at BME can apply for the certificate, the only exceptions are students from the Master's in Regional and Environmental Economic Studies and the Master's in Environmental Engineering specialization of Environmental Management, as their compulsory core subjects include already the required courses. After the completion of the five elective courses, the students have to request the green certificate by filling in a simple online form on the Department's website. Each semester the department organizes a graduation ceremony where the green certificates are handed out. The actual green certificate provides information in both English and Hungarian on the number of hours and courses in environmental economics and management that the holder has completed. The green certificate is a tool for conscious career development, since based on the informal feedback of former students, the certificate can be an advantage in job applications.

2 METHODOLOGY

The main objectives of this practice paper are to provide a quantitative analysis of the Green Certificate based on the related administrative data from the last five years - between 2018-2023. The aim of our paper was two-folded, firstly to showcase this successful local best practice on how to integrate a multidisciplinary educational approach into the engineering programmes, and secondly, to formulate recommendations for future developments based on the data analysis. The methods used for the quantitative analysis are descriptive statistics and exploratory data analysis. We built our conceptual framework based on existing literature summarized in the introduction part about the importance of multidisciplinary in education. The actual data for the analysis were retrieved from Neptun, the online educational administration system that holds all academic data and personal information of the students. We focused on the frequencies and percentages related to the participating students, and their chosen courses, and we used graphical display methods to present the results. Based on the lessons learnt we formulated recommendations for further improving the impact of the program.

3 RESULTS

As it was previously mentioned, the retrieved data covered 5 years starting from June 2018 till March 2023. During these years and months, all together 909 students completed successfully the requirements and applied for the green certificate. Fig. 1. shows the number of certificates per academic year, and it only counts with 859 certificates, as 50 certificates were obtained before September in the academic year of 2018/19. The data for the 2022/23 academic year is not yet complete. The key finding is that COVID-19 did not have a negative effect on the number of green certificates issued, the opposite is true: most certificates were issued during the two worst years of the pandemic (2019/20, and 2020/21). There is a significant fallback in the number of certificates in 2021/22 by almost one-third. Further investigation is needed to discover the potential reasons behind the fallback and the final results of 2022/23 should also be added to see whether the decline is continuing.

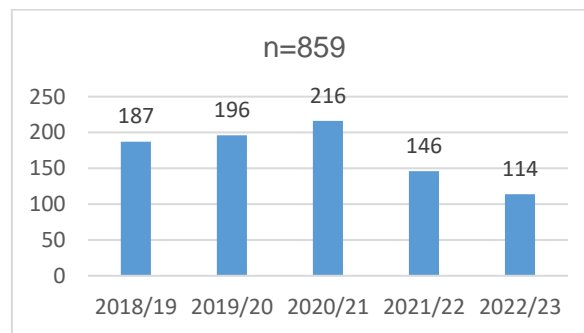


Fig. 1. Number of issued Green Certificates for 5 academic years

Fig. 2. shows the ratio of different fields of study among those 909 students who obtained their certificates between June 2018 and March 2023. More than 60% of the students study engineering, and 31% have a management background. There was only one PhD engineering student, and one from natural sciences giving less than 0,3 % of the total throughout the 5 years. The key results from these data are to increase the number of students participating in the Green Certificate program from the Faculty of Natural Sciences, and also potentially PhD students from any faculties.

We were also interested to see which level of study is represented the most among the participating students (Fig. 3.). The results mostly matched our expectations, as the majority of the students belonged to bachelor-level studies, however, it is surprising how much higher the ratio is – a little more than 92% (almost 62% engineering, and 31% management students), whereas only 7,5% students studied at master level among the participating students. There are much more bachelor students at BME than master students, however, there is a place for improvement in recruiting more master-level.

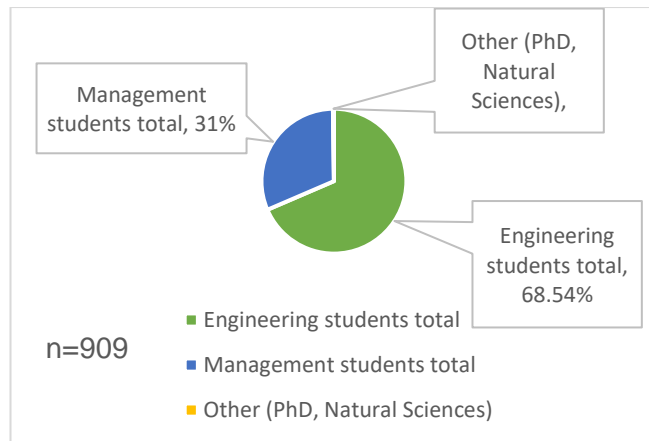


Fig. 2. Ratio per Fields of Study 2018-2023

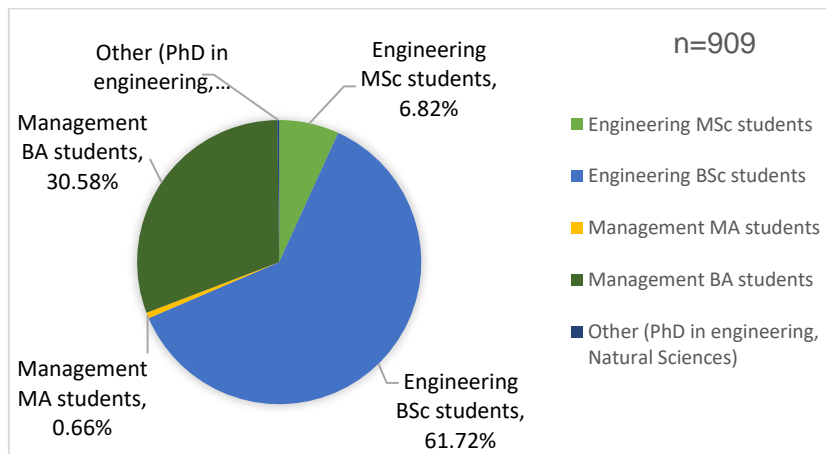


Fig. 3. Ratio of level of studies among those awarded with Green Certificates between June 2018 and March 2023

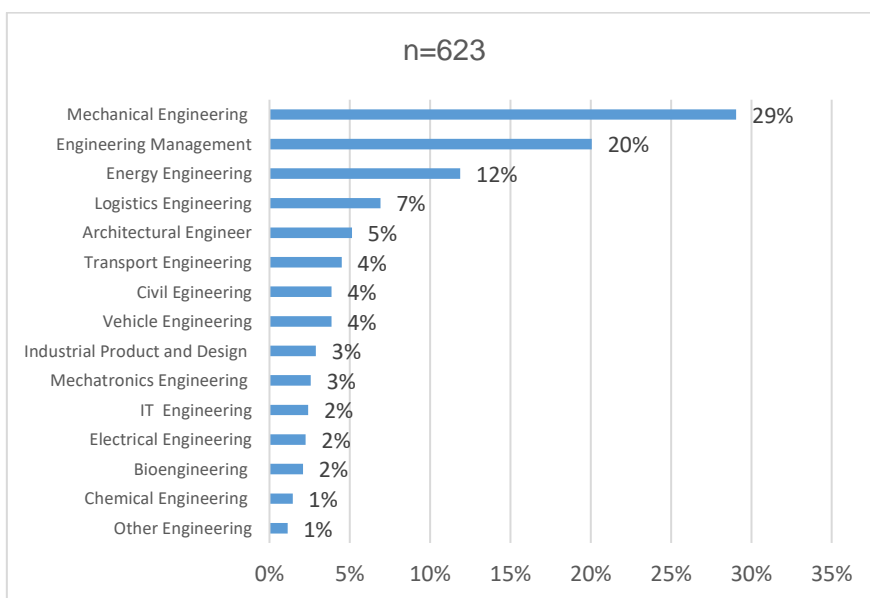


Fig. 4. Different fields of study of engineering students

All faculties from BME are represented among those who obtained the Green Certificates. Fig.4. shows the ratio of students from different engineering studies. The highest ratio of the students awarded studied Mechanical Engineering (29%) either at bachelor or master level, the second highest ratio is from Engineering Management (20%) from the Faculty of Economic and Social Sciences, the third highest is from the Energy Engineering students (12%). Some engineering fields are very underrepresented, such as Chemical and Bioengineering (1% and 2%) and Computer Science Operational Engineering (below 1%).

The international students and courses ratio in the Green Certificate program is very low. The non-Hungarian student ratio is less than 1% - there are only 8 students out of 909 who are non-Hungarians. Sometimes Hungarian students also choose courses held in English, therefore all together 71 English courses were attended out of the 4801 total course number.

Table 1. shows the top 10 list of courses chosen by the engineering and management students separately. The list is different for the two groups even in the top three places. The most popular course in both cases is Environmental Economics. The course Waste Management is also widely chosen by both groups, it is in second place for engineering, and third place for management students. The third place for engineering students is Environmental Management, while Strategic Planning of Climate Protection is the second place for management students. This latter course is completely missing from the list for engineering students together with the Sustainable Business Models course. Climate Change – Advanced level, and the Environmental Management Systems courses are missing from the management students' list but appear on the engineers' top ten list. The courses that appear in both lists but in different places are Environmental Law, Environmental Practices in Energy Management, Environmental and Regional Policy of the EU, Regional Economics, and Human Nature vs. the Natural Environment.

Table 1. The 10 most popular courses among engineering and management students

Engineering Students n= 3268		Nr.	Management Students n= 1512	
Environmental Economics	16%		1	19%
Waste Management	15%	2	13%	Strategic Planning of Climate Protection
Environmental Management	10%	3	12%	Waste Management
Environmental Law	8%	4	11%	Regional Economics
Climate Change – Advanced level	7%	5	11%	Sustainable Business Models
Environmental practices in energy management	7%	6	7%	Environmental Management
Environmental and Regional Policy of the EU	6%	7	5%	Environmental Law
Regional Economics	5%	8	5%	Environmental practices in energy management
Environmental Management Systems	4%	9	4%	Environmental and Regional Policy of the EU
Human nature vs. the natural environment?	4%	10	3%	Human nature vs. the natural environment?

4 SUMMARY AND ACKNOWLEDGMENTS

In this practice paper, we have overviewed the Green Certificate program. We examined with quantitative methods through descriptive statistics and exploratory data analysis the data from the last five years (2018-2023). We have seen that the Green Certificate is widely known among the students of the university, during the 5 years more than 900 certificates were issued providing sustainable management competences to engineering and management students. In conclusion, we can say that the program is indeed successful as a multidisciplinary approach for sustainability competences among engineering students. The weakest points are internationalization and involving master and PhD level students. There are a lot of similarities in what topics engineers and management students consider important, but there are significant differences as well that could be addressed when planning and designing the available courses. Overall, this model is suitable to be implemented in other universities as well.

The limitations of our research include its presentation solely based on the data available from our administrative system. It was beyond the scope of this paper to conduct a survey or interviews among the participants. Therefore, in the future, we plan to conduct both quantitative and qualitative research among green diploma holders to explore whether the students obtained a comprehensive sustainability mindset as a result of their studies and the impact of the green diploma on their employment.

We have formulated the below recommendations based on our results to further improve the Green Certificate program.

- A communication campaign could be organized at the university in English targeting Erasmus incoming students and regular foreign students to increase the international student participation ratio in the Green Certificate program.
- A communication campaign should also be organized for Hungarian students from the fields that are less represented in the program: natural sciences, all master and PhD level students.
- To further develop the level of sustainability integration in the engineering programme curricula, designing new interdisciplinary courses together with the engineering departments might be beneficial.
- To develop an e-badge as a digital proof of the recognized green competences that allow the students to showcase them on digital platforms. This can be a more suitable solution for the younger generations, and it can increase the popularity of the program.

This study was supported by the UNKP-22-3-II, the UNKP-22-5 New National Excellence Program of the Ministry for Innovation and Technology and the Bolyai János Research Scholarship of the Hungarian Academy of Sciences. This endeavor would not have been possible without the help of colleagues Katalin Kász and László Valkó, PhD, who provided valuable input, insights, and assistance for this paper.

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