

Global Economic Development Research within 2025 Vision

## STEM Education and Soft Skills at Higher Education - Selected Results of The Erasmus+ Project 'SOFTEN'

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### Abstract

The paper presents the assumptions of the SOFTEN project (co-financed by EU through the Erasmus+ program) and issues related to higher education, STEM concept and indicates the importance of soft skills in the teaching process and building future professional competences of students (especially those that will help build a more environmentally friendly economy and help adapt to climate change). The main goal of the study is to exchange views in these areas of higher education, and additionally to disseminate the research results of the SOFTEN project. Source materials are primary and secondary. Secondary sources come from available literature and reports and studies of public institutions. Primary data was collected in the first half of 2023 using survey and interview methods. Respondents were students (98 persons) and academic staff (65 persons) from six countries (Poland, Finland, Greece, Italy, Lithuania and Portugal) where the institutions implementing the SOFTEN project come from. The descriptive method (including statistical description) was used to develop the research results, and the results are presented in descriptive, tabular, and drawing form. The results of the conducted research indicate a great need to integrate soft skills into existing higher education programs to better prepare future graduates for professional work, especially in industries of the green industry.

**Keywords:** higher education, STEM education, soft skills, green soft skills, sustainable development, sustainability.

### Introduction

Modern education is looking for new methods, solutions and concepts that will improve teaching as well respond to emerging challenges resulting from social, economic and environmental changes. Learners, and more broadly the entire society, expect education that will allow them to understand the world and its governing rules. Moreover, it is expected that the universities will help them to gain an appropriate social position and a job bringing adequate incomes for the family. Employers expect that the educational system will prepare well-qualified employees for them, which will later translate into higher labour efficiency and make it easier for enterprises to achieve satisfactory profits. All this is happening within a dynamic environment characterized by the digital revolution, globalization processes and attempts to take care of local development. There are visible and harmful consequences to the natural environment because of the way economies are ran in addition to the period of global warming and strong climate changes in weather patterns, which supports the need for an action oriented towards higher education institutions and more specifically universities. This means that education at all levels, including higher education, should face with these changes, adapt to new challenges and conditions, and change its approach to teaching. The

problem here, however, is both the general availability of education on a global scale (which applies especially to underdeveloped countries and war-torn areas), and separation of theoretical knowledge from practice experience. Moreover, a wide separation of fields of knowledge without indicating connections with other parts of knowledge and the emphasis on the transfer of knowledge itself, but without improving intra- and interpersonal skills, which in today's increasingly advanced economy are essential at work and are often a source of competitive advantage. This makes learning less effective, more difficult to absorb and less attractive for students. Therefore, it seems that it is worth considering moving education towards a model that will show the possibilities of greater practical use of various fields of knowledge as part of the implementation of specific projects. It is about a model that at the same time can help in building the so-called soft skills among learners, which will better prepare them to work with other people and to cope with problems resulting from social, economic and environmental changes and is in line with the principles of sustainable development.

## **STEM and soft skills in the context of the SOFTEN project**

The full name of the SOFTEN project is 'Embedding SOFt skills in sTem academic curricula for the transition to sustainable grEen economy'. SOFTEN is an international educational project co-financed by the European Union under the ERASMUS+ (type of program: KA220-HED). The project consortium consists of the following 7 partners: Wrocław University of Environmental and Life Sciences (UPWR, Poland), INOVA+ (Portugal), Hub-21 (Greece), Kaunas University of Technology (Lithuania), X Why Agency of Understanding (Lithuania), Turku University of Applied Sciences (Finland) and Politecnico di Milano (Italy). The project duration is 36 months in years 2022-2025. The main goals of the project are, as follow:

- 1) Developing competencies focused on sustainability and ecology, which will further strengthen the potential of STEM educational service providers and (intermediate and long-term) youth learners.
- 2) Improving the professional development of STEM educational service providers in the field of innovative methods of teaching soft skills and modernizing and improving subject curricula to fill gaps in soft skills and adapt to the requirements of the "green" labor market.
- 3) Supporting new ways of effective collaboration between universities and green industries and building lasting partnerships to cement such collaboration.

As the above presented objectives might suggest, a special area of interest of the project are educational concepts related to STEM disciplines, as well as issues related to the characteristics of professional competences classified as the so-called soft skills - particularly useful from the point of view of the emerging 'green economy', i.e. related to sustainable development and ecology. For this reason, the focus below is on these problematic areas related to higher education and the implementation of the described project.

STEM is an acronym for four independent disciplines: Science, Technology, Engineering, and Mathematics (White, 2014). Characteristic of the STEM educational approach is cross-curricular integration, which is similar to the natural way of learning about reality by humans (Margot & Todd Ketler, 2019). STEM education is not a simple combination of these four scientific disciplines, but rather a certain philosophy of education according to which the ability to teach is combined with learning in a very similar way to real life. People learn about the world in a holistic way through learning at all levels of education, which should be treated similarly. Learning in the STEM model helps to discover interesting issues with the help of cooperation, mutual understanding and respect. Thanks to the use of active working methods, such as: experiments, design thinking, project methods, combined with posing educational challenges, creative thinking and a critical approach to the discovered facts are developed in students. The STEM approach awakens a desire to learn and a curiosity about the world and helps with self-directed learning and self-regulated learning (Szewczuk, 2021). The STEM approach is based on learning through experience, getting to know the world in practice using all the senses (including through experiments showing the practical application of knowledge). The basic assumption of STEM is to show the organic relationship of various sciences as an inseparable whole, thanks to which the student from an early age learns to think independently and acquire knowledge in a very broad perspective (PSES, 2023). There are various modifications and transformations of the STEM acronym and the disciplines that may be included under it (Ferrari, 2020; Wikipedia, 2023). Details related to this are presented in table 1.

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**Table 1: STEM acronym and its modifications and transformations, according to the disciplines it can embrace.**

Abbreviation of the name of an educational concept	Area of knowledge included in a specific concept
STEM	Science, Technology, Engineering, Mathematics
STEAM	Science, Technology, Engineering, Art, Mathematics
STREAM	Science, Technology, Reading & Writing, Engineering, Art, Mathematics
STEMLE	Science, Technology, Engineering, Mathematics, Law & Economics
STRAEM	Science, Technology, Robotics, Art, Engineering, Mathematics
MINT	Mathematics, Informatics, Natural Sciences, Technology

Source: own elaboration.

By implementing an educational concept based on STEM or its modifications, students learn to think independently and acquire knowledge from a very broad perspective. This is important because the nature of work in various professions has changed over recent years, and, consequently, the skills required of many young employees due to various challenges and conditions, including: effects of climate change. This led to new requirements for transferable competences in the way we behave, act, think, communicate, resolve problems in all environments and especially in green professions. Universities and academic staff play a profound role in instilling new competences towards the effective adaptation of students as future employees in the green transformation of economy, with technical occupations and STEM fields being on the frontline.

There are various definitions of soft skills, but almost all of them relate to understanding human nature (Urhan Torun, 2018). The Cambridge Dictionary defines soft skills as *'people's abilities to communicate with each other and work well together'* (Cambridge Dictionary, 2023). According to Alex (2009) soft skills can be divided into three categories:

- 1) social skills (examples: communication and interpersonal skills, positive attitude, values, perception, social etiquette);
- 2) negotiating skills (examples: coping with time, stress, emotions and teamwork);
- 3) thinking skills (they help in imply creativity, problem-solving and decision-making).

Soft skills are also called social skills and are defined as personality traits, communication skills, facility with language, personal habits, kindness, and optimism that help characterize people (Alex, 2009). Soft skills are related to personality development, which include social, communication and language skills, as well as interpersonal habits, assertiveness, kindness, and optimism, which are useful for building relationships with other people (Nitonde, 2014). In the literature, an interesting approach can be found that soft skills can help in a professional career and adapt to the requirements of the labour market, as well as being a way to make family life more pleasant and happier. Therefore, they concern both the search for better professional and private relationships between husband, wife, children, and other household members. Soft skills are interpersonal and intrapersonal skills that objectively combine and increase a person's EQ (emotional intelligence quotient) (Iland, 2013).

Soft skills are strongly related to personality traits, goals, and motivations. It is indicated that they create value that facilitates achieving success in the modern labour market (Rego et al., 2016). Soft skills help in achieving results effectively and improve the quality of implemented goals and strategies (Caggiano et al., 2020). They have been suggested to improve interactions, work performance, critical thinking, and career prospects (Schulz, 2008). Soft skills aren't specific because they cannot be directly linked to a specific profession or activity (Panadero & Alonso-Tapia, 2014). Unlike hard skills, which dominantly refer to the ability to perform a specific type of task or activity, soft skills are interpersonal in nature and apply in various cases and situations (Peeraer et al., 2007). It is believed that soft skills can be learned and developed, what would support the design of effective learning methods to achieve increased levels in soft skills (Tynjälä et al., 2016, Caggiano et al., 2020).

Research shows that many employees have basic deficiencies in soft skills. Research conducted among selected managers operating in Finland and Italy indicates that particularly useful soft skills from the point of view of enterprise management staff are teamwork and flexibility in development (Schleutker et al., 2019). The need for reskilling and investment in new skills – especially soft skills – is also confirmed by the 'World Economic Forum's Future of Jobs' Report, concluding that 50% of all employees will need a 'reskilling' by 2025. This has recently

increased by the “double-disruption” of the economic impacts of the pandemic (World Economic Forum, 2020a). Among the most important distinguished soft skills are critical thinking, creativity, complex problem-solving and analytical thinking, that are placed at the top list of skills that employers believe will grow in prominence (World Economic Forum, 2020b).

In today’s workplace the need to gain soft skills is considered critical because of globalization, virtual offices, technology and increasing society diversity in age, gender, education, ethnicity, etc. Employers tend to place more importance on the candidates’ personal qualities, which cannot be validated by conventional diplomas or certificates, as they are often cultivated and developed in practice. This is observed not only in multinational environments and big corporations, but also in SMEs. It is strongly acknowledged that soft skills are needed for the success and competitiveness as hard skills (Dall’Amico & Verona, 2015). When it comes to the climate change effects and young employees’ adaptability to manage environmental challenges, the significance of hard skills is fundamental. Besides the scientific knowledge and technical expertise in any STEM field, many studies strongly emphasize the equally vital role of soft skills in the rapidly changing labour market as a pathway to update the STEM educational curricula with new collaborative and interdisciplinary methods. Soft skills become more and more critical for technical occupations that will spearhead the sustainable transition (ILO, 2019) and for some green sectors they are considered equally fundamental as hard skills, as they can offer an adaptability in a new working environment in combination with technical know-how (Pavlova, 2018).

In SOFTEN project, it was noticed and recognized that one of the major challenges of today is the need to adapt to climate change through to meeting the requirements towards the ‘green transformation’ (i.e. the transition of the EU economy and society towards achieving climate and environmental goals primarily through policies and investments, in accordance with EU legal regulations) and striving to develop the so-called ‘green economy’ (described as management that helps improve human well-being and achieve social equality, while reducing or eliminating environmental risks and ecological deficiencies). In such conditions, ‘green jobs’ are also created, which include occupations that facilitate the achievement of net zero emissions goals and/or other environmental goals (e.g. restoring the balance in nature, adapting to climate change, caring for biodiversity, etc.). In this context, the concept of “green soft skills” becomes relevant, covering knowledge, skills, values and attitudes important for human existence and social development consistent with sustainable development and effective management of resources available in the economy (Galani et al., 2023). This is not about special new types of soft skills, but rather about their adaptation and use in a direction useful for implementing the principles of sustainable development in practice and building a greener economy.

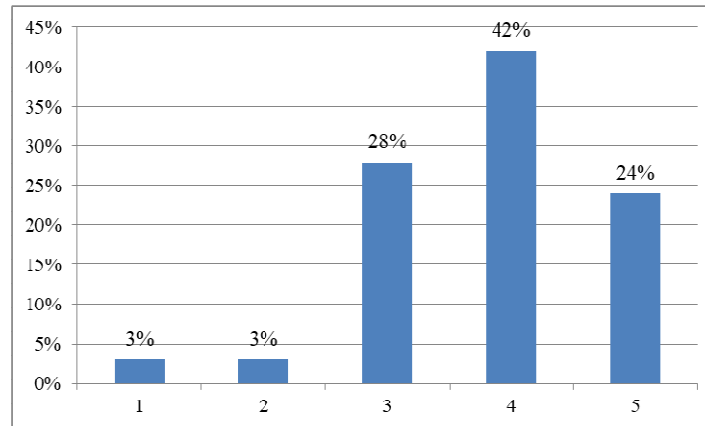
## **Research Material and Methodology**

The main goal of the study was to exchange ideas in the field of contemporary higher education, including the presentation of the STEM concept and indication of the importance of soft skills in the teaching process and building future professional competences of students.

The materials used for research are both primary and secondary sources. Secondary sources come from available literature and reports and studies of public institutions - especially those dealing with education and socio-economic development. Primary sources were obtained during the implementation of the SOFTEN project, obtained through a survey method from selected students and academic staff using research questionnaires. The research was conducted in the first half of 2023. The respondents came from the following EU countries: Finland (FI), Greece (EL), Italy (IT), Lithuania (LT), Poland (PL) and Portugal (PO), which resulted from the location of the institutions forming the SOFTEN project consortium. In total, 98 students (one group) and 65 university teachers (second group) took part in the research (assuming that there were at least 10 people from each country in each group). The selection of respondents was purposeful and concerned people studying or working at different university departments where education in STEM fields is provided. The research results could be treated as valuable survey information that is necessary from the point of view of the objectives of the SOFTEN project and fully useful for the implementation of the tasks planned therein, however, due to the relatively small number of research groups, they cannot be considered representative for the entire population. Despite this reservation, the results obtained provide an opportunity for further discussion and may be a starting point for further extended research on educational issues that will cover the entire population. The descriptive method (including statistical description) was used to develop the research results, and the results are presented in descriptive, tabular, and drawing form.

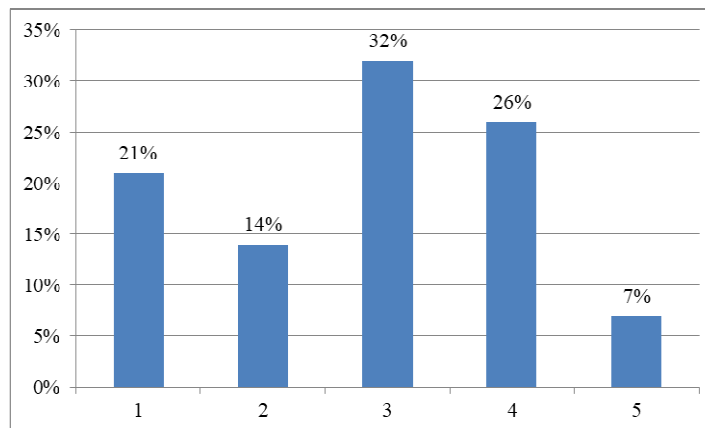
## Results

The results present selected information obtained among STEM students and academic staff, which were carried out in countries represented by the SOFTEN project partners. Firstly, universities students' responses are presented. Most respondents from the group of STEM students come from Poland (almost 43% of respondents). In case of the each of remaining countries (Greece, Italy, Lithuania, Finland, Portugal) the share of respondents is between 10.2-12.2%. A similar number of women and men participated in the research (proportion 51% to 49%). When it comes to their level of education, most respondents (approximately 61%) are undergraduates, i.e. pursuing a bachelor's degree and about 28% of respondents are graduates, pursuing a master's degree. About 11% of respondents are PhD students, post-doc researchers or other staff members affiliated with academic institutions. The issues addressed to respondents included a question about how familiar they with the concept of 'soft skills' are. The distribution of their responses is presented in Figure 1.



**Fig 1. Distribution of students' answers about their familiarity of the concept of soft skills (1 – not familiar at all, 5 – extremely familiar).**

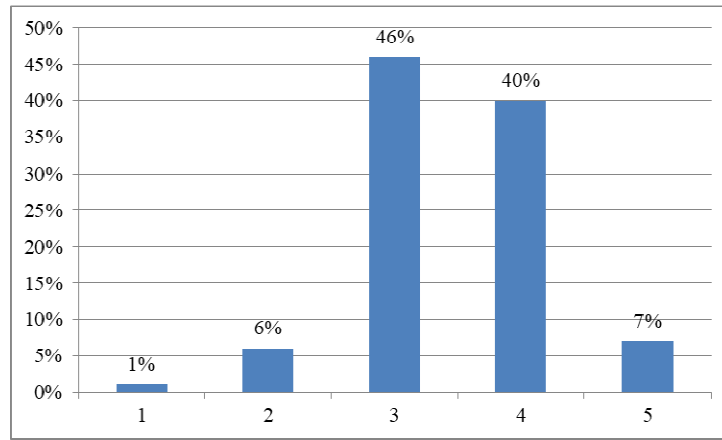
Concerning the level of knowledge on soft skills, 42% of students expressed that they are quite familiar with this typology of skills (Figure 1). Nevertheless, in the following question, which focuses on 'green' soft skills, we can see that less students indicated high and significant familiarity to the concept. This is presented in the Figure 2 below.



**Fig 2. Distribution of students' answers about their familiarity of the concept of 'green soft skills' (1 – not familiar at all, 5 – extremely familiar).**

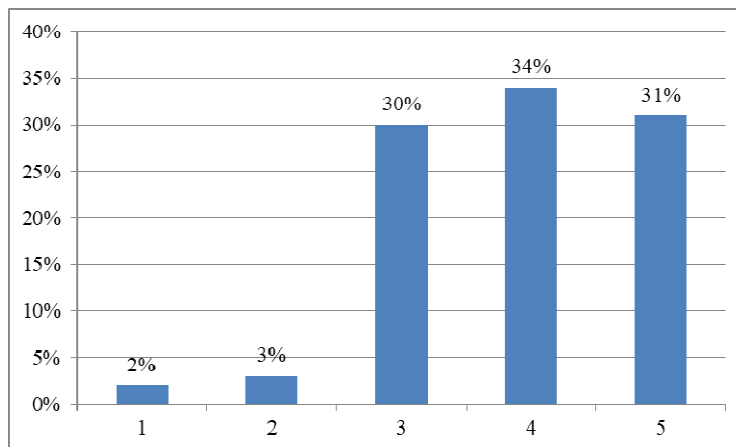
When it comes to focusing on the selected STEM students' self-assessment of their soft skills level, we see that 46% of the students indicated a medium skill level, as it is shown in Figure 3.

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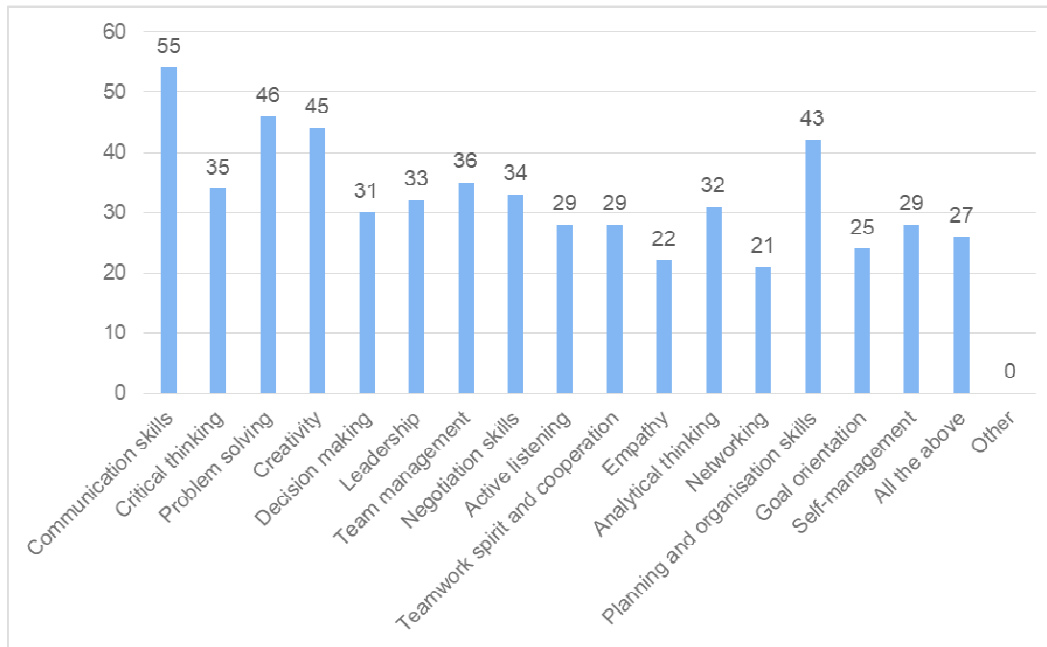
**Fig 3. Distribution of students' answers regarding their assessment of the level of their own soft skills (1 – very poor level, 5 – very high).**

In the next step, the surveyed group of students was asked to determine the extent to which they agreed with the opinion that soft skills can improve and strengthen their ecological skills, both as individuals and as scientists. Here, approximately 65% of students agreed with this statement by giving the note 4 or 5 (agree and fully agree). All results related with this question are presented in Figure 4.



**Fig 4. Students' indications of their level of agreement with the statement: "I believe that soft skills can improve my environmental awareness and further expand my environmental skills - both personally and as a potential STEM scientist" (1 – I am strongly disagree, 5 – I fully agree).**

The results presented in Figures 5 below indicate the type of soft skills were considered the most important in the group of students. Respondents had the option of multiple choices in this questions, therefore the sum of the answers in this cases is greater than 100%.



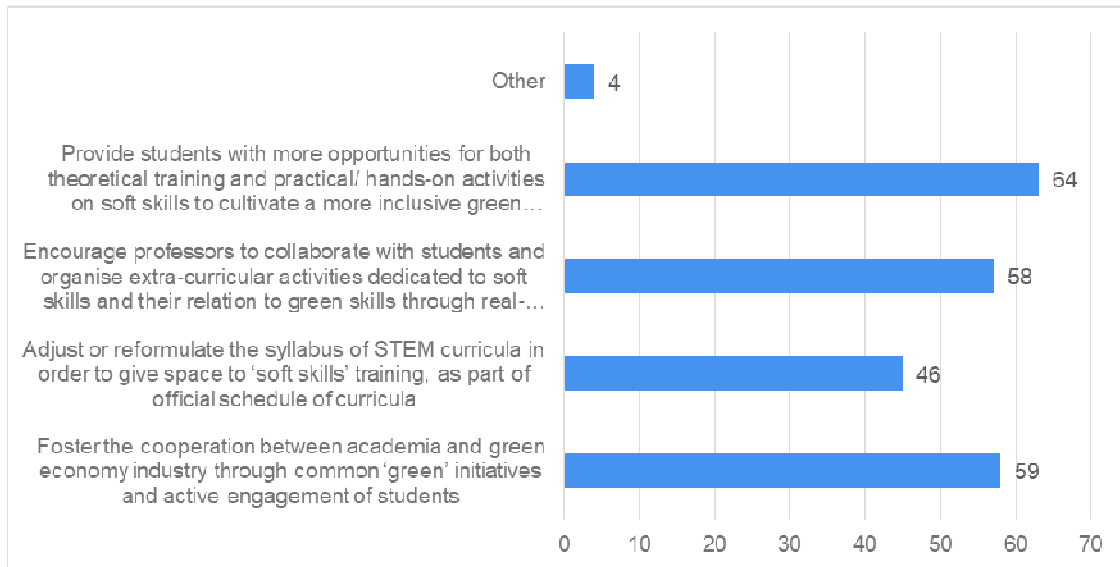
**Fig 5. Students' indications of the most important soft skills in the context of future professional development in green economy sectors.**

Selected students placed the greatest emphasis on the following skills that could help them in their future career in the green economy: communication skills (55% of responses), problem solving (47% of responses), creativity (almost 45% of responses), planning and organization (approximately 43% of responses), and team management (36% of responses). The remaining options received less than 35% of responses (Figure 5).

Further part of the research served to investigate students' opinion on barriers and challenges that hinder the integration of soft skills in STEM courses, especially those with green orientation. In addition, students have been given the opportunity to express their opinion for possible ways through which current shortages can be better addressed by their university or any other higher education institution. Some students cited various barriers limiting the development of soft skills in their STEM studies. Examples of such barriers include:

- Lack of interest or willingness on the part of teachers.
- Lack of engagement from peers or lack of understanding of the benefits that soft skills can offer them in the long run in their future work environment.
- Old-fashioned way of teaching, outdated grading process and old-fashioned way of thinking of teachers.
- Lack of interdisciplinarity in STEM fields
- General lack of knowledge about soft skills - lack of publicly available information about soft skills courses.

In addition to the difficulties and existing institutional gaps in integrating STEM soft skills courses, STEM students expressed their views on how to overcome the reported barriers (Figure 6).



**Figure 6. Students' preferred ways of integrating soft skills into STEM education.**

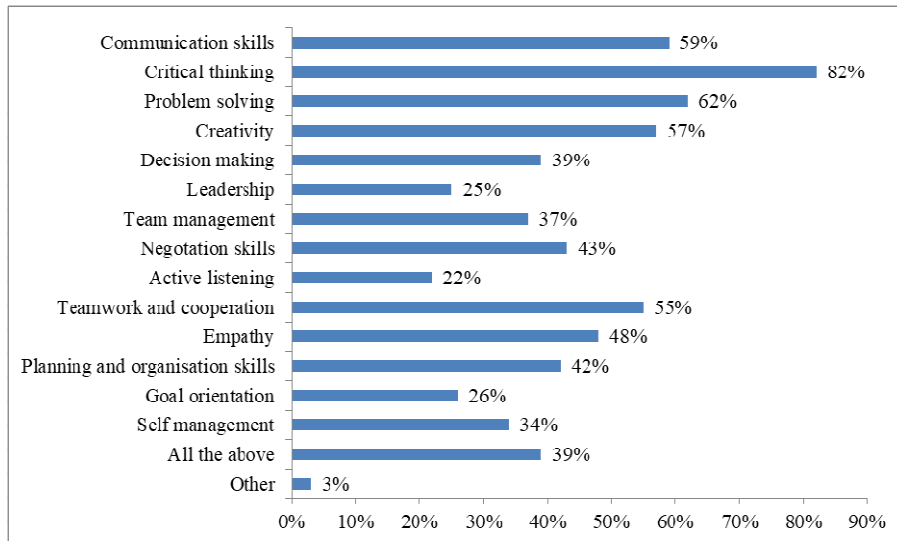
The option that seems to be most preferred by students is a combination of theoretical training with practical classes on soft skills (approximately 64% of all of the responses). Other proposals that aroused their interest included cooperation between the academic community and 'green' companies, with the active involvement of students (59% of responses). In third place, cooperation between educators and students was selected to cooperate in organizing and co-creating extracurricular activities devoted to soft skills and their connection with ecological skills using real-life examples or case studies (Figure 6).

The second part of the presented research concerns the viewpoints of academic staff. A total of 65 responses were collected in the survey aimed at university-level educational institutions. In this group, 21.5% are associate professors, similarly 21.5% are lecturers, approximately 20% of respondents are full professors, approximately 19% are assistant professors and almost 17% are young researchers and assistants. In the study group, women constituted 43% and men 57% of the selected study participants classified as academic staff. This study presents the results obtained from academic staff regarding the identification of the most important soft skills for the green economy in the field of STEM education, the identification of barriers and difficulties in the implementation of soft skills training in study programs. Additionally, it contains suggestions on how to implement education in the field of soft skills, including "green" ones, and how to avoid previously defined barriers and limitations.

The results presented in Figure 7 indicate the soft skills that were considered the most important for the green economy according to the group of educational service providers. Respondents had the option of multiple choices in these questions, therefore the sum of the answers in these cases is greater than 100%.



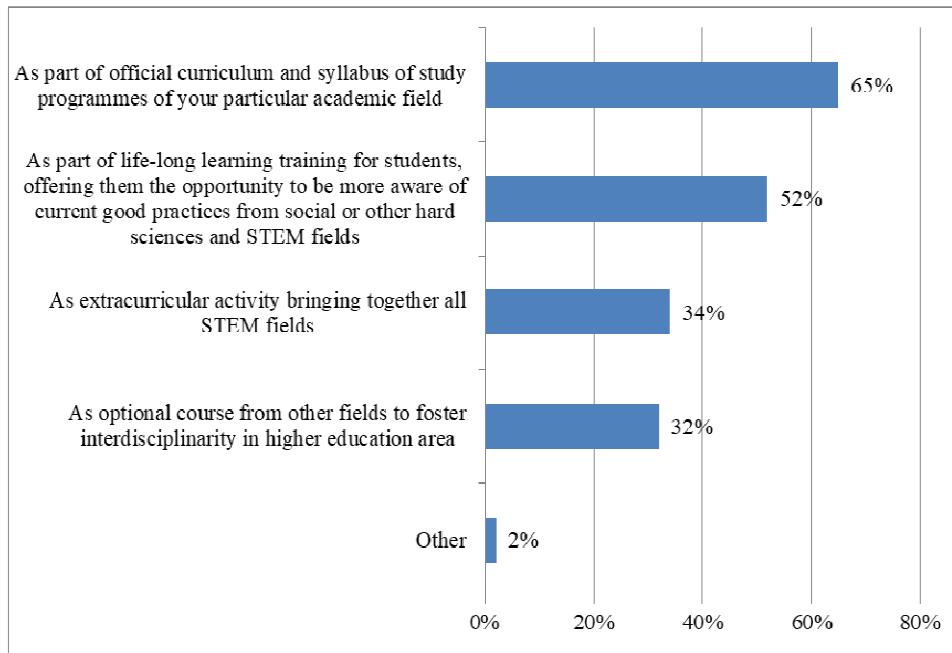
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**Figure 7. Academic staff and teachers' recommendations on the most useful soft skills in the green economy.**

When it comes to choosing the most important soft skills, critical thinking is the most important according to the STEM education providers (as many as 82% of respondents chose this option). In second place was problem solving (62% of participants representing academic staff), and in third place were communication skills (chosen by 59% of surveyed educators/trainers). The following soft skills that were considered most important: creativity (57% of responses), teamwork and cooperation (reaching 55% of indications). Detailed data in this regard are shown above in Figure 7.

One of the key questions in the survey concerned the respondents' opinions on opportunities to include and develop soft skills in STEM curricula at universities more effectively. Figure 8 presents the results regarding this issue.

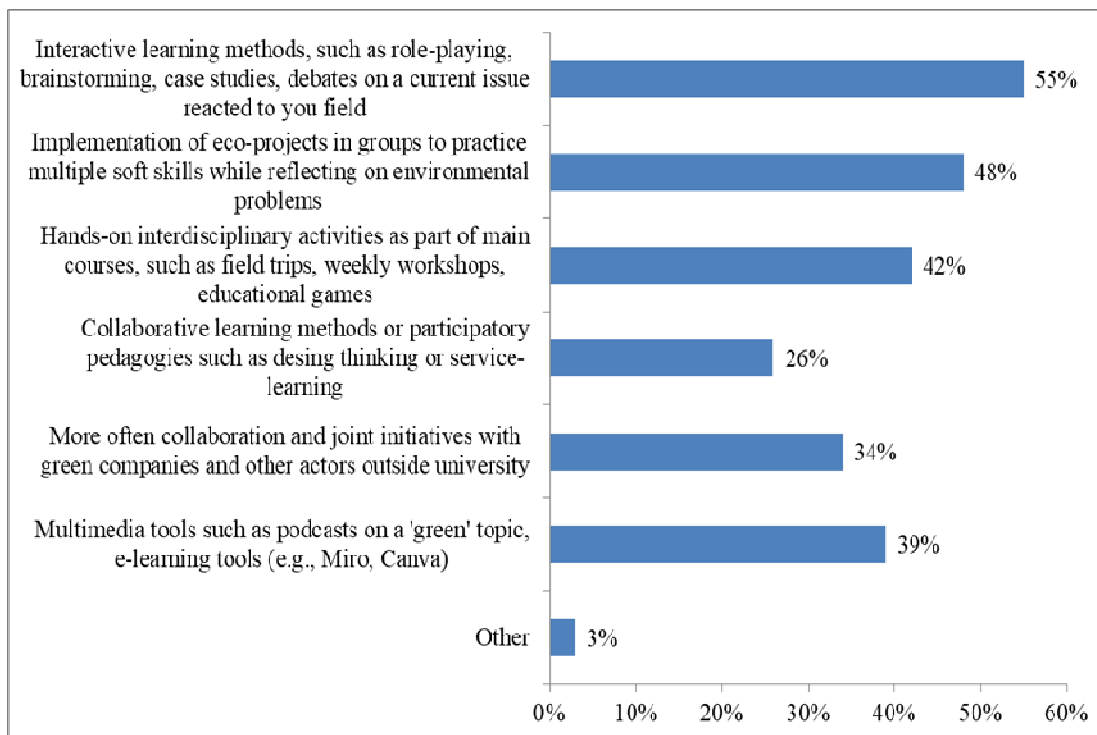


**Figure 8. Indications by academic teachers what forms of soft skills classes to introduce into the curriculum.**

The last part of the results focuses on identifying gaps and barriers identified by respondents from the academic staff group, regarding the development of soft skills in STEM curricula. Respondents indicated the following gaps and barriers:

- Low level of awareness of good initiatives in this topic.
- Poor understanding of the demand for these skills from today's green industry.
- Lack of interest on behalf of educators in teaching soft skills.
- Soft skills not being formally recognized and valued in higher education, which often prevents other colleagues or students from understanding the uniqueness of soft skills, let alone their connection to the ecological transition.
- Lack of motivation or interest of colleagues to promote interdisciplinarity and soft skills or to teach hard skills in a more creative way, especially the sustainability aspects of technical courses.
- Many technical courses still rely on traditional teaching styles, i.e. low inclination to a multidisciplinary and holistic approach to problem solving and determination.

Education service providers who took part in surveys were asked to identify educational tools and methods that they can use as academics to improve and strengthen soft skills in STEM education and to point the way to overcoming related gaps and barriers at the higher education level. These proposals are presented in Figure 9.



**Figure 9. Educational methods indicated by academic staff and teachers useful for improving soft skills in STEM education and 'green thinking'.**

When it comes to educational tools that can help integrate soft skills more effectively into STEM courses, almost 59% of respondents suggested using interactive learning methods (such as role-playing, brainstorming, case studies) to teach and cultivate soft skills in practice (Figure 9). Similarly high percentage of responses is observed in the case of proposals to implement projects focusing on environmental issues in combination with group activities. In this case, many soft skills can be promoted (communication, problem solving, exchange of ideas and critical thinking, innovative ideas, etc.). Other suggested methods include practical interdisciplinary activities using a variety of tools (from workshops to educational games and field trips), which were chosen by 51% of surveyed

university employees. Additionally, great importance was attached to the use of collaborative methods (e.g., design thinking or service learning (Figure 9).

Following the analysis and interpretation of the presented results, we can state that it is time for a complete integration of soft skills, in particular green soft skills, into academic courses, as it happens in school for pupils, since they can be acquired through practice and exercise, not only theoretically. The processes of acquiring non-disciplinary competences should not separate from the processes of acquiring other knowledge or technical skills. In our days, a key competence seems to be the ability to be creative, to properly manage the knowledge, to comprehend reality (Innerarity, 2010). and to find solutions for limitations in terms of sustainability.

Universities want to maintain their attractiveness in the face of challenges and changes in the surrounding world, and this requires an innovative teaching approach. It is not only about reproducing knowledge and improving various skills, but also about better understanding the world and identifying ways to solve problems and cooperate in society (Sancassani et al., 2019). As a result, university lecturers are increasingly being called upon to transform their courses and introduce innovative teaching methods that put students at the heart of the learning process, motivate them to learn and engage in activities that require active participation and responsibility.

Didactic innovation, understood precisely as the process of revising teaching practices to better meet learners' needs, not depending on the selection of specific methods or approaches, but pertaining to the process of continuous evolution of a didactic environment oriented towards improving the learning experience, naturally brings with it the development of transversal skills. Therefore, there is a need for training for academic staff, firstly, to realize the potential they have in their hands, secondly, in terms of teaching methodology, and thirdly, in terms of soft skills and their assessment.

## Summary

The challenges emerging in the modern world mean that the education system have to change and adapt to new conditions in order to be as effective as possible and serve people. More and more attention are paid not only to acquiring hard skills, but also to soft skills related to personality traits and human nature. The growing importance of soft skills in education results from changes in the economic environment and the desire to look for new competitive advantages and cope with new economic conditions. Climate change, pressure from institutions creating the legal framework, emerging new consumer trends and technological possibilities result in the development of an increasingly green economy, where we try to conduct business in a more ecological way and consistent with the principles of sustainable development. Jobs are created there, for which soft skills appear to be very useful, and if while they help to increase the level of environmental performance and implement sustainable development in practice, we can then call them 'green' soft skills. We should support their inclusion in educational programs, especially at university level and in sectors involving the STEM concept, because they are particularly related to the development and growth potential of the green economy.

The study presents the assumptions of the SOFTEN project implemented under EU funding from the Erasmus+ programme, which is focused on issues related to soft skills and STEM education. The results of the conducted research indicate a great need to integrate soft skills into existing higher education programs to better prepare future graduates for professional work, especially in industries of the green industry.

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