UNPACKING THE NEEDS AND CHALLENGES OF EMBEDDING SOFT SKILLS IN STEM CURRICULA IN EU HEIs

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Abstract

The climate crisis and green transition are reshaping the way STEM young graduates respond to challenges in a rapidly changing workplace. Several studies highlight the emerging role of soft skills, as part of the development of new competences for green jobs. For soft skills to be adopted in green industries, synergies between Higher Education Institutions (HEIs) and companies are needed. The Erasmus+ SOFTEN project promotes the integration of 'green soft skills' into STEM schools across four HEIs in the EU by training educators and equipping STEM graduates with capabilities needed. As part of the research phase, the project designed a framework about the current needs and challenges of soft skills integration in green STEM curricula in Europe, through mixed-method research. The project's team performed desk research about initiatives in HEIs on soft skills integration in STEM courses, followed by semi-structured interviews with STEM educators and green industry representatives in Greece, Lithuania, Italy, Poland, Portugal and Finland. An online survey was distributed to STEM students in these countries to triangulate results about needs and gaps. The findings were validated through online focus groups. The paper presents the qualitative component of the research, in particular the results of the semi-structure interviews with STEM educators and green economy stakeholders. As such, it contributes to the growing body of literature about mismatches between green soft skills supply side (by HEIs) and demand side (by green industry) across different academic and industry settings in the EU.

Keywords: Green transition, soft skills, green soft skills, STEM, higher education, research.

1. Introduction: The rising importance of green soft skills in HEIs

Green soft skills represent a specialised subset of soft skills that focus on fostering environmentally sustainable practices within various sectors. They span from effective communication about sustainability issues to adaptability to new environmental technologies. They are increasingly recognised as essential for individuals in both leadership and operational roles across industries.

Incorporating green soft skills into STEM curricula involves a multifaceted approach. Their development necessitates implementing teaching strategies that encourage critical thinking and communication, which are essential for collaborative problem-solving in sustainability-related projects. HEIs that emphasize soft skills alongside technical competencies significantly enhance the employability of graduates, as employers place equal importance on both types of skills (Messaoudi, 2021; Rodríguez et al., 2021). However, educators and business leaders face barriers in the implementation of green soft skills in STEM curricula in HEIs. One challenge is the traditional focus on hard skills and technical knowledge in these fields, often at the expense of soft skills (Mwita et al., 2023). This focus can result in a skills gap wherein graduates lack the necessary interpersonal skills to navigate the complexities of modern workplaces (Messaoudi, 2021). Additionally, institutional policy plays a crucial role in shaping the curriculum. Some HEIs lack the necessary infrastructure and commitment to embed soft skills into their programmes. It can also be difficult for educators, who may not have been trained to teach soft skills, to effectively introduce these concepts into existing curricula (Ernawati & Bratajaya, 2021; Amantay

& Ermakov, 2021). Another barrier is the ingrained perception within HEIs that hard skills are of primary importance, often at the expense of soft skills (Hwang, 2022).

To counteract such trends, approaches like project-based learning can help illustrate the real-world relevance of soft skills while maintaining a strong focus on technical knowledge (Joseph & Uzondu, 2024). Professional development programmes on methods for integrating soft skills can empower faculty members (Joseph & Uzondu, 2024). Collaborative efforts among disciplines and the establishment of a shared vision for curricular integration can facilitate a more coherent approach to teaching green soft skills within STEM programmes (Tan et al., 2019). As sustainability-related challenges in fostering soft skills development in green STEM curricula are context-dependent, the SOFTEN project performed research to unpack specific barriers and repercussions in six EU countries, thus informing the associated educational solutions.

2. Research design & methodology

The research phase was framed as stakeholder-informed research that combines qualitative depth with wider quantitative information. The qualitative arm comprised semi-structured interviews involving two principal sets of participants: (i) STEM academic staff and (ii) members of the green sector, conducted across Greece, Lithuania, Italy, Poland, Portugal, and Finland. Interviews probed how soft skills are now perceived, ordered, and (under)developed in educational and working life, guided by an interview protocol that allowed contextual consistency but national variation. Participants were invited through purposive and snowball sampling to offer variety in expertise, institutional role, and disciplinary background. The interviews yielded rich context-specific insights into facilitators and barriers to the development of STEM soft skills, and the data was analysed thematically to produce concrete results.

The research approach combined depth and scope through 57 semi-structured interviews with STEM educators and green industry representatives in six European countries. A shared thematic guide ensured consistency across interviews while allowing local relevance. Participants were sampled from a variety of STEM fields and green sectors, including circular economy, energy, and sustainable technologies. Interview answers addressed green soft skills awareness, opinions regarding their perceived utility to future graduates, operational barriers to their implementation, and existing activities to incorporate them into education or into in-work training. The interviews were thematically coded to look for recurring patterns and national differences. The findings were triangulated with quantitative survey outcomes and refined through discussion in focus groups.

3. Objectives

The qualitative research pursued three general objectives. Firstly, it sought to understand how green industry professionals and STEM educators perceive the role and importance of green soft skills in sustainability careers. Secondly, it sought to identify specific gaps in current STEM curricula in terms of incorporating soft skills, particularly emphasising structural, cultural, and institutional barriers. Third, the research aimed to reveal examples of good (best) practice and stakeholder-driven recommendations to inform curriculum innovation. The achievement of the objectives ensured that the research provided an evidence-informed foundation for the SOFTEN framework and the subsequent results, such as a Massive Open Online Course (MOOC) and an online platform to support STEM educator capacity-building.

4. Findings: deficiencies in the skills supply and repercussions to the skills demand side

The findings reveal a set of barriers to the integration of soft skills in green STEM curricula (for STEM educators) and how these barriers translate into challenges in green industry workplaces during the education-to-workplace transition of STEM students. Therefore, the findings offer a comprehensive overview of academic gaps (skills supply side) and associated problems in the green occupational sector (skills demand side) of the academic-employment trajectories of STEM students.

The cross-country analysis of data generated a cluster of commonly perceived barriers and needs across all examined academic settings. The recurrence of these barriers in academic contexts which differ culturally and institutionally illustrates their significance and informs EU-wide policy actions.

At the institutional level (macro- and meso-level), STEM educators stressed the absence of clear state-level or university-driven strategies that are necessary to support more inclusively green skills with the integration of soft skills. This is naturally linked to limited or absent dedicated time regarding introducing and teaching soft skills in the syllabus of STEM courses. In addition, lack of resources and poor cooperation with the private sector and non-academic stakeholders have been cited by interviewees.

At the individual level (micro-level), STEM educators across all countries self-reported the lack of proper training of teachers on soft skills. From a behavioural angle, reluctance from educators in

changing teaching methods and embracing interdisciplinarity through innovative learning units is a theme that has been observed in all countries.

The interviewed stakeholders from the green sectors outlined a series of current gaps that are exhibited by employees in the workplaces and are associated with the deficiencies in the supply side of the skills equation. The sectors that were covered in the research indicatively include circular economy, green energy, waste management, refining industry, green infrastructure, water treatment, and green architecture; thus, capturing a plethora of green occupations.

A major problem that was discussed concerns the difficulty from the side of young STEM graduates and young employees to adjust their technical knowledge and skills into real-world needs. This points out a mismatch between technical knowhow and contemporary green challenges that require an interdisciplinary mindset to be addressed. Additional gaps relate to the lack of taking risks, limited creativity and poor communication skills that young employees display in their work tasks.

The second strand of challenges that was discussed with industry stakeholders regarded obstacles to workplace initiatives that can compensate for the skills gaps of employees by providing training in soft skills. Interviewees highlighted the lack of organised and top-to-bottom efforts to develop soft skills due to immature organisational culture in the local green industries. Limited budget in organising capacity building training is another organisational barrier that keeps green soft competences underdeveloped.

5. Conclusions

Green soft skills are increasingly recognised as essential for leadership and operational roles across sectors. Despite their importance, gaps persist in how these skills are integrated in HEIs.

Research across six European countries revealed that HEIs often lack clear strategies and dedicated time for embedding soft skills into STEM curricula. Educators report insufficient training and show reluctance to adopt interdisciplinary and innovative teaching methods. Limited resources and weak cooperation with industry further hinder progress. On the industry side, young STEM graduates frequently struggle to apply their technical expertise to real-world green challenges, lacking creativity, risk-taking, and communication skills. Organisational barriers, such as immature cultures and limited budgets for green soft skills training, keep these competencies underdeveloped in the workplace. Addressing these gaps requires multi-actor collaboration to foster holistic skill development.

The SOFTEN project responds to these challenges by developing a framework for green soft skills integration and creating resources to support STEM educators' capacity building. These initiatives aim to better equip graduates for the demands of a sustainable, rapidly evolving labor market.

References

Amantay, Z., & Ermakov, D. S. (2021). Socio-pedagogical features of the formation of soft skills in the Republic of Kazakhstan. *Advances in Social Science, Education and Humanities Research.* https://doi.org/10.2991/assehr.k.210527.006

Ernawati, E., & Bratajaya, C. N. A. (2021). Senior nurses' perceptions of essential soft skills for novice nurses in a private hospital in jakarta, indonesia: a phenomenological study. *Belitung Nursing Journal, 7*(4), 320-328. https://doi.org/10.33546/bnj.1549

Joseph, O. B., & Uzondu, N. C. (2024). Curriculum development for interdisciplinary STEM education: a review of models and approaches. *International Journal of Applied Research in Social Sciences, 6*(8), 1575-1592. https://doi.org/10.51594/ijarss.v6i8.1371

Hwang, S. (2022). Effects of engineering students' soft skills and empathy on their attitudes toward curricula integration. *Education Sciences, 12*(7), 452. https://doi.org/10.3390/educsci12070452

Messaoudi, M. E. (2021). Soft skills: connecting classrooms with the workplace—a systematic review. *ÜNİVERSİTEPARK Bülten, 10*(2). https://doi.org/10.22521/unibulletin.2021.102.2

Mwita, K., Kinunda, S., Obwolo, S., & Mwilongo, N. (2023). Soft skills development in higher education institutions. International Journal of Research in Business and Social Science (2147- 4478), 12(3), 505-513. https://doi.org/10.20525/ijrbs.v12i3.2435

Rodríguez, M. C., et al. (2021). Teaching soft skills in engineering education: an European perspective. *IEEE Access, 9*, 29222-29242. https://doi.org/10.1109/access.2021.3059516

Tan, C. Y., Abdullah, A. G. K., & Ali, A. J. (2019). The effects of soft skill integration on quality of college life of diploma business students. *Journal of International Education in Business, 12*(2), 133-146.