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Instrumental or transformative? An exploratory analysis of sustainability competences and pedagogy in European micro-credentials

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Abstract

Purpose – Sustainability-focused micro-credentials delivered by European universities are growing. However, it is unknown how and to what extent sustainability competences are being taught within these programmes. The purpose of this study is to explore the nexus of European micro-credentials, sustainability competence integration and active learning pedagogies to examine how they interact in practice and whether they provide a transformative or instrumental education for professional learners.

Design/methodology/approach – A mixed-method analysis using quantitative content analysis and qualitative thematic analysis of 100 European sustainability-focused micro-credential course descriptions and learning objectives was used. A coding framework based on the GreenComp sustainability competence framework was collaboratively developed and directed content analysis was conducted in NVivo. Pedagogical approaches were coded and analysed.

Findings – Micro-credentials sampled addressed an average of three GreenComp competences displaying low breadth of competences, with instrumental competences more present than value-based competences. Less than half used active learning pedagogies. A positive relationship ($r = 0.43$) was found between active learning and the number of embedded competences. Poor communication of competences and reliance on transmissive pedagogies challenge micro-credentials' potential for transformative sustainability education. Tensions are apparent between the interrelatedness of sustainability competences and the narrow, instrumental focus of many micro-credentials. Active learning and improved transparency of competence communication may enhance their educational and transformational value.

Originality/value – To the best of the authors' knowledge, this study is the first to analyse how sustainability competences and pedagogical strategies are embedded in a large data set of university-provided, publicly available European sustainability micro-credential course descriptions using the GreenComp framework between March and April 2025. This study contributes a novel understanding of the presence and teaching of sustainability competences within European micro-credentials.

Keywords Micro-credentials, Sustainability, Active learning, Pedagogy, Competences

Paper type Research paper

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Introduction

Micro-credentials are a European strategic objective for fostering educational innovation, improving access to education, developing skills to address labour market gaps and increasing trust and recognition of short-term learning experiences (Shapiro Futures *et al.*, 2020). From a European perspective, micro-credentials are defined as a "record of the learning outcomes that a learner has acquired following a small volume of learning. These learning outcomes have been assessed against transparent and clearly defined standards. Courses leading to micro-credentials are designed to provide the learner with specific knowledge, skills and competences that respond to societal, personal, cultural or labour market needs" (Council of the European Union, 2022, p. 5). In tandem, the urgent need for global sustainability has prioritised *upskilling* and *reskilling* of European individuals within areas related to green skills and employment (Annette, 2023). Given the strategic growth of micro-credentials and the need for sustainability-specific training, these two objectives are strongly associated.

However, it is unknown whether European sustainability micro-credentials are teaching sustainability competences to address this skills gap, whether these are balanced across competence frameworks or weighted towards instrumental or normative/value-based competences. Furthermore, exploring how sustainability micro-credentials are being taught can bring to light whether they are supporting the development of sustainability competences and inform future developers on pedagogical choices for optimal delivery. Because of the short nature of micro-credentials and the target audience of lifelong learners, who want to upskill and reskill by hands-on training, pedagogical approaches that promote active learning, deeper engagement and competence-focus are favoured. This research seeks to explore the nexus of European micro-credentials, sustainability competence integration and active learning pedagogies. It contributes a novel understanding of sustainability competences via a conceptual framework and suggests that active learning approaches may improve the transformational potential of European micro-credentials.

Literature review

Micro-credentials have seen growing interest from educational providers, policymakers, governments and external stakeholders since the early part of the 21st century (Brown *et al.*, 2021). Greater demand for industry-specific skills and competences, reskilling needs because of environmental and social factors (e.g. COVID-19 pandemic, artificial intelligence [AI] and sustainability challenges), and higher education interest in modular and professional learning have all contributed to this growth (Varadarajan *et al.*, 2023). This increased demand has been scaffolded with the emergence of institutional, national and supranational (Council of the European Union, 2022; UNESCO, 2022) micro-credential strategies, policies and frameworks. Development of and participation in micro-credentials are being encouraged at the European level, and member states are tasked with piloting their implementation (Council of the European Union, 2022).

In practice, micro-credential uptake varies widely across the continent. Some countries are offering funding opportunities for micro-credential learners and providers, documenting quality assurance frameworks and legislation and developing strategies with industry partners (Irish Universities Association, 2025; NPULS, 2025). Yet other countries are not engaging with micro-credentials either because of a lack of legislation, challenges with aligning national policies and qualification frameworks, lack of incentives and limited awareness.

European micro-credentials have grown across a wide variety of disciplines and topics; however, global sustainability challenges and "green skills" employment gaps have

encouraged the development of micro-credentials within the broad domain of sustainability (Council of the European Union, 2022). These include micro-credentials related to corporate and financial sustainability, energy and climate action, urban sustainability and the built environment, agriculture and food systems and social elements of sustainability, among many others. Although need is documented, implementing relevant and successful sustainability micro-credentials remains challenging; many universities are slow to adopt new technologies, processes and educational innovations (Resei *et al.*, 2019); and gaps remain between the needs of industry and content provision by micro-credential providers (Messaoud *et al.*, 2022). In addition, whether sustainability micro-credentials are delivering specific competences needed for the sustainability of the planet is unknown.

Sustainability competences and micro-credentials

Although the term "competences" has a wide variety of definitions and applications (Hoffmann, 1999), in general it refers to "the proven ability to use knowledge, skills and personal, social and/or methodological abilities, in work or study situations and in professional and personal development" (European Commission, 2025). Investigations into sustainability-specific competences have matured from initial case studies (Barth *et al.*, 2007) to more developed academic frameworks (Brundiers *et al.*, 2021; Lozano *et al.*, 2017; Redman and Wiek, 2021) and intergovernmental publications to guide educational developers and policy-making (Bianchi *et al.*, 2022; Rieckmann, 2018). These frameworks were developed to define and clarify sustainability competences, guide curriculum design and institutional practice, enable recognition and visibility of competence acquisition, support policy development and promote shared understanding.

Competence-based education, whereby educational delivery and assessment are designed to evaluate mastery of competences (Gervais, 2016), is at the bedrock of micro-credentials. This is because of their focus on validating and recognising professional learning and competences that learners acquire. For instance, learners are awarded micro-credentials, which clearly indicate competences they have acquired and can share these with employers and the labour market (Ahsan *et al.*, 2023). Within sustainability micro-credentials, competences identified by these frameworks should be integrated for learners to gain knowledge and skills to address complex sustainability challenges.

One sustainability competence framework from a European perspective, the GreenComp, has recently been used to classify, assess and reflect on sustainability competences in educational activities (Ardila Echeverry *et al.*, 2025; Cichoń and Baarová, 2025; Mertens *et al.*, 2024; Stouthart *et al.*, 2025). Its overall aim is to "to foster a sustainability mindset by helping users develop the knowledge, skills and attitudes to think, plan and act with empathy, responsibility, and care for our planet" (Bianchi *et al.*, 2022, p. 2). It consists of 12 sustainability competences grouped into four areas and serves as a reference framework for a consensual definition of sustainability competences (Table 1). It is particularly suited to investigations into European micro-credentials given its alignment with European policy and strategy, its recognition across European educational institutions and diversity of application (both informal and formal) (Bianchi *et al.*, 2022).

The four areas within this framework are strongly interrelated, illustrated by a bee pollination metaphor in the report. Acting for sustainability is visualised by bees working together and individually to pollinate flowers. Envisioning sustainable futures, is visualised by flowers which produce seeds to sustain life. A beehive represents embodying sustainability values which *protects and sustains* the bees and pollen and nectar as embracing complexity in sustainability. This metaphor not only is a means to understand the interconnectedness of the different competences but also indicates subtle differences across areas, particularly those that

Table 1. GreenComp Areas and competences

Area	Competences
Embodying sustainability values	Valuing sustainability Supporting fairness Promoting nature
Embracing complexity in sustainability	Systems thinking Critical thinking Problem framing
Envisioning sustainable futures	Futures literacy Adaptability Exploratory thinking
Acting for sustainability	Political agency Collective action Individual initiative

are more instrumental (envisioning futures, embracing complexity) and those that follow a more value-based approach (embodying values and acting for sustainability). Ensuring an integrated and balanced development of competence areas in learners is essential as part of transformative learning (Rodríguez Aboytes and Barth, 2020). However, there is a recurring tension between instrumental and value-based teaching and how these approaches should be addressed in sustainability communication and education (Wals *et al.*, 2008).

Micro-credentials as enablers of sustainability competences

Moving from the identification of competences to actioning competences is a critical point for sustainability education (Lozano *et al.*, 2017). Micro-credentials have been identified as a medium particularly suited to acquiring sustainability competences and fostering sustainability education (Ironsi and Ironsi, 2025). Their ability to validate transversal interdisciplinary competences, bridge theory and practice, support flexible and personalised learning and appeal to employers and learners (Martín-Ramos *et al.*, 2025) makes them a relevant tool for sustainability skills acquisition. As is evident from the literature, much work has been done on identifying sustainability competences that should be taught; however, little is known about the extent to which sustainability micro-credentials address sustainability competences. Research on sustainability micro-credentials is at an early stage of development, and there is a knowledge gap in this space. Disparate research foci are evident, including discipline-specific frameworks (De Rosa *et al.*, 2024), learner perceptions (Ilarri *et al.*, 2024), stakeholder perceptions (Halttunen *et al.*, 2024; Miller and Jorre de St Jorre, 2024), inclusivity possibilities (Gwin and Foggin, 2020) and descriptive case studies (Nielsen *et al.*, 2024; Vucic *et al.*, 2024).

At face value, micro-credentials appear to be a potentially strong enabler of sustainability competences. However, ascertaining whether educational providers are teaching competences in practice and if there is alignment between competence frameworks and industry needs is crucial for European sustainability education. Some competences or areas may be more evident than others (e.g. *critical thinking* might be more present in sustainability micro-credentials than *promoting nature*) given disciplinary instrumental and value-based sustainability education tensions (Sterling, 2010; Wals *et al.*, 2008). Identifying gaps in competence provision can inform institutional or organisation strategy, guide educators to implement a more balanced and comprehensive sustainability educational programme and bridge the gap between industry competence needs and practice.

Additionally, identifying pedagogical strategies within sustainability micro-credential teaching can also inform competence analysis. In essence, some pedagogies inherently support specific competences (e.g. challenge-based learning [CBL] supports collaboration). Analysing pedagogies embedded within micro-credentials could further indicate which competences are being actively scaffolded.

Pedagogical approaches in sustainability micro-credentials

Sustainability is a complex concept which requires collaboration across disciplines and stakeholders, systems understanding and interpersonal skills, among many others, to achieve competence. Active learning approaches, including project/problem/case/challenge-based learning, collaborative learning and experiential learning, have been indicated as key pedagogies for sustainability education (Evans, 2019). Many of these have been mapped as having a high likelihood for addressing sustainability competences (Lozano *et al.*, 2017). For example, project-based learning can evidently support a *systems thinking* competence. Engaging with external stakeholders and having a student/learner-centred approach for design (De Rosa *et al.*, 2024) can also support competences related to *problem framing* and *collective action*. However, given the wide breadth of micro-credential content, scope, provider, target market and length, the application of pedagogies to support sustainability competences may vary widely.

Research has argued that many micro-credentials follow transmissive and instrumentalist pedagogies (Pollard and Vincent, 2022), and passive, asynchronous teaching is common. Given the emphasis on competence-based education for sustainability micro-credentials, more practical, personalised, reflective and active pedagogies should be used (Ahsan *et al.*, 2023; Alias and Abdul Razak, 2023; Bruguera *et al.*, 2025; Halttunen *et al.*, 2024; Hunt *et al.*, 2020). Although active learning could be key to a successful micro-credential, this could be even more crucial in sustainability education. Many of the competences listed in sustainability competence frameworks would benefit from active learning approaches for successful learner outcomes.

Conceptual framework

As micro-credentials appear to be a means for sustainability competence acquisition in times of green transition and active learning approaches may support these types of competences, investigating the nexus across these areas serves multiple research gaps. Developed via iterative personal reflection and analysis of micro-credential practice and academic literature, Table 2 provides a conceptual framework which considers four thematic alignments across these concepts; skills and competences, personal growth, collaboration and relevance. Existing research supports these conceptual alignments, for instance, Rodríguez Aboytes and Barth (2020) note that transformative learning includes discourse, action and critical reflection, evident via active learning and GreenComp themes. The thematic alignment resembles Sterling's (2010) argument that an integrative and intrinsic approach is key to address the urgency of sustainability. As such, this conceptual framework questions whether micro-credentials in their current state risk reinforcing an instrumental approach or if paired with active learning and the consideration of sustainability competences can foster more transformative learning. However, little is known about these alignments in practice.

Research aim

This research seeks to explore the nexus of European micro-credentials, sustainability competence integration and active learning pedagogies via the following research questions:

Table 2. Thematic alignment across micro-credentials, active learning and sustainability competences

Micro-credentials	Active learning	Sustainability competences (GreenComp)	Thematic alignments
Skills-orientated Competence-based approach	Developing skills and competences Higher-order thinking Critical thinking and problem-solving Construction of new knowledge	Adaptability Critical thinking Exploratory thinking Futures literacy Systems thinking	Skills and competences
Learner-centred Flexibility and pathways	Reflection Learner-centred Exploration of attitudes and values Educator as a guide	Individual initiative Valuing sustainability	Personal growth
Cooperation with external stakeholders	Collaboration or interaction with others Connection with society	Collective action Political agency	Collaboration
Real-life scenarios Societal, personal, cultural or labour market needs Short-term learning experience	Relevant and meaningful	Problem framing Supporting fairness Promoting nature	Relevance

RQ1. To what extent do European sustainability micro-credentials self-report sustainability competences?

RQ2. To what extent do European sustainability micro-credentials self-report active learning approaches?

RQ3. Are there any relationships between sustainability competences and active learning approaches in European sustainability micro-credentials?

Methodology

This research sampled and analysed micro-credential descriptions and learning objectives of 100 European sustainability-focused micro-credentials offered by universities and universities of applied sciences. Qualitative and quantitative data analysis were used to identify the presence of sustainability competences and active learning approaches within these micro-credentials.

Data collection and sampling

A total of 100 sustainability micro-credentials were identified within the European Education Area (EEA) for this analysis. The sampling procedure first involved an initial review of the national progress on the uptake and implementation of European micro-credentials within national policy and official documentation. This step was undertaken to explore national engagement with micro-credentials and identify countries where micro-credential initiatives were most likely to be available for sampling.

As there is no centralised database of all European micro-credentials, an exploratory search was conducted in March and April 2025 across multiple open sources, including Google

Search, institutional micro-credential webpages, national higher education directories and EU-level platforms. To identify sustainability-related university micro-credentials, we applied the following Boolean search string in English in each European country name separately "micro-credentials" AND "professional learning" AND "digital badges" AND universit* AND "higher education" AND sustain* AND [country name]*. Where no results for a country were retrieved, further searching within universities from that country was conducted using the same search string but using [institution name]. This list of universities was gained from the Times University Rankings from that country. Returned results were screened manually to identify university-provided micro-credentials that met the inclusion criteria below.

Figure 1 provides an overview of countries, a total of 41, involved in the first pass. Countries (n = 15) with no documented micro-credential presence were excluded from the sample either because of a lack of micro-credentials, language barriers or a lack of sustainability-focused micro-credentials. Therefore, samples could be collected only from 26 countries.

A purposive sampling strategy (Palinkas *et al.*, 2015) was used whereby a target of five samples per country was set, possibly one micro-credential per institution to ensure geographical and institutional diversity; nevertheless, this could not be achieved in all cases, mainly in Central and Eastern Europe. In these regions of the EEA, the concept of micro-credentials is gaining traction, particularly through collaborative projects and initiatives aimed at integrating these flexible learning certifications into the educational and professional landscape. Specific micro-credential programmes are still emerging, supported by educational institutions, but sustainability is not currently a priority theme. As a result, the sample was predominantly from Western European higher education institutions.

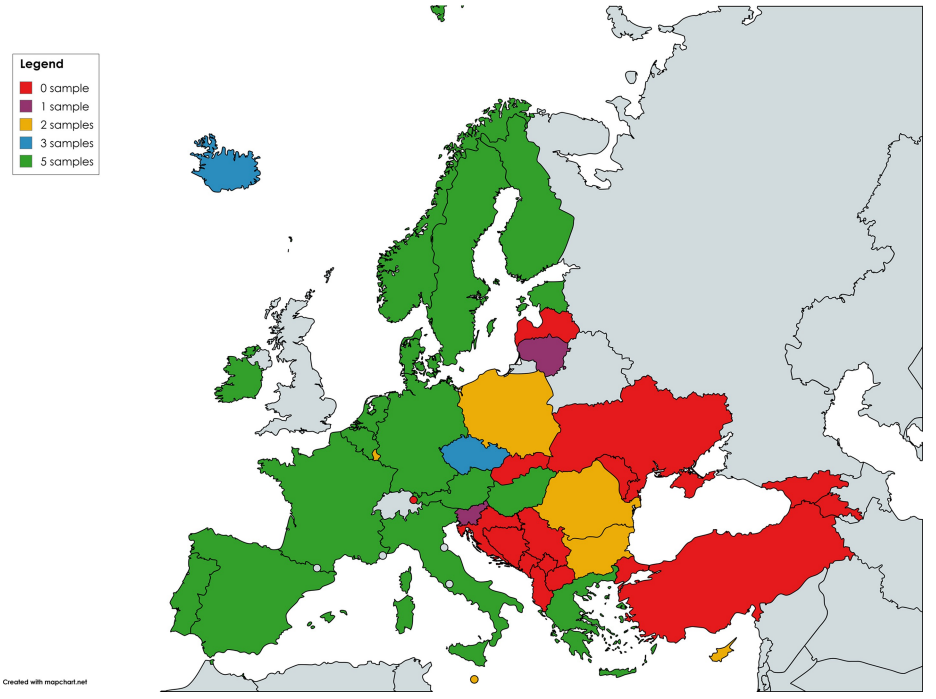

Figure 1. Countries sampled for sustainability micro-credentials

Micro-credentials that were included in the analysis adhered to the following inclusion criteria:

- align with the European definition of micro-credentials [1];
- delivered by a European university within the EEA area;
- professional target market (i.e. not explicitly for university students);
- broad sustainability topic; and
- self-defined as a micro-credential or short-term programme with a validation of effort.

The initial list of 104 was screened and 4 micro-credentials were removed because of a lack of information presented. The final sample varies in themes, ranging from general sustainability to more specific topics, such as corporate sustainability, reporting, energy, climate, natural resources management, circular economy and food systems. The duration of the analysed courses spans a broad spectrum: European Credit Transfer and Accumulation System (ECTS)-bearing micro-credentials (n = 94) between 1 and 45 ECTS, with an average of 8 ECTS and shorter courses (n = 6) between 7 and 21 h, with an average of 15 h.

When the final list of sustainability micro-credentials was agreed upon, course descriptions and learning objectives were extracted from publicly available websites and course manuals and uploaded into NVivo qualitative software and Microsoft Excel and divided between two coders for thematic coding (Braun and Clarke, 2006). The analysis of learning objectives for research is evidenced in previous educational publications documenting its use in both quantitative (Badawy *et al.*, 2016) and qualitative methods (Homa *et al.*, 2013).

Data analysis

A mixed-method analysis was used using quantitative content analysis and qualitative thematic analysis of European sustainability-focused micro-credential course descriptions and learning objectives. For the qualitative analysis, each coder coded 50 micro-credential texts using directed content analysis identifying the presence of distinct GreenComp competences (n = 12). A coding framework was collaboratively developed to ensure coding alignment and validity and mutual understanding of each competence. This framework included the description of the competence, key words and examples from the text. The presence of a competence was highlighted in a fragment of text using NVivo, and text could be coded for multiple competences. For active learning presence, common words related to active learning were included in the codebook defined by mutual design by the researchers (e.g. problem based, construction). Partial alignments and ambiguous course descriptions were individually identified by each researcher and brought to multiple reflection and agreement sessions. Mutual agreement was facilitated by the codebook and via iterative reflection from both researchers.

Inter-coder rater reliability was ensured by an initial pilot of 30 micro-credentials. Cohen's Kappa coefficients were calculated for each of the 12 codes to assess intercoder reliability. Kappa values ranged from 0.59 (*Individual initiative*) to 0.95 (*Valuing sustainability*), with a mean of 0.70 (standard deviation, SD = 0.10), indicating substantial agreement according to benchmarks (McHugh, 2012). Active learning kappa values were 0.62. Overall agreement percentages exceeded 97% across all codes (Supplementary Table 1). Following the pilot, inter-coder rater reliability on ten additional micro-credentials was analysed by both coders as there had been three months between the pilot and the subsequent analysis. This overlap was initially calculated using Kappa values, but because of the large

amount of uncoded text, the Kappa values were reported as low (0.16), a known limitation of Kappa (Byrt *et al.*, 1993). To ensure further reliability, first the researchers manually reviewed each micro-credential to ensure alignment. Then a prevalence-adjusted and bias-adjusted kappa (PABAK) score was calculated (0.93), indicating almost perfect agreement between coders.

For the quantitative analysis, Excel was used to aggregate competence and active learning presence and Grapher for visualisation. A total of 48,413 words were within the analysed data set.

Results

Sustainability competences in European sustainability micro-credentials

The quantitative content analysis of the sample (n = 100) aimed to inventory the occurrence of the 12 GreenComp competences in the course descriptions and learning objectives. The distribution and frequency of the competences in the sample are represented in Figure 2. The majority of the investigated courses addressed 2–5 competences, with an average of 3.4 (SD = 2.24). However, there were six micro-credentials without any reported or identified GreenComp competences. The maximum number of incorporated competences was 10 out of 12, which was achieved by three micro-credentials.

The occurrence analysis of the 12 GreenComp competences revealed the leading presence and reporting of the *Envisioning Sustainable Futures* competence area, with a total count of 114 and a mean of 38% (SD = 3.60) (Figure 3). Within this, *Adaptability* had the highest ratio of appearance (42%), followed by *Exploratory thinking* (37%). While the *Embracing Complexity in Sustainability* area was addressed by 33% of the micro-credentials on average (SD = 3.78) and with a total count of 100, *Acting for Sustainability* (total count of 66) and, especially, *Embodying Sustainability Values* (total count of 59) areas scored the lowest, at 22% (SD = 6.08) and 19% (SD = 8.08), respectively. The competences of *Valuing sustainability*, *Supporting fairness* and *Individual initiative* were the least addressed (15%) by the analysed micro-credentials.

Following this initial analysis, the researchers examined how the four clusters could be conceptually aligned with "instrumental" or "transformative" learning in sustainability education. Within GreenComp literature, *Embodying Sustainability Values* and *Acting for Sustainability* are interpreted as predominantly transformative (i.e. personal reflection and

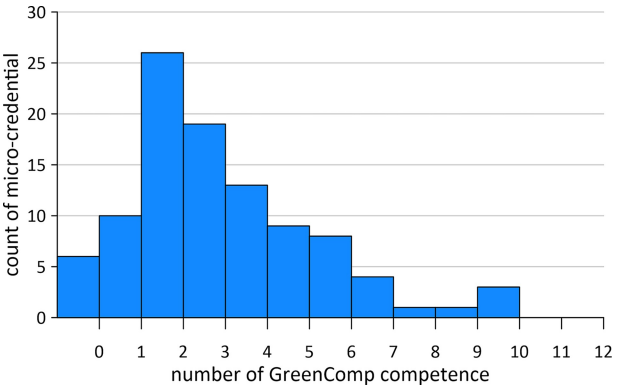

Figure 2. Histogram of the number of addressed competences in the sample (n = 100)

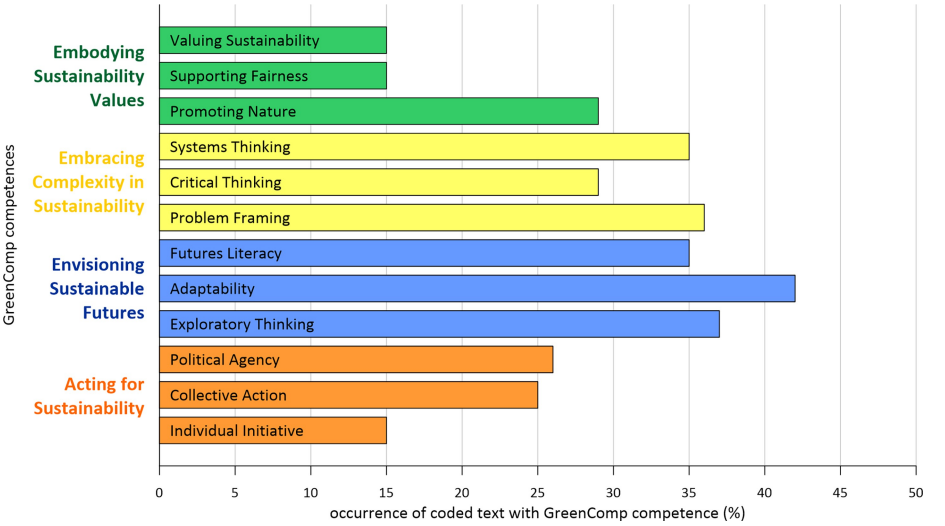

Figure 3. Occurrence rate of the twelve GreenComp competences in the sample (n = 100)
Note(s): Because of the sample size, percentages indicate absolute numbers

behavioural change); however, *Envisioning Sustainable Futures* and *Embracing Complexity in Sustainability* leaned more towards instrumental learning (i.e. connections between issues, planning future scenarios). Although competences such as *critical thinking* and *systems thinking* are often considered transformative, coded text presented these competences in a more instrumental manner (i.e. emphasising the skill of critical thinking rather than reflexivity or exploring values). The results indicate an imbalance between the rather transformative (n = 125) and rather instrumental (n = 214) GreenComp competence areas, revealing the skewed prevalence of instrumental micro-credentials in the sample.

A qualitative thematic analysis was then performed on text coded within each of the GreenComp competences to ascertain what key themes were communicated to learners. Table 3 summarises these themes.

Embodying sustainability values

Four distinct themes were apparent in the *Embodying Sustainability Values* data; *human-nature systems*, *individual values and ethics*, *social sustainability* and *impacts*. Micro-credentials within this data taught the importance of interactions between and consequences of *human-nature systems*, often in an interdisciplinary manner. *Social sustainability*, focusing on inclusivity, justice and the social context of sustainability, was also a common theme. Developing *individual values and ethics* was also a key theme where courses encouraged sustainability values and being responsible, ethical and respectful. Finally, many courses taught the positive and negative *impacts* of sustainability, both personally for learners and in wider topical contexts.

Embracing complexity in sustainability

Within this GreenComp competence area, five themes were generated within the data; *critical thinking*, *systems thinking*, *navigating perspectives*, *self-regulation* and *working on a*

Table 3. Themes identified in micro-credential descriptions related to GreenComp competence areas

GreenComp area	Themes generated within text extracts
Embodying sustainability values	– Individual values and ethics – Social sustainability – Human–nature systems – Impacts
Embracing complexity in sustainability	– Critical thinking – Systems thinking – Navigating perspectives – Self-Regulation – Working on a problem
Envisioning sustainable futures	– Skills for future planning – Understanding transitions – Conceptualising sustainable futures – Inter- and transdisciplinary foresight – Future scenario development
Acting for sustainability	– Transformation – Communication – Decision-making – Inter - and transdisciplinarity for action – Sustainability personas

problem. Teaching *critical thinking* was highly evident with a focus on personal and contextual critical thinking skills, implications and outputs following critical thinking and an understanding of complexity. Application, evaluation and knowledge of systems thinking, understanding interconnections and fostering a holistic approach were aspects mentioned within *systems thinking*. These two themes were strongly linked to *navigating perspectives* from diverse stakeholders and disciplines. *Self-regulation* via reflection activities were also commonly mentioned. The micro-credentials themed within this area also highlighted *working on a problem*, whereby students would identify, evaluate and provide solutions to a challenge or problem and gain problem-solving skills.

Envisioning sustainable futures

Five themes were identified within the *Envisioning Sustainable Futures* competence area from the data; *skills for future planning*, *understanding transitions*, *conceptualisation of sustainable futures*, *inter- and transdisciplinary foresight* and *future scenario development.* Explicit skills that learners would be taught to plan for a sustainable future included strategic development, trend identification, resilience and planning tools under the theme of *skills for future planning*. The ability to *understand transitions* was also a key theme, whereby temporal thinking (e.g. long-term and learning from the past), risks and opportunities, adaptation, managing transitions and identification of transitions and transformation were present. Described activities that supported the *conceptualisation of sustainable futures* included exploring, generating, designing, innovating and developing solutions and models. The importance of *inter- and transdisciplinary foresight* for sustainable futures was commonly mentioned, focusing on the provision and interpretation of different disciplinary perspectives, collaboration across disciplines and challenges between disciplines impacting on sustainable futures. The final theme, *future scenario development*, described how learners would reimagine and consider future possibilities and ideate potential scenarios for the future.

Acting for sustainability

Within the course descriptions, five themes were generated within *Acting for Sustainability*; *transformation*, *communication*, *decision making*, *inter- and transdisciplinarity for action* and *sustainability personas*. *Transformation* emphasised actions students would do, or learn to do, to action a change related to sustainability. This was strongly tied to the second theme *communication* whereby learners would discuss, collaborate and network with others during the course. Another action-orientated theme, *decision-making*, was commonly highlighted. Teaching general decision-making techniques and skills and integrating these into practical actions were present. Throughout many of the courses, explicit or implicit mention of *inter- and transdisciplinarity for action* were identified, which aligns with the last theme *sustainability personas*. This theme described a variety of personas involved in sustainability, including stakeholders, policymakers, non-governmental organisation, corporate departments, investors and communities, key for inter- and transdisciplinary work.

Across multiple GreenComp areas, there were similarities observed in the generated themes. For example, *systems thinking* was present in the *Embracing Complexity* area; *human nature systems* in *Embodying Sustainability Values*; and *inter- and transdisciplinarity* is present in both *Acting for Sustainability* and *Envisaging Sustainable Futures*. Value-based themes, such as *individual values and ethics*, *decision-making* and *self-regulation*, were present across three areas. Transformative actions, such as *transformation and understanding transitions*, were across two areas.

Active learning in European sustainability micro-credentials

The analysis of active learning integration within the sample (n = 100) revealed limited adoption of such pedagogical approaches, identified through the codes of *situated*, *authentic*, *problem-based*, *case-based*, *challenge-based*, *collaborative*, *discussion* and *reflection*. Only 47% of the micro-credentials demonstrated clear evidence of active learning strategies, and the majority (53%) indicated a predominant reliance on more traditional, passive instructional methods. Some good practices involved moving beyond identifying and understanding problems, developing solutions in interdisciplinary teams and working on real-world case studies.

Sustainability competences and active learning in European sustainability micro-credentials

Micro-credentials with and without active learning pedagogies were analysed separately in terms of the number of incorporated competences (Figure 4). Passive learning courses addressed two to four competences, with an average of 3.1 (SD = 1.86); meanwhile, micro-credentials integrating active learning could incorporate two to six competences, with a mean of 3.7 (SD = 2.57). The point-biserial correlation between active learning integration and the number of embedded competences in European sustainability micro-credentials revealed a weak positive but statistically nonsignificant relationship (r = 0.15, p-value = 0.13, 95% CI [−0.05, 0.34] and Fisher z-transformation). Note that one of the variables (active learning) was a qualitative, descriptive and non-numerical attribute, which was converted to numerical values (no = 0 and yes = 1) (Kornbrot, 2014). This could yield a lower correlation value because of the semi-quantitative nature of the analysis. The results suggested that active learning is modestly associated with more comprehensive competence integration.

However, when the "intensity" of active learning, that is, the total number of individually coded text fragments related to active learning pedagogies present in individual micro-credentials, was quantified, a stronger positive and statistically significant correlation emerged between active learning integration and the number of embedded competences

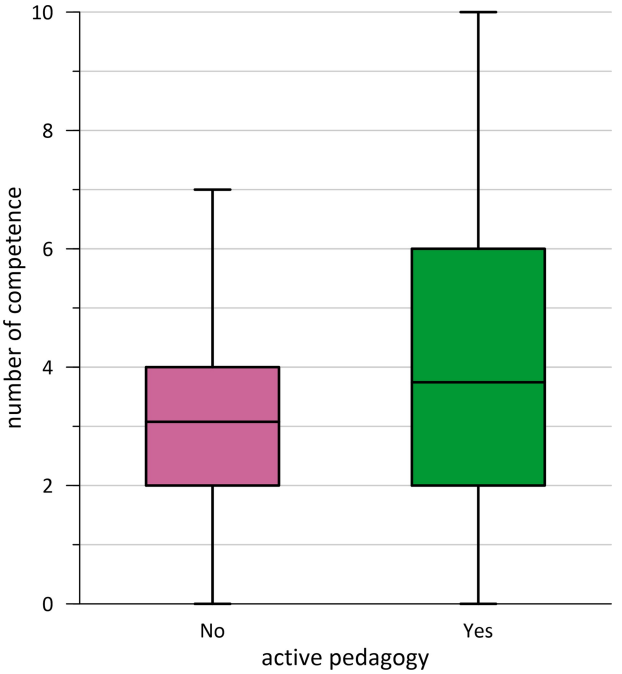

Figure 4. Box plot of the number of competences in the analysed micro-credentials (n = 100) without and with active pedagogical approaches

(r = 0.43, p-value < 0.0001, 95% CI [0.26, 0.58] and Fisher z-transformation). This finding highlighted that micro-credentials with higher levels of active learning integration tend to embed a greater number of competences, underscoring the important role of active learning pedagogical approaches in fostering sustainability competence development.

Discussion

The majority of European micro-credentials analysed were not integrating a large breadth of sustainability competences (mean = 3.4) and were often focused on instrumental rather than transformative or value-based competences. This focus on specific rather than broad competence acquisition conflicts with GreenComp values, in that it emphasises that all are interrelated and should be "treated as parts of a whole" (Bianchi *et al.*, 2022). The imbalance between instrumental and transformative competences suggests that personal and professional growth, fostered by these micro-credentials, is orientated towards professional upskilling rather than transformative sustainability competence acquisition. Evidently, these are tensions between the goals of micro-credentials and the interests of frameworks.

From an implementation standpoint, these findings could be because of the environment in which they were taught (i.e. online), the short duration of the programme, alignment with specific labour market needs that support explicit competences (Cedefop, 2022) or the perceived need for instrumental teaching approaches for professionals. Developers may lack awareness of sustainability competence frameworks and are implicitly teaching certain competences but not explicitly mentioning them in their course descriptions.

Given that sustainability is a European and institutional strategic priority, universities carry a responsibility to learners, employers and funding agencies to clearly teach and articulate sustainability competences. Learning objectives and programme aims within institutional websites are how universities communicate competences to potential students and employers. Although it could be argued that many sustainability competences are being implicitly taught in micro-credentials, websites serve as a public statement of potential competence acquisition. Poor visibility or explicitness of competences is problematic (Ciraso-Calí *et al.*, 2022; Fitzgerald *et al.*, 2020). Employers lack the means to evaluate the relevance or value of the programme and may be less inclined to invest in the programme for their staff. Learners lack knowledge and self-awareness of the competences they can or do acquire and may be unable to communicate what they have learned to future employers or to themselves. Policymakers have difficulty in aligning professional needs with actual teaching practice. For universities, lack of visibility and transparency makes the evaluation of the quality, impact and breadth of their sustainability education or competence-based teaching challenging. As such, clearly described competences that align with existing frameworks are crucial.

This research has described tensions between the content of sustainability micro-credentials and the overall goal for transformative sustainability education purported by many sustainability competence frameworks and theorists. First is the tension between instrumental and value-based competence teaching in sustainability micro-credentials. Micro-credentials are often developed in response to labour market needs and not explicitly to scaffold values. Learners may be gaining professional skills (Varadarajan *et al.*, 2023) but not internalising values for meaningful sustainability transformation. It may be a missed opportunity for transformative change if these types of educational programmes do not integrate value-based competences to produce learners with a broad sustainability mindset. This aligns strongly with Sterling's argument that "A great deal of learning, both every day and through formal education, makes no positive difference to a sustainable future, and may indeed make that prospect less rather than more likely" (Sterling, 2011, p. 18). It raises the question of how value-based competences could be supported in sustainability micro-credentials.

Active learning approaches were present in less than half of the analysed micro-credentials. However, they could help address this value-based competence gap, and a positive relationship was observed between their use and the teaching of personal commitment and action-oriented competences. Preliminary conceptual research into active learning approaches, such as CBL, indicates strong alignment between GreenComp competences and the characteristics of these approaches (Gallagher and Savage, 2023). CBL explicitly addresses real-world challenges and global themes, and learners are asked to reflect, collaborate, ideate and innovate solutions to these challenges. This aligns with *Valuing sustainability*, *Supporting fairness* and *Promoting nature* competences (Gallagher and Savage, 2023). Given its flexibility, CBL could be integrated into small or large-scale educational micro-credential activities, and micro-credential developers could experiment with small-scale active learning approaches as a transition to these pedagogies. As the role of teachers in CBL is as co-researchers and coaches, it also aligns with Sterling (2011) notion that teachers should have a personal intention to encourage change in learners.

However, active learning takes more effort in design and implementation, and certain micro-credentials may benefit from a more transmissive approach given their content (e.g. solar panel installation). Training and support for online and blended programmes to implement active learning approaches would be needed for teachers to have the ability and confidence to deliver. More in-depth qualitative analysis connecting active learning activities

(e.g. problem-based learning, collaboration and discussion) with eco-pedagogy constructs such as critical reflection, collective agency and place-responsiveness could be a means to gain further insights into this.

Second is the tension between the interrelatedness of sustainability competences in frameworks and the limited provision in micro-credentials. Meaningful sustainability education should include interrelated and balanced competences, but in practice, this is not the case because of the short-term, labour market focus of sustainability micro-credentials. While the sampled micro-credentials aimed to address sustainability challenges, many still fell short in aligning with contemporary educational practices that promote deeper learning, learner engagement and skill development through active participation.

Micro-credentials are an opportunity for European Universities to integrate sustainability competences in their professional and lifelong learning portfolio. However, developers must improve their communication of GreenComp competences by using standardised frameworks, integrate more competences where possible and report pedagogical approaches in their micro-credentials. In practice, active learning approaches should be applied to bridge the gap across competences. For policymakers and quality assurance bodies, the findings highlight the need to look beyond traditional metrics like ECTS credits and assessment methods and suggest considering pedagogical approaches and the incorporation and acquisition of competences when evaluating sustainability-focused micro-credentials. This connects directly to current European Union initiatives around micro-credential recognition and the green skills gap identified by Cedefop (2022) and Chatzichristou *et al.* (2025). The finding that most micro-credentials focus on instrumental competences has important implications for whether these programmes can truly contribute to the transformative change needed for sustainability transitions. Given that many of these micro-credentials are available to a broad range of disciplines and professions, embedding more value-based competences could strengthen their societal impact by cultivating more personal and integrated sustainability values in learners. In an ideal scenario, these values could trickle down beyond the workplace into the wider community.

To facilitate the required change and ensure transparency, micro-credential developers are recommended to consider these results in their curriculum design, and practical tools should be developed to enhance the visibility of GreenComp competences and active learning in sustainability micro-credentials. For example, a simple template or checklist based on the codebook developed in this research could already help transparently communicate GreenComp alignment and pedagogical approaches used in course descriptions. Additionally, a more reflective and iterative AI-supported dialogic pedagogy tool could guide developers to reflect on their curriculum and how it integrates sustainability competences.

Limitations and further research

The research carries some limitations, mainly because of the sample (ir)representativeness. The first barrier was identifying micro-credentials across various countries. English was used as the primary language during the search; however, many institutions communicated more information in their native languages, which may have led to potential errors during translation. In some cases, diverse offerings were encountered, but the publicly disseminated information was not detailed; therefore, course aims and descriptions could not be harvested. Only a few micro-credentials presented their course guides that could enhance the robustness of the qualitative analysis. For the same reason, the sample might be skewed in some countries. Even though one course per institution was set as a criterion, there appeared to be leading institutions in micro-credential provision. Therefore, to reach the goal of five courses per country, multiple micro-credentials were included from the same university. Finally, the

inventory targeted courses offered by universities and universities of applied sciences. However, vocational education and training shows rapidly evolving developments in the micro-credential space (Pouliou, 2024).

Reliance on public course descriptions rather than how the course was taught in practice is another limitation. These course descriptions may emphasise marketable instrumental skills while understating value-based or transformative competences that emerge in actual course delivery. Pedagogical nuances apparent in course delivery would not be present in course descriptions. There may also be a tension between what university administration perceives should be marketed and the goals of micro-credential providers. In addition, course descriptions may differ in length and detail across universities depending on university communication strategies and as such may limit comparability.

Future research could involve local experts from the EEA countries to improve micro-credential identification because of the experienced language barriers, and obtain nuanced information on the national micro-credential uptake and strategy that are not always reported on websites. To further enhance the depth of analysis, micro-credential providers could contribute through focus group interviews or surveys and help access detailed course documentation, including session plans. Similar research could be carried out to track and monitor the micro-credential development over time, investigating how offerings, pedagogies and institutional participation evolve, particularly the uptake of the GreenComp framework and CBL in European micro-credentials compared to this baseline study.

Conclusion

This research has contributed a novel understanding of the interconnections between sustainability competences and active learning in European micro-credentials. The sampled 100 micro-credentials embed 3.4 GreenComp competences and 47% of the micro-credentials incorporate active learning approaches, with a notable imbalance favouring instrumental competences over value-based ones. Tensions appeared between the vision of sustainability competence frameworks, that competences should be parts of a whole, and the goal of micro-credentials as a labour market skills gap filler. Active learning may be a means of bridging this gap and a means for transformational sustainability education. In addition, improved institutional communication of competences and alignment to competence frameworks should be considered by European universities.

Note

[1.] Although the researchers recognise that there are definitional challenges and complexity with the term, to standardise our methodology, this definition was proposed because of its strategic importance for many European universities.

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Supplementary material

The supplementary material for this article can be found online.

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