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Setting Up an Educational Ecosystem for Enabling Sustainability Competences Development

Nicoleta ACOMI [1,*]
Miriam LANZETTA [2]
Ovidiu ACOMI [3]
Gianluca ABBRUZZESE [4]

[1] PhD, Principal investigator, Constanta Maritime University, Constanța, Romania, https://orcid.org/0000-0003-3564-6867; nicoleta.acomi@cmu-edu.eu
[2] PMP, Researcher, LASCÒ, Caserta, Italy, https://orcid.org/0000-0001-9675-0647; miriam.lanzetta@lasco.io
[3] MBA, Researcher, TEAM4Excellence Research Centre, Constanța, Romania, https://orcid.org/0000-0001-9308-1441; ovidiu.acomi@team4excellence.ro
[4] PMP, Researcher, LASCÒ, Caserta, Italy, https://orcid.org/0000-0001-7686-7784; gianluca.abbruzzese@lasco.io
* corresponding author: nicoleta.acomi@cmu-edu.eu

Abstract: *Developing sustainability competences is critical for addressing global challenges and preserving resources for current and future generations. The GreenComp European sustainability competence framework offers a non-prescriptive reference for embedding sustainable development into pedagogical practices and curricula. However, barriers such as inadequate teacher support, unclear evaluation criteria, insufficient stakeholder collaboration, and limited scalability hinder its application in real-world contexts. This study addresses the need for sustainability education in Vocational Education and Training (VET) institutions across Europe by proposing a European network of national sustainability education centres, termed "Green Combs." Using a systems approach—system thinking, system mapping, ecosystem building, and transition design—this initiative fosters dynamic collaboration among stakeholders, enabling adaptable and multi-level solutions. The research engaged over 50 teachers from 20 educational institutions across five European countries through qualitative methods, including national workshops and an international gathering. Data analysis centred on six key domains: governance, organisation, community, activities, tools, and central hub relationships. Teachers' needs, such as adapting content, engaging learners and communities, and leveraging extracurricular activities, were prioritised. Findings highlight strategies for establishing and managing "Green Combs" and provide VET institutions with inquiry-based canvases to align sustainability goals with the needs of schools and communities. These canvases guide the integration of sustainability principles into education, fostering innovative practices and stakeholder engagement. The study underscores the importance of continued teacher support and stakeholder dialogue to adapt initiatives to national contexts and maximise the impact of sustainability education in VET schools.*

Keywords: *sustainability education; inquiry-based canvases; educational ecosystem; systems approach; VET education.*

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Introduction

Sustainability competences are essential skills and abilities that enable learners to address the global challenges of the 21st century, such as climate change, biodiversity loss, social inequality, and poverty (Scalabrino, 2022). Sustainability competences are not only relevant for environmental education but also for all disciplines and domains of knowledge, as they foster interdisciplinary and transdisciplinary approaches to complex problems (Tejedor et al., 2018). An example of sustainability competence is the interdisciplinary approach between engineers and bird biologists to reduce the impact of wind turbines on bird populations. They applied systems thinking, future thinking, values thinking, and strategic thinking to address a complex environmental problem involving producing renewable energy and reducing biodiversity loss (Levesque, 2019).

Moreover, sustainability competences are not only cognitive, but also affective, behavioural, and relational, as they involve attitudes, values, emotions, motivations, and actions that contribute to personal and social transformation (Roach, 2023). Therefore, teachers need to develop and implement teaching strategies that foster the development of these competences in their students. This can include incorporating experiential learning, problem-based learning, and collaborative learning approaches and providing opportunities for students to engage in real-world sustainability challenges and projects (McGibbon & Van Belle, 2015; Nguyen et al., 2024). By doing so, teachers can help students develop the knowledge, skills and attitudes necessary to become agents of change for sustainability (Ernst et al., 2020).

In order to support educators and learners in embedding environmental sustainability topics into all educational systems and curricula, the European Commission has developed the European Sustainability Competence Framework, GreenComp (Bianchi et al., 2022). In this framework context, sustainability means prioritising the needs of all life forms and the planet by ensuring that human activity does not exceed planetary boundaries. In relation to this, a sustainability competence empowers learners to embody sustainability values, and embrace complex systems, to take or request action that restores and maintains ecosystem health and enhances justice, generating visions for sustainable futures (Bianchi et al., 2022).

Although various studies have revealed some attempts to advance the integration of sustainability competences at different educational levels (Wiek et al., 2011; Leal Filho et al., 2019; Sterling & Thomas, 2006), the current educational ecosystems are still at an early stage of development and need more in-depth research. Further research is needed to identify potential

obstacles and opportunities for implementing a systems approach to sustainability education that fosters value generation and stakeholder engagement.

Therefore, this article focuses on one main research question: How can a systems approach to sustainability education in VET schools foster value generation and stakeholder engagement?

This article aims to explore the challenges and opportunities of developing sustainability competences in vocational education and training (VET) schools across Europe and to create premises for the development of a systems approach to sustainability education in VET schools. In this context, the systems approach is understood as a holistic and integrative way of thinking and learning that takes into account the interdependence and complexity of social, economic and environmental issues.

While frameworks like the European GreenComp provide foundational guidance, their application in diverse educational settings remains inconsistent. This study bridges this gap by offering an internationally adaptable model—the 'Green Comb' and 'Green Hive' ecosystem—to embed sustainability competences into education systems effectively. Unlike previous studies that focus on specific regional contexts, this research addresses the universal need for scalable, systemic approaches to sustainability education.

The study is based on a critical literature analysis and qualitative methods using data collected during focus group interviews in national environments followed by a facilitated co-creation international workshop. Throughout the research, the authors considered the perspective of the relevant key actors: VET teachers, decision-makers at the VET school level and the labour market, significantly impacting what and how competences would be developed at school.

The following sections of the article are structured as follows: literature review on sustainability education, research methodology including the sampling strategy and research methods, research findings on the systems approach to sustainability education and the identification of value-generation mechanism in sustainability education. Finally, the discussion and conclusions are presented along with limitations and further research.

Literature review

The ongoing efforts at the international level regarding the evolution of education for sustainability show a shift from Environmental Education in the 1970s-, focused on helping students to understand better the natural environment from a scientific perspective to a larger concept of Education for Sustainability, in 2000s-, linking human to ecological systems, valuing

partnerships between educational institutions, public-private sectors and NGOs (Simon, 2022).

Among educational institutions, Higher Education Institutions are considered to be promoters of change and the key to implementing sustainability principles through leaders that can contribute to the successful United Nations Sustainable Development Goals (SDGs) implementation (Zalenienea & Pereira, 2021). Hence, educational institutions are crucial in equipping students, who are future decision-makers, to tackle the complex and uncertain challenges our planet faces. This requires a specific set of competences, including anticipation, systemic thinking, interdisciplinary approach and participation (Jelonek & Urbaniec, 2019). The last few years demonstrated an interest in orienting the curriculum towards sustainability, but the results are still inadequate and inconsistent across different educational contexts and levels (Leal Filho et al., 2021; Wilhelm et al., 2019; Brandt et al., 2019). The challenges of integrating sustainability competences and pedagogies into the curriculum include the lack of clear definitions, standards and guidelines, the resistance from some faculty members and students, insufficient resources and support, and the misalignment between the learning outcomes, assessment methods and learning activities (Pesha, 2021; Dlouhá et al., 2019).

Although the sustainability competences are largely identified, argued and discussed, their implementation in education curricula remains complex and challenging, requiring systemic and holistic approaches.

In literature, the education for sustainability practice and perceptions has been investigated to identify a suitable systems model for effective education (Littledyke et al., 2013). It resulted in a distributed model of leadership in which individuals are responsible and collectively empowered to take action, which is relevant to a systems model for education and sustainability. The concept of 'distributed leadership' is an alternative to models of leadership that concern themselves primarily with the attributes and behaviours of individual 'leaders' (Marturano & Gosling, 2007). This approach argues for a more systemic perspective, whereby leadership responsibility is dissociated from formal organisational roles, and people at all levels are given the opportunity to influence the overall direction and functioning of the organisation (Bolden, 2011). The systems model integrates approaches to governance, curriculum and infrastructure management (Littledyke et al., 2013).

From a different perspective of using system models as a conceptual framework for curriculum alignment, three major strengths of the systems approach for education arose: the ability to engage complexity, the capacity to describe system dynamics and change, and the ability to relate macro and micro levels of analysis (Lee, 2015). There is no doubt that in this context, a vital role in the pursuit of sustainable development stays with the educators'

competences (Leal Filho et al., 2021), and in response, various competency models have been developed and tested (Imara & Altinay, 2021). In addition to competences, researchers suggested potentially effective pedagogies for teaching them (Evans, 2019). A pedagogical approach that emerged as highly relevant and confident for sustainability studies is project- or problem-based learning in an organisational or community setting (Evans, 2019). This approach enables learners to engage with real-world challenges and collaborate with stakeholders to find feasible and sustainable solutions.

As stated by UNESCO, it is paramount to enhance the capacities of educators by mainstreaming education for sustainable development into teacher education programmes, a priority in "Education for Sustainable Development Beyond 2019", which emphasises that teacher education should offer more opportunities for educators, to strengthen their capabilities as facilitators of learning that lead to transformation (Buckler & Creech, 2014).

Holistically, a master thesis in Arts in Creative Sustainability used the systems approach to analyse data from interviews and identify feedback loops, system archetypes, mental models, and barriers and opportunities for the integration of sustainability in a university (Nsanbayeva, 2019). The study helped to identify leverage points that could potentially lead to significant changes towards sustainability education and to formulate recommendations. Among the findings, it was emphasised that teachers are very focused on their particular disciplines. Consequently, they found it difficult to connect their discipline with sustainability challenges in a holistic way. Recommendations were given towards exposure to the international academic and professional community, partnerships with foreign universities, and participation in international conferences, competitions and workshops (Nsanbayeva, 2019).

Over recent years, numerous articles have contributed to substantial progress in exploring the learning outcomes and competences that educational programmes need to seek to develop in students and teachers' abilities which are particularly critical to the development of sustainability literacy of students (Lim et al., 2022; Duarte et al., 2023; Lozano et al., 2019; Wiek et al., 2011; Sterling & Thomas, 2006). In addition, guidelines for the creation of a sustainability course which proposes a transdisciplinary curricular unit to be included in university degree programs have been elaborated under the Erasmus+ programme (Pulselli et al., 2021). However, some articles present the implementation in own institutions based on local needs, perceptions and conditions, and acknowledge that fulfilling local needs often has international effects and consequences (Sato, 2020).

Despite the significant progress in conceptualising sustainability competences and integrating them into various educational contexts, the current

literature reveals persistent gaps in translating these frameworks into actionable, scalable solutions for vocational education and training (VET). While models like GreenComp provide a solid theoretical foundation, their practical application is often hindered by limited systemic approaches, inconsistent implementation across contexts, and insufficient stakeholder engagement. Furthermore, the challenges of aligning curricula with sustainability principles, fostering interdisciplinary collaboration, and addressing resource constraints remain underexplored. This study addresses these gaps by proposing a systems approach that integrates governance, organisational frameworks, community engagement, and practical tools to create a cohesive educational ecosystem.

Possessing a comprehensive understanding of the current work, derived from an extensive review of relevant literature, our ambition in this article is to support the advancement of sustainability education in vocational education and training (VET) schools, offering a methodological framework for facilitating the exchange of good practices and fostering collaborative learning among educators across Europe. By critically engaging with the literature, the authors emphasise the need for adaptable and participatory methods, underscoring the importance of co-creation and localised solutions to maximise impact. The process of developing a European network of national sustainability education centres and setting up a cooperation mechanism for enabling the development of sustainability competences will be presented in detail, facilitating scalability and replication. Applying the systems approach, this article explores how diverse stakeholders can address sustainability challenges, develop transdisciplinary and collaborative competences, anticipate future needs for green skills, and ultimately empower individuals and organisations to collaborate in innovating and co-creating value for sustainable development.

Research methodology

Context of the research

Aiming to introduce substantial changes in VET practices, particularly in the VET ecosystem-building practices and teaching and learning processes, the authors established a consortium of five diverse European organisations (SME, NGO, university, research institute, VET provider) to produce the methodological framework and tools to build a European ecosystem, the "Green Hive", composed of localised hubs for sustainability education, namely "Green Combs". While the Green Hive is intended to be an open and cross-sectoral long-term cooperation network dedicated to innovation, continuous improvement and co-creation in sustainability education, the

Green Combs would make VET providers the managing centre of networks of local stakeholders for learning, networking and cooperating on sustainability challenges. Hence, this article emphasises how VET providers can engage with local and external actors through networking and internationalisation systems.

Methodology

The need for developing sustainability competences is growing exponentially, creating new opportunities for collaboration among stakeholders and necessitating a systems approach to integrate sustainability principles into education. The complexity of the systems approach to sustainability, which emphasises both quantitative and qualitative characteristics, has introduced significant methodological strength to mixed-methods research (Fırat et al., 2020). Consequently, this study employed a mixed-methods research design to explore how a systems approach can foster value generation and stakeholder engagement for sustainable development. The mixed-method design incorporates multiple stages, including focus groups, participatory workshops, and qualitative data analysis. This approach, as highlighted by several researchers, is particularly well-suited for investigating complex processes and systems, addressing the limitations of relying solely on either qualitative or quantitative data, and effectively accommodating diverse data types (Brannen, 2005).

Participants were selected through a purposive sampling strategy to ensure a diverse and representative group of stakeholders across countries, institutions, and professional roles. The recruitment criteria prioritised individuals with expertise in VET and experience in sustainability education. This approach ensured alignment with the study's objectives while capturing a broad spectrum of perspectives to enrich and inform the findings (Patton, 2002).

The primary data collection strategy involved focus groups that brought together VET stakeholders with expertise in sustainability. The focus group approach, a widely recognised qualitative method, facilitates structured and focused discussions within a small group, making it one of the most effective and frequently used techniques for collecting qualitative data (Gundumogula, 2020). The working group sessions were conducted using this methodology, specifically designed to elicit participants' insights, identify challenges, and share best practices related to sustainability education. These sessions followed a semi-structured format, guided by open-ended questions to foster open dialogue while ensuring alignment with the study's research objectives (Morgan, 1997; Bryman, 2016).

Secondly, following the focus group sessions, participatory workshops were organised to bring together representatives from the national working groups, culminating in an international co-creation workshop. Participatory workshops are widely recognised in research as effective methods for fostering collaboration, integrating diverse perspectives, and validating findings (Bergold & Thomas, 2012). The international co-creation workshop served to synthesise the findings from the national working groups, validate emergent themes, and collaboratively develop practical tools. This participatory approach aligns with established methodologies that emphasise co-creation as a means of ensuring stakeholder ownership, contextual relevance, and the practical applicability of research outputs (Sanders & Stappers, 2008).

Ultimately, the collected data were qualitatively analysed through a process of organisation, interpretation, codification (Castiblanco & Vizcaino, 2020) and presentation in this article. Qualitative methods are particularly effective for gaining an in-depth understanding of stakeholders' perspectives, experiences, and needs, aligning seamlessly with the systems approach advocated in sustainability education research (Creswell & Poth, 2018). Thematic analysis was employed to analyse the data, following the six-phase framework: (1) familiarising with the data, (2) generating initial codes, (3) searching for themes, (4) reviewing themes, (5) defining themes, and (6) writing the analysis (Clarke & Braun, 2013). This widely recognised method is valued for its ability to identify, analyse, and interpret patterns within complex datasets, making it particularly suitable for addressing sustainability challenges in education (Nowell et al., 2017). The analysis synthesised insights across six key domains, highlighting strategies for implementing the "Green Comb" framework and fostering stakeholder engagement.

Composition of the working groups

A total of 51 stakeholders, including VET teachers, trainers and school directors, and other education and training experts (e.g., school, adult, higher or non-formal education providers) have been recruited from five countries (Greece, Ireland, Italy, Romania and Spain) to take part in the sessions of the working groups, Figure 1. Each of the five consortium organisations appointed two leaders to manage the recruitment and selection processes, facilitate the members' participation, and document progress and conclusions. The recruitment started with an open call for stakeholders to be part of five working groups established to work on six development domains for the "Green Combs", the local hubs for sustainability education. Particularly, the working groups have been invited to cooperate on

Governance, Organization, Community, Activities, Tools, and Relationships of the "Green Combs" with the "Green Hive". The recruitment took place between 10 November and 05 December 2023. Within this period, the eligible stakeholders, including but not limited to, vocational teachers, vocational trainers, directors of VET centres, and administrative personnel of VET providers, submitted online applications. The final selection of working group members has been operated according to the following key criteria: Expertise and experience ensuring alignment of the applicant's professional background with the working group objectives; Balanced composition between the types of stakeholders, taking into consideration the multi-level governance principle as well as the diversity of expertise; Geographical coverage for diversity across the different regions of each country; and Commitment and availability to take part in the working group sessions and international workshops over its whole duration (18 December 2023 – 31 January 2024).

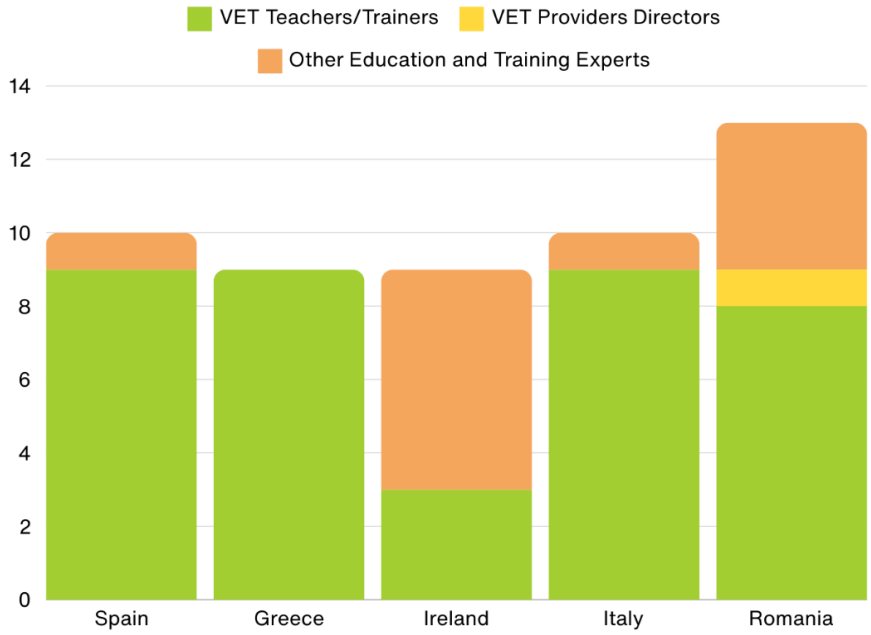


Fig. 1 Graphical representation of participants distribution, Source: Authors

Data collection

The qualitative data were gathered from the discussions during the working group sessions, based on teachers' perceptions of sustainability education and their current practices. Each national working group focused on a specific domain of development for the "Green Combs" sustainability

education hubs: Governance and organisation (Romania); Community development and management (Greece); Activities (Spain); Tools for communication and collaboration (Italy); Relationships within the Hive ecosystem (Ireland).

During the working group sessions, discussions were facilitated to collect participants' views, experiences and practices related to sustainability education. Focus group discussions facilitated by appointed leaders (moderator and observer) guided each working group to explore specific themes within their assigned domain. The moderator of each working group ensured the collection of views and opinions on the research question. A note-taking person observed the interactions and processes during these sessions, noting key themes, collaboration dynamics, and decision-making processes. Meeting notes were recorded to supplement the findings from the discussions and observations.

Qualitative data analysis

The qualitative data collected from the working group sessions and the international co-creation workshop were analysed using thematic analysis. This method, well-suited for identifying, analysing, and reporting patterns within complex datasets, was chosen to synthesise insights from diverse stakeholders across the five countries involved in the study.

The analysis began with a detailed review of all data sources, including reports of the working group and co-creation workshops discussions, observation notes and documentation, to familiarise the researchers with the content and context of participants' contributions. Systematic coding was then applied using both inductive and deductive approaches. Inductive codes were derived directly from the data, capturing participants' experiences and reflections, while deductive codes were guided by the research question and existing literature on sustainability education and systems thinking. These coding processes ensured a balance between emergent insights and alignment with the study's objectives.

Following coding, the researchers identified and organised broader themes encapsulating the main patterns and insights relevant to the research question: how a systems approach can foster value generation and stakeholder engagement in VET. Particular attention was given to the alignment of themes with the specific domains assigned to each national working group. For instance, themes related to governance and organisation were enriched by data from Romania's working group, while insights into tools emerged prominently from Italy's sessions.

The identified themes were further refined to ensure accuracy and relevance across the international contexts represented in the study. Themes were supported by examples drawn from participants' contributions to illustrate key findings. The final synthesis of themes was validated during the international co-creation workshop, ensuring the findings resonated with stakeholders' experiences and practical insights.

To ensure the reliability of the qualitative analysis, the researchers employed a triangulation strategy by corroborating data across multiple sources, including focus groups, observations, and documents. Participant validation was also integrated into the process by inviting stakeholders to review and provide feedback on preliminary findings. This iterative approach ensured the themes accurately represented the diverse perspectives and experiences gathered throughout the research process.

Research results

The findings from the qualitative analysis were synthesised to explore how a systems approach can enhance the effectiveness of education in VET schools by fostering value generation and stakeholder engagement. Building on these results, the authors developed two key outputs: a **How-to Guide** (Abbruzzese et al., 2004) and a set of **inquiry-based canvases** (Abbruzzese et al., 2024). These resources provide the strategy and tools needed to position VET institutions as managing centres of networks of local stakeholders, enabling collaboration on sustainability challenges. Through these hubs, known as Green Combs, students are encouraged to think in systems, understand the interconnectedness of the economy, society, and environment, and develop critical and systemic thinking competences by collaborating with peers and external stakeholders. Both the How-to Guide and the canvases are structured around six domains, Figure 2, essential to establishing and managing a Green Comb: governance, organisation, community, activities, tools, and the relationship with the central hub.



Fig. 2 Graphical representation of the six domains. Source: Authors

The **How-to Guide** is intended as a roadmap for establishing and managing Green Comb hubs within VET institutions. It provides actionable strategies, practical tools, and step-by-step instructions to empower educators and institutions to create sustainability-focused educational ecosystems. Complementing the guide, the **inquiry-based canvases** offer structured frameworks that operationalise the guide's concepts, helping institutions align sustainability goals, activities, resources, and outcomes with the specific needs of learners, schools, and communities. Together, these resources foster innovative practices and stakeholder engagement, creating a cohesive system for embedding sustainability principles into education.

The How-to Guide

The How-to Guide serves as a detailed blueprint for establishing and managing Green Combs. It provides actionable strategies, practical tools, and step-by-step instructions to empower educators and institutions to build effective sustainability-focused local hubs:

- **Governance**: The guide outlines how to define a vision, mission, and guiding principles for the Green Comb while establishing clear leadership structures and integrating sustainability goals into institutional policies. It provides recommendations for securing financial and physical resources, setting measurable goals, and ensuring compliance with relevant legal and ethical standards.
- **Organisation**: This section details creating an operational framework that includes team formation, role allocation, and capacity-building initiatives. It offers guidance on project management, monitoring progress, and developing partnerships to enhance the reach and impact of the Green Comb.

- **Community Management**: The guide emphasises creating a strong sense of community by engaging internal stakeholders, such as educators, students, administrators, and external stakeholders, including NGOs, businesses, and local communities. It includes strategies for recruiting members, fostering inclusivity, and maintaining collaborative relationships to ensure sustained engagement.
- **Activities**: The guide provides practical advice on designing and implementing a range of sustainability-focused initiatives. These include internal activities, such as capacity-building workshops and curriculum development, and external initiatives, like public engagement events, sustainability challenges, and community projects. The activities are designed to align with the overarching goals of the Green Comb and maximise their impact.
- **Tools**: This section addresses both digital and thinking tools. Digital tools enhance communication, collaboration, and project management, while thinking tools, such as resource-sharing platforms, decision-making frameworks, and scenario-mapping techniques, foster systemic problem-solving and strategic planning. These tools are essential for ensuring the effective functioning of the Green Comb and promoting a holistic approach to sustainability challenges.
- **Relationships with the Hive**: This section focuses on building connections between local Green Combs and the broader Green Hive network. It provides strategies for knowledge sharing, fostering collaboration among hubs, and leveraging collective expertise to address shared sustainability challenges. This section highlights the importance of maintaining strong, mutually supportive relationships within the network to enhance the overall success of sustainability initiatives.

Inquiry-Based Canvases

The inquiry-based canvases, aligned with the How-to Guide, provide visual and strategic scaffolds for implementing sustainability initiatives. Each domain comprises multiple canvases to address specific aspects of Green Comb development.

The *Governance* canvases establish the foundation for decision-making and strategic management. They guide institutions in aligning their mission, vision, and sustainability principles while ensuring transparency, accountability, and ethical operations. These canvases also address critical governance functions, including defining leadership roles, integrating

sustainability goals into institutional policies, and establishing performance metrics, ensuring that Green Combs operates with integrity and strategic focus.

The *Organisation* canvases focus on creating a robust operational framework for Green Combs. They provide practical guidance for team formation, defining roles and responsibilities, and fostering collaboration among stakeholders. These canvases also support curriculum development, professional capacity building, and project management to ensure the smooth implementation of initiatives. Feedback mechanisms are incorporated to enable continuous monitoring and improvement, ensuring the sustainability of organisational efforts over time.

Community Management's canvases focus on fostering a sense of belonging and collaboration among internal and external stakeholders. They provide tools to support stakeholder recruitment and engagement, facilitate long-term partnerships, and maintain open communication channels. These canvases ensure that Green Combs thrive as dynamic, interconnected ecosystems, actively involving their communities in co-creating sustainability solutions.

The *Activities* canvases are dedicated to planning internal and external initiatives that promote sustainability. Internal activities include capacity-building workshops, organisational training, and curriculum integration efforts, while external activities focus on broader community engagement, such as public events, sustainability challenges, and collaborative projects. These canvases ensure that all activities are aligned with the Green Comb's mission and goals, maximising their relevance and impact for stakeholders.

The *Tools* canvases comprise two sets of canvases designed to assist Combs' managers in identifying the digital tools necessary to support a variety of operations, activities, and workflows, and fourteen "**thinking tools"**, which encompass methodologies, frameworks and models aimed at broadening perspectives on complex problems and their potential solutions. These tools are designed to foster a deeper understanding of the intricate interconnections within ecosystems, fostering a holistic view that transcends a narrow focus on isolated components.

The thinking tools incorporate methodologies such as systems thinking and design thinking, along with advanced visualization and decision-making techniques like force field analysis, causal loops, and feedback loops. These tools are designed to deepen users' understanding of contexts, problems, and systemic interactions, enabling them to identify leverage points and craft robust, sustainable design processes. By embedding interdisciplinary models and frameworks, the tools foster a multi-perspective approach to

problem-solving and strategic planning. They empower users to develop solutions with a systemic and innovative mindset, bridging disciplines to address complex challenges effectively.

When integrated into VET curricula, these tools can equip educators and learners with innovative strategies to tackle sustainability challenges effectively. This interdisciplinary set of tools not only strengthens critical analysis skills but can also facilitate the practical application of sustainability principles across diverse vocational contexts, laying the foundation for systemic and transformative change.

The *Relationships with the Hive* canvases focus on strengthening the connections between local Green Combs and the broader Green Hive network. They provide frameworks for mapping stakeholders, establishing inclusive communication channels, and fostering knowledge sharing. These canvases also emphasise the importance of shared visioning and collaboration across the ecosystem, enabling Green Combs to leverage collective expertise and resources. This domain ensures that Green Combs remains interconnected and mutually supportive, driving the success of sustainability initiatives at both local and transnational levels.

Discussions and Conclusions

The overarching objective of this study was to explore and create an effective way of setting up a cooperation mechanism for enabling the development of sustainability competences in VET schools. The study was based on qualitative research considering the perspective of the main actors (VET teachers, decision-makers at the VET school level and the labour market), which significantly impacted what competences would be developed at school and how. This study answers the following research question: How can systems approach sustainability education in VET schools to foster value generation and stakeholder engagement?

Based on the literature review, there is a significant shift towards integrating sustainability into education, mostly at the higher education level, emphasising the need for systemic and holistic approaches. The research findings highlight substantial progress in identifying and defining sustainability competences, but also reveal challenges in their implementation. The empirical results show that while there are efforts to integrate these competences, there are still gaps and inconsistencies in practice. These are caused by the lack of clear standards and guidelines, resistance from faculty and students, insufficient resources, and misalignment between learning outcomes, assessment methods, and learning activities. However, the research indicates opportunities for improvement through systems approaches and

distributed leadership models. While a systems approach for curriculum alignment has strengths such as engaging complexity and describing system dynamics and change, the distributed model of leadership collectively empowers individuals to take action.

Subsequently, using the second research strategy, the current findings were summarised, presented and verified with a collaborative approach during 5 national focus groups with 51 education and training experts. The collected data revealed teachers' needs and reflections on adapting content knowledge, their thinking about learner and community needs, their autonomy for organising extracurricular activities and the benefits for educational institutions. They concluded on the need for a Charter, defining the vision, mission, and goals, as well as the procedure for the establishment of the Green Comb in VET schools. As a minimum, the following management team and roles are required for each educational comb: coordinator, curriculum integration specialist, stakeholder engagement coordinator, professional development leader, student empowerment facilitator and communication manager. The same VET teacher can manage two or three roles.

Finally, an international gathering was organised to brainstorm and express views on six key domains essential for establishing "Green Comb": governance, organisation, community, activities, tools, and relationship with the central hub.

Key findings include strategies for setting up and managing the "Green Comb", emphasising the importance of innovative practices and stakeholder engagement for sustainability education. The results are presented as inquiry-based canvases providing VET institutions with a scaffold for designing and implementing sustainability education initiatives. The canvases guide the "Green Comb" on how to align the goals, activities, resources, and outcomes of sustainability education with the specific needs of learners, schools, and community.

By identifying the key stakeholders and their roles, respondents emphasise the importance of a collaborative approach to sustainability education. It should be underlined that discussions conducted by the five educational institutions and stakeholders took place separately in groups of ten, followed by integrating into a unified framework during the co-creation process, which the participating experts validated. The participants have been invited to review and provide feedback, giving a broader view of the current needs of VET institutions. When examining the systems approach to sustainability education, on the one hand, this means that diverse stakeholders can address sustainability challenges more effectively. On the other hand,

considering the sustainability perspective allows for the development of transdisciplinary and collaborative competences.

In conclusion, it can be highlighted that wide international consultation and collaborative practice were viewed as essential for the successful implementation of sustainability education initiatives and for setting up a self-sustainable cooperation mechanism to enable the development of sustainability competences.

Limitations

Despite the efforts invested in designing the research, this study presents limitations. Given its qualitative nature and the involvement of stakeholders from only five countries, the sample size is limited (51 stakeholders from five European countries), which may restrict the generalizability of specific findings across all VET environments. Second, the geographical scope of the research, which included Greece, Ireland, Italy, Romania, and Spain, offered a range of perspectives but did not encompass the full diversity of educational practices or socio-economic conditions across Europe or globally. Additionally, the focus group method, while effective for generating rich qualitative data, carries inherent limitations. These include the potential for bias or manipulation by dominant participants, challenges in distinguishing individual views from group consensus, and difficulties in generalising findings from a small focus group to a broader population due to the challenge of obtaining a truly representative sample (Gundumogula, 2020). Finally, the research was conducted within a specific timeframe, from November 2023 to January 2024, capturing stakeholder perspectives and practices during this period. While this timeframe provided sufficient data to meet the study's objectives, it does not account for longer-term trends or the evolving nature of sustainability practices in education. Future research should consider employing longitudinal studies to better capture changes and developments over time.

However, the overall results hold substantial potential to create value for stakeholders who adopt the approach and engage with the ecosystem. Acknowledging these limitations, the study's findings are best viewed as a foundation for further research and adaptation to diverse contexts.

Taking into consideration the limited number of market and industry representatives in the focus group and international workshop, further research should focus on identifying potential obstacles and opportunities to develop transdisciplinary and collaborative competences in VET schools across Europe.

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