



APPROACH FOR FOSTERING THE INTEGRATION OF SUSTAINABILITY EDUCATION IN VOCATIONAL EDUCATION AND TRAINING SETTINGS



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ABSTRACT

The green and digital transitions are reshaping vocational education and training (VET), driving growing demand for sustainability-related knowledge and skills. Research conducted in Bulgaria, Italy, Romania, and Türkiye shows that VET educators acknowledge this need; however, their capacity to implement advanced sustainability frameworks remains limited. **Objectives:** The paper presents an approach to integrating sustainability education into VET systems, developed in the framework of the international project GreenTeach. **Methods/Approach:** As part of the project, a secondary integrative analysis is conducted using two complementary evidence sets: baseline research involving VET educators and experts, and subsequent transnational piloting in four countries. **Objectives:** Quantitative descriptive results were triangulated with qualitative feedback and country-level implementation observations. Based on the collected evidence, a model encompassing a seven-stage integration cycle is suggested, including diagnostic baseline, strategic alignment, educator capacity building, curriculum translation, supported delivery, practice and partnership, and quality assurance with institutionalisation. **Conclusions:** The proposed model provides a practical context for VET providers to move from policy commitment to consistent implementation while allowing flexibility to adapt to different contexts.

Keywords: GreenComp; sustainability development education, green competences; continuing professional development (CPD); curriculum transformation; digital pedagogy; institutional change

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INTRODUCTION

The ecological transition in vocational education and training is now a key component of VET. Decarbonisation, resource efficiency and digitalisation are reshaping job roles and creating new skill combinations. VET should therefore equip learners to do their work safely and efficiently while understanding the environmental and social aspects of their decisions. This expectation is explicitly reflected in the EU VET policy model, which links vocational excellence to sustainable competitiveness, resilience, and the green and digital transitions (Council of the European Union, 2020; Cedefop, 2020). Recent labour market data show that VET graduates are highly exposed to jobs being reshaped by the green transition, and that curriculum adaptation, upskilling and reskilling will continue to be key policy objectives (Kuczera, 2025).

Sustainability education, however, is not the same as adding a few environmental topics into the curriculum. Competence-oriented frameworks like GreenComp define sustainability through values, systems thinking, and action capacity, whereas UNESCO's Education for Sustainable Development (ESD) focuses on cognitive, socio-emotional, and behavioural learning outcomes (Bianchi, Pisiotis, Cabrera Giraldez, Punie, & Bacigalupo, 2022; UNESCO, 2017). These perspectives suggest that education needs to adapt its content, teaching methods, and connections to real-world jobs. In VET, this is particularly difficult, as it must be technically accurate, meet industry qualifications, address employer needs, and develop sustainability competencies.

The institutional dimension is equally important. International guidance for greening Technical and Vocational Education and Training (TVET) emphasises strategic planning, staff capacity, institutional practices, partnerships and monitoring rather than individual curriculum interventions (UNESCO-UNEVOC, 2017). The European Training Foundation views greening as a whole-institution process involving training provision, teachers, stakeholders, strategies and resources (European Training Foundation, 2023). Such a systemic view is consistent with the GreenTeach project (GreenTeach, n.d.), which addresses sustainability integration through teacher training in line with the European sustainability competence framework GreenComp (Bianchi, Pisiotis, Cabrera Giraldez, Punie, & Bacigalupo, 2022), curriculum development, digital learning, stakeholder cooperation, and pilot sessions conducted in Bulgaria, Italy, Romania, and Türkiye.

This study draws on the GreenTeach experience to develop a practical, evidence-based approach to integrating sustainability education into VET settings by strengthening teachers' competences through tailored professional development. This integrates the needs identified before teachers were trained and the lessons learned from the international pilot and its evaluation. Instead of a single model that can be applied in the same way in every country, a flexible sequence of actions is identified that VET institutions can adapt to their own context, thereby moving beyond policy commitments and embedding sustainability more consistently in everyday teaching practice.



ANALYSIS OF RECENT RESEARCH

Sustainability competencies have always been a topic of focus in integrative rather than knowledge-based learning. Systems thinking, anticipatory, normative, strategic, and interpersonal skills are identified as core competencies for sustainability programs (Wiek, Withycombe and Redman, 2011).

Within the GreenTeach initiative, a model has been developed in line with the recommendations of the European Reference Framework GreenComp, grounded in sustainability values, complexity, and a vision of a sustainable future and action for sustainability (Bianchi, Pisiotis, Cabrera Giraldez, Punie, & Bacigalupo, 2022). GreenComp framework is not prescriptive. It provides guidance for curriculum designers and teachers on how to turn broad sustainability objectives into meaningful learning outcomes relevant to their educational contexts.

Vocational education and training is exposed to technological, production, and labor market change. The shift towards greener economies affects both new occupations and existing jobs and requires adaptation across sectors (OECD/Cedefop, 2014; Cedefop, 2023; Kuczera, 2025). The European Skills Agenda accordingly links upskilling, reskilling, and partnerships to sustainable competitiveness (European Commission, 2020).

The Council Recommendation on learning for the green transition calls for connected learning on environmental, economic and social dimensions, while UNESCO's Education for Sustainable Development (ESD) for 2030 roadmap highlights policy, learning environments, educator capacity, youth engagement and local action (Council of the European Union, 2022; UNESCO, 2020).

Teacher capacity is therefore a key factor. Vocational educators must integrate their occupational expertise with pedagogy and continuing professional development to meet the changing demands of workplace practice (OECD, 2022). The Digital Competence Framework for Educators (DigCompEdu) also adds an important digital dimension to sustainability education through online resources, digital tools, and technology-enhanced learning, which is an increasingly prominent part of the curriculum (Redecker, 2017). Consequently, green and digital transitions are interrelated in teaching practice.

Sustainability education thrives on active, contextualised, and problem-oriented methods due to the complexity of its challenges (Al Badawi, 2025; Montes de Oca, Navarro, & Byers, 2026). Approaches such as project-based learning, inquiry-based learning, and case studies effectively link conceptual understanding to decision-making and application. These methods in VET can be especially effective in connection with real occupational activities in energy use, material choices, waste reduction, maintenance, production planning, sustainable procurement, or service design, where learning tasks are related to those that are real in real work life - energy use, material selection, waste reduction, and production.

Standards and standardisation add an important practical dimension by showing how sustainability



principles are translated into workplace practices through environmental management systems, technical standards and reporting requirements. However, standards-related education is still not sufficiently integrated into many educational programs (Gabriel, de Vries, & Cleeland, 2022; International Federation of Standards Users, 2018). ISO Strategy 2030 establishes a stronger connection between standardisation and sustainable development (International Organization for Standardization, n.d.). VET should therefore connect competence frameworks with the standards and requirements encountered at work.

Studies and publications highlight that the current gap between sustainability ambitions and the repeatability of VET practice remains unresolved. The literature provides a good theoretical basis for integrating sustainability into VET. Yet less attention has been paid to the practical question of how VET institutions can manage and plan this process in relation to organisational, curricular and resource constraints.

Referent frameworks help to define the competences that learners and educators should develop, but institutions still need a practical and coherent way to bring these elements together. This includes preparing teachers, adapting curricula, using digital tools effectively, creating opportunities for practical application, involving stakeholders, and ensuring that quality improvement is not only one of the main functions of VET but also its core.

The GreenTeach findings are particularly useful in this respect because they combine an initial assessment of teachers' needs with the implementation of professional development training based on a common educational course architecture and a shared e-learning platform for delivery across several countries, and a structured post-training evaluation.

GreenTeach indicates that many VET educators are willing to integrate sustainability education into their VET settings but lack structured preparation, familiarity with relevant frameworks and standards, or opportunities to convert sustainability concepts into vocationally authentic learning activities (GreenTeach Consortium, n.d.-a; GreenTeach Consortium, n.d.-b).

The main purpose of this paper is to present a transferable model and approach for fostering sustainability education in VET settings, grounded in evidence from the GreenTeach baseline and pilot research phases.

The study focuses on identifying where VET institutions and educators are least prepared to integrate sustainability and what needs strengthening before meaningful curricular change can take place. It also examines the features of the GreenTeach international pilot that sustained participation and contributed to the training's positive evaluation. Building on these findings, a staged institutional approach is proposed to guide the integration process in practice, along with indicators that institutions can use to monitor progress, evaluate implementation, and support further improvement over time.

METHODOLOGY

The study applies a secondary integrative analysis of two complementary GreenTeach evidence sets. The first consists of the research findings summarised in the study on sustainability integration in VET, produced through GreenTeach Deliverables 2.1 and 2.2. The research design combined desk research, policy analysis, 20 semi-structured expert interviews across Bulgaria, Italy, Romania and Türkiye, and an online survey of 204 VET educators. The survey investigated awareness of sustainability frameworks, confidence in applying green competences, familiarity with innovative pedagogies, digital competencies, and professional development needs (GreenTeach Consortium, n.d.-a; GreenTeach Consortium, n.d.-b).

The second evidence set is the international pilot of the GreenTeach online course for VET educators' professional development. The common course architecture comprises seven training modules that focus on the foundations of sustainability, sustainable teaching methods, the use of technology in sustainability education, methods and tools for assessing GreenComp competencies, and approaches to developing sustainable learning environments and collaborative platforms.

The pilot training sessions across all countries were delivered via a shared virtual learning environment, with each national pilot using a distinct support model tailored to the country's specific context.

Across the four countries involved, 193 VET educators were registered as trainees, with 12 facilitators providing pedagogical, technical, and organisational support. 167 trainees worked on the modules to differing extents, 153 finalised the training, and 144 completed the voluntary anonymous final satisfaction questionnaire. The common post-training questionnaire included 11 statements on a five-point Likert scale with 1 as the lowest and 5 as the highest score, grouped under several dimensions (GreenTeach Consortium, n.d.-c):

- Technical reliability and platform usability;
- Design, Structure, and Feasibility;
- Relevance, Viability, and Overall Satisfaction;
- Suitability, Efficacy, and Quality.

The analysis was conducted in four steps: baseline findings were grouped into readiness dimensions; piloting evidence was analysed to identify implementation strategies; barriers were mapped to enabling responses; and repeated relationships were synthesised into a seven-stage institutional cycle. The model is design-based and based on needs and implementation experience, with reference to established European and international sustainability education frameworks. Only descriptive statistics are used. Country-level means are not ranked because cohort sizes, participant compositions, and national support arrangements differ. Post-training statements are considered an indication of perceived development, feasibility, and acceptance, and qualitative evidence is used to identify practical requirements for transfer and further refinement.



RESULTS AND DISCUSSION

1. From motivation to operational readiness

The baseline evidence reveals a clear readiness gap. VET educators generally recognised the importance of sustainability, and 79.41% reported integrating sustainability-related themes into their teaching either regularly or occasionally. Nevertheless, familiarity with the GreenComp framework was limited: only 13.36% described themselves as very familiar, 23.53% as slightly familiar, and 18.55% as not familiar at all. Familiarity with sustainability-related standards and frameworks such as ISO 14001, EMAS and the SDGs was also uneven, with only 12.3% reporting high familiarity and 24.5% reporting no familiarity (GreenTeach Consortium, n.d.-b).

The same pattern appears in pedagogy and professional development. Educators expressed interest in learner-centred approaches such as project-based, inquiry-based, and experiential learning, yet formal preparation was often limited. In Romania, for example, 88.9% of surveyed teachers reported no formal training in the contemporary pedagogical methodologies investigated in the study. At the same time, willingness to participate in Continuing Professional Development (CPD) was very high: 96.8% in Bulgaria, 97.2% in Romania, 91.7% in Italy and 75.8% in Türkiye. Interest in digital training for sustainability education exceeded 90% in each country. These findings indicate that motivation is a strong enabling condition, but motivation alone does not create operational competence.

The next table (Table 1) presents summarised baseline research results, their interpretation and design implementation recommendations.

Table 1. Baseline evidence and implications for institutional design

Evidence from the baseline research	Interpretation	Design implication
79.41% integrate sustainability topics regularly or occasionally	High perceived relevance, but integration may be informal or fragmented	Build on existing practice rather than introducing sustainability as an entirely new subject
Only 13.36% report being very familiar with GreenComp	Limited operational familiarity with a key competence framework	Begin with shared concepts and explicit competence mapping
Only 12.3% report high familiarity with sustainability standards	Weak connection between broad sustainability ideas and workplace standards	Include standards, management systems and sector-specific requirements
Strong interest in project-based, inquiry-based and experiential methods, but training gaps remain	Pedagogical willingness exceeds methodological preparation	Prioritise application-oriented CPD and model teaching activities
CPD willingness: 96.8% - Bulgaria, 97.2% Romania, 91.7% Italy, 75.8% - Türkiye	A large share of educators are open to structured professional learning	Use flexible professional-development routes adapted to national preferences
Interest in digital sustainability training exceeds 90% in all 4 countries	Digital delivery is feasible, but confidence is uneven	Combine online access with orientation, support and optional interaction

Source: Own calculations based on the GreenTeach data collected



The first institutional task should therefore be diagnostic rather than immediately curricular. Providers need evidence on what teachers already do, which concepts and standards are familiar, confidence with active methods and digital tools, and realistic forms of professional learning. A baseline also supports differentiated pathways, avoiding both repetition for experienced educators and overly abstract content for beginners.

2. What the international pilot adds to the evidence

The piloting phase also provided valuable insight into how the course worked in practice across different national settings. Although all four countries used the same digital course and followed the same overall objectives, each adapted the support model to its own context. In Bulgaria, online self-study was complemented by face-to-face activities at the beginning and end of the pilot, together with additional on-demand (face-to-face and virtual) support. Italy relied mainly on asynchronous online learning, supported by targeted virtual workshops. Romania combined self-paced e-learning with regular guidance and clearly structured online checkpoints, while Türkiye used a blended approach that brought together online learning, virtual support and face-to-face sessions. These differences show that the support format can remain flexible without altering the program's core content and learning objectives (GreenTeach Consortium, n.d.-c).

Participation data indicates significant outreach, highlighting the need to separate registration from active engagement. Of 193 registered trainees, 153 completed the course, or about 79.3%. Among those who became active, completion rates were about 84.3% in Bulgaria, 92% in Italy, 88% in Romania, and 93.2% in Türkiye. The final questionnaire captured 144 responses, about 94.1% of reported completers. Early orientation, clear requirements and prompt support are therefore important for limiting disengagement before sustained participation begins.

The next two tables present data on the gender and age distribution of participants (Table 2) and on professional experience in the VET sector (Table 3).

Table 2. Gender and age distribution of participants in piloting by country

Country	Gender distribution			Age distribution							
	Female	Male	Not specified	≤ 25	26-30	31-35	36-40	41-45	46-50	≥ 50	Not specified
Bulgaria	71.7%	26%	0.3%	2.2%	6.5%	2.2%	8.7%	21.7%	15.2%	43.5%	0.0%
Italy	84.6%	10.2%	5.2%	2.6%	0.0%	2.6%	20.5%	0.0%	17.9%	53.8%	2.6%
Romania	100%	0%	0%	0.0%	0.0%	0.0%	22.2%	27.8%	16.7%	33.3%	0.0%
Türkiye	68.3%	31.7%	0	19.5%	4.9%	4.9%	7.3%	29.3%	29.3%	4.9%	0.0%

Source: Own design based on the GreenTeach data collected

The transnational gender profile shows that female educators dominate, with varying degrees of dominance across all countries.

Age and professional experience diversity also contributed to the pilot by broadening professional perspectives. Experienced participants could evaluate the integration of course content into established teaching practices, while younger participants assessed digital learning and sustainability topics, reflecting the



impact of digitalisation, the green transition, and competence-based education in their emerging careers.

Table 3. Professional experience of participants by country

Country	Less than 1 year exp.	1-5 years exp.	6-10 years exp.	Over 10 years exp.
Bulgaria	13.0%	17.4%	19.6%	50.0%
Italy	28.9%	34.2%	5.3%	31.6%
Romania	33.3%	22.2%	5.6%	38.9%
Türkiye	19.5%	2.4%	4.9%	73.2%

Source: Own design based on the GreenTeach data collected

The experience distribution also suggests that sustainability-related professional development is not limited to early-career educators. The strong participation of teachers with more than ten years of experience indicates continuing demand for structured opportunities to engage with GreenComp, Education for Sustainable Development, and innovative approaches to integrating sustainability across subjects.

The transnational evaluation of the GreenTeach Online Course compiles results from national pilot activities across all participating countries. This analysis draws on a participant satisfaction questionnaire, national records, platform observations, and qualitative recommendations from the partner teams.

The national means for technical reliability and platform usability were 4.80 (Bulgaria), 4.33 (Italy), 4.68 (Türkiye), and 4.94 (Romania), but these figures cannot be regarded as a ranking because the cohorts and implementation models differed. The results underscored the importance of face-to-face support for launching training and assisting less experienced trainees. Participants provided feedback on three topics for improvement: more detailed platform guidance, clearer progress tracking, and the addition of synchronous sessions and collaborative activities. The platform's technical reliability and usability were measured with a weighted transnational average of 4.64 out of 5, highlighting its strengths and potential for use in various educational contexts and settings.

The next evaluation dimension is Design, structure, and feasibility. The national overall mean was 4.50 (Italy), 4.67 (Türkiye), 4.83 (Bulgaria), and 4.94 (Romania). These figures should not be considered a ranking due to differences in implementation models and cohorts. More importantly, the participants valued the course structure, current content, additional resources, professional relevance, and the feasibility of online delivery (GreenTeach Consortium, n.d.-c). The weighted transnational mean for this dimension is 4.71 out of 5, the highest of all main evaluation dimensions. This result shows strong agreement that the GreenTeach online course offered a coherent learning pathway and was feasible for educators to complete through a predominantly self-paced online format.

The third evaluation dimension examined the practical usefulness of the information, the improvement of participants' knowledge, the usability of the online tools, the value of supplementary resources, and the clarity and appropriateness of the learning content. National means varied from 4.80 (Bulgaria), 4.44 (Italy), 4.65 (Türkiye), and 4.94 (Romania). The weighted transnational mean was 4.67 out of 5, indicating that participants

perceived the GreenTeach Online Course as pedagogically valuable, professionally suitable, and supported by high-quality learning materials.

The Relevance, viability and overall satisfaction dimension assessed whether the course was engaging, informative and capable of providing a clear understanding of sustainability-related concepts, as well as whether it met participants' expectations. The national means were 4.75 for Bulgaria, 4.46 for Italy, 4.63 for Türkiye, and 4.94 for Romania. The weighted transnational mean was 4.66 out of 5. This shows that respondents in all four countries are likely to have viewed the GreenTeach Online Course as relevant to their professional development and as usable in VET and related educational contexts.

These results indicate three key findings:

- The course addressed a professional development need that was consistent with ESD, GreenComp and the green transition.
- Participants found the content useful for raising awareness and incorporating sustainability skills into their teaching.
- The interdisciplinary approach allowed for participants from different disciplines to identify connections with their professional practice.

The following table (Table 4) presents the key transnational piloting indicators and achieved results, the systematised grounds for successfully transferring the proposed model to other contexts, and the identified critical issues relevant to the work.

Table 4. Core transnational piloting indicators

Indicator	Result	Grounds for transfer	Caution
Registered or selected participants	193 (57 - Bulgaria, 41 - Italy, 34 - Romania, 61- Türkiye)	The model reached a sizeable multi-country professional cohort	Registration is not equivalent to active participation
Reported completers	153 (51 - Bulgaria, 39 - Italy, 22 - Romania, 41- Türkiye), i.e. 79.3% of registered)	A common modular course can be completed across diverse contexts	National workload and support arrangements differed
Final questionnaire respondents	144 (46 - Bulgaria, 39 - Italy, 18 - Romania, 41- Türkiye) 94.1% of completers)	Post-course evidence represents most reported completers	Participation and evaluation were voluntary
Platform usability	4.64/5	Digital delivery is viable when support is available	Depending on their prior digital literacy, some participants may need detailed and clearer instructions and on-demand support
Design, structure and feasibility	4.71/5	Preserve modular architecture and logical sequencing	Further differentiation may still be useful



Indicator	Result	Grounds for transfer	Caution
Sustainability, efficacy and quality	4.67/5	Strong pedagogical quality and effective resource package	Practical toolkit including various subject-specific practical examples and assessment rubrics
Relevance, viability and Overall satisfaction mean	4.68/5	Strong acceptance of the existing course foundation	Satisfaction is not a direct measure of long-term behavioural change

Source: Own calculations based on the GreenTeach data collected

Qualitative feedback supports the high scores achieved by participants, who endorsed the existing structure but requested more subject-specific examples, implemented lesson plans, case studies, assessment guidance, optional interaction, clearer progress indicators, and continued access to resources. Improvements should focus on translating sustainability concepts into practical classroom applications.

The completion requirements reinforced the course's practical focus. Participants were expected not only to complete all modules and achieve at least 70% in the assessments, but also to prepare and submit a final Green Lesson Plan that met defined pedagogical quality criteria. The lesson plan was particularly important because it linked professional development to actual teaching practice. Rather than demonstrating learning solely through tests, educators had to show how sustainability competences could be translated into concrete lesson design and classroom activities.

3. A seven-stage approach for integrating sustainability education in VET

The results from the research suggest a seven-stage cycle is more effective than a one-time training intervention. These stages provide a clear implementation path and enable institutions to reassess prior recommendations in light of new evaluations. The GreenTeach model aligns with the whole-institution approach of UNESCO-UNEVOC and the European Training Foundation, with successful teacher development and flexible delivery methods. (UNESCO-UNEVOC, 2017; European Training Foundation, 2023). The stages of the proposed approach are as follows:

Stage 1 - Diagnostic baseline

Stage 1 starts with gathering institutional evidence. A targeted diagnostic should assess educators' awareness of sustainability, sector standards, curriculum coverage, confidence in active pedagogies and digital tools, prior professional development, and perceived barriers. Staff questionnaires, curriculum mapping, program leader interviews and employer feedback will help create a concise set of documented priorities.

Stage 2 - Strategic alignment and governance

Diagnostic findings should be linked to institutional goals, VET programs, quality systems and labor-market relationships. Leadership should define the level of integration, responsibilities, staff development time and the curriculum work expected of the executive and curriculum. Embedding sustainability in the current



mission and quality system reduces dependence on one enthusiastic teacher or temporary project funding and reflects the whole-institution TVET greening guidance (UNESCO-UNEVOC, 2017; European Training Foundation, 2023).

Stage 3 - Educator capacity building

The professional development should address the gaps identified in Stage 1. In a common core curriculum, sustainability concepts, GreenComp, relevant SDGs, sector standards, systems thinking, assessment, and learner-centred teaching can be addressed. Digital competence is required for resource adaptation and collaboration. GreenTeach suggests flexible, self-paced access and clear guidance in face-to-face and online sessions, structured online checkpoints, and on-demand individual assistance (pedagogical, technical and organisational). Advanced pathways can help educators with more prior knowledge.

Stage 4 - Curriculum translation into vocational practice

Sustainability knowledge must be translated into occupational work. Teachers or curriculum creators must relate knowledge gained in sustainability skills to specific learning outcomes, practical activities, assessment criteria, and work environments. Instead of adding theory, tasks can be based on material choice, energy and resource use, waste streams, environmental management, circular process design or social consequences. A Green Lesson Plan (or similar template) makes this translation visible and reviewable.

Stage 5 - Supported delivery through flexible virtual learning environments (VLE)

Delivery should remain flexible without leaving participants alone with a digital platform. Across the four pilots, online, face-to-face and hybrid support all proved workable. More important than one fixed mode were clear orientation, deadlines and assessment rules, visible progress, technical and pedagogical support, and timely reminders. For educators CPD, asynchronous learning can remain the core while optional live sessions and peer discussion add professional exchange.

Stage 6 - Practice, industry and stakeholder partnership

Sustainability competences are most credible when linked to real occupational problems. Employers, professional associations, municipalities and environmental organisations can supply cases, data, expertise, workplace challenges and feedback. Such cooperation helps keep examples aligned with current technologies, standards, and organisational practice, supports the partnership logic of the European Skills Agenda (European Commission, 2020), and can progressively expand the practical resource bank.

Stage 7 - Quality assurance, follow-up and institutionalisation

Delivery should be flexible without leaving participants alone with a digital platform. Across the four pilots, online, face-to-face, and hybrid support proved successful. More important than one mode were clear orientation, deadlines and assessment rules, visible progress, technical and pedagogical support and timely reminders. For educators' CPD, asynchronous learning can remain the primary mode, with optional live

sessions and peer discussions adding to professional exchange.

4. Operational conditions for successful transfer

GreenTeach showed that a common course architecture can operate in different support models. The transfer can only be successful if it is based on a common core and expected outputs, local adaptation through examples and support, realistic practical tasks, interaction without too much compulsory synchronous attendance, and educationally reviewed localisation. These conditions preserve comparability while allowing for national, institutional and sectoral fit.

Sustainability outcomes in curriculum documents are often superficial when educators lack the skills to teach and assess them effectively. Training programs that are not aligned with institutional objectives may result in isolated practices that fade away once project funding ends. In this model, educator competence and institutional integration are interrelated. This approach aligns with the findings of GreenTeach, which demonstrate a high willingness among educators, low formal training, and the importance of human support in digital learning environments.

Standards provide the basis for a meaningful link between values and evidence-based professional practice by informing learners about common requirements and how their environmental performance is recorded (International Federation of Standards Users, 2018; International Organization for Standardization, n.d.). Educators' awareness about standards and standardisation should be enhanced because VET learners meet sustainability through environmental and energy management, quality assurance, procurement, reporting and technical specifications.

GreenComp helps move sustainability education beyond environmental knowledge transfer to a level of complexity, future thinking and informed action. These competencies are developed in vocational education through real-world practice, which involves analysing work processes and comparing them with other aspects of work. Additionally, they are cultivated through team-based learning projects and decisions about what constitutes a valuable project in the workplace or community. The approach should be competence-based and consistent with established research on sustainability competences and with UNESCO's emphasis on cognitive, socio-emotional and behavioural learning domains (Wiek, Withycombe, & Redman, 2011; UNESCO, 2017).

CONCLUSION AND FURTHER RESEARCH DIRECTIONS

The analysis of the GreenTeach findings yields three broader conclusions. First, the central implementation problem is a capability gap rather than a motivation gap: high willingness for CPD and digital sustainability training coexists with limited familiarity with key concepts, frameworks and methods. Second, online delivery need not be impersonal. A common digital course worked across four countries when combined with various forms of human orientation, feedback and professional exchange. Third, high course ratings validate the



training foundation but do not prove long-term integration. Requests for more application-oriented examples, collaboration, and assessment scaffolding show that participants want stronger transfer into practice. The evidence therefore supports improved perceived readiness and a workable professional-development architecture, while the next research task is to document actual classroom and institutional change. The pilot itself measured perceptions rather than long-term teaching or learner outcomes.

For wider implementation, completion and satisfaction should be seen as intermediate indicators rather than final outcomes. Stronger evidence would link teacher participation in CPD with concrete curriculum outputs, implemented lessons or projects, learner results, internal dissemination and integration into routine planning and quality processes. This would provide more meaningful information for managers, policy makers and funders.

Integrating sustainability education into VET requires more than curriculum enrichment. The research results presented in the paper show that educators are generally willing to engage with sustainability, but many need stronger conceptual, methodological, digital and standards-related preparation. At the same time, these results demonstrate that a common modular professional-development training program can be implemented across different national and institutional contexts when the core learning architecture is combined with flexible support and practical output requirements.

The proposed seven-stage cycle brings together diagnosis, strategic planning, teacher development, curriculum adaptation, supported delivery, partnerships and quality assurance. Its main strength is that these stages reinforce one another. Diagnostic findings help identify training needs; governance supports continuity; professional development strengthens teachers' capacity; curriculum adaptation links sustainability with vocational practice; learner support helps maintain engagement; partnerships add practical relevance; and quality assurance enables the approach to be reviewed and improved over time.

For VET management, the key is to maintain a common core of sustainability competences while allowing sufficient flexibility for different sectors and national contexts. Practical outputs such as lesson plans and vocational projects can help link training to real teaching practice, especially when combined with flexible digital learning, opportunities for interaction, relevant standards and workplace examples. Following up on how these elements are applied in practice can also help make sustainability part of institutional practice and professional culture rather than remaining an additional topic in the curriculum.

Further research should move beyond participants' immediate self-reported perceptions and track how the approach is applied over time. Future studies could examine whether GreenTeach lesson plans are implemented, adapted, and reused in teaching practice; how experience is shared within institutions; how learners perform in sustainability-related vocational tasks; and how employers assess their relevance to the workplace. Future work could also compare support intensity and examine differentiated pathways for



educators with different prior expertise. This would allow the model to evolve from a project-derived approach into a more rigorously validated framework.

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The data presented in this study are available on request from the corresponding author.

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