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Recommendations for Innovating Teacher Education for Sustainable Development: An International Perspective

Output of the Final Joint Seminar of the JSPS Core-to-Core Programme
Formation of Centre of Excellence to Promote Teacher Education for ESD:
Towards Achieving the SDGs

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Foreword

As we convene for this final joint seminar of the Japan Society for the Promotion of Science (JSPS) Core-to-Core Programme, we are reminded of the profound journey we have undertaken together in integrating sustainability into education. Our collective commitment to Education for Sustainable Development (ESD) has been unwavering. We share a deep belief in the transformative power of education to shape a sustainable future.

Our collaboration, facilitated by the JSPS Core-to-Core Programme, has been instrumental in advancing this mission. Through this programme, we have established a solid international network dedicated to developing innovative teacher education programmes that embed sustainability at their core. This partnership has allowed us to share knowledge, resources, and best practices across continents, fostering a global community united in the pursuit of sustainable development.

Looking ahead, we see a clear path. By continuing to innovate and collaborate, we can transform teacher education to meet the demands of a sustainable future. We are confident that the insights and discussions from this seminar will inspire us all to deepen our commitment to ESD and to empower the next generation of educators and learners to contribute meaningfully to a sustainable and just world.

We thank all our partner institutions, researchers, educators, and students for your dedication and partnership in this vital endeavour. Finally, we would like to extend our sincere gratitude to the Okayama University team, particularly Khalifatulloh Fiel'ardh, for their invaluable contributions to the manuscript preparation.

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Introduction

Background

Engaging the world's teachers—and the institutions that train them—has long been a global priority in advancing sustainable development. This was first highlighted by Gro Harlem Brundtland in the foreword of *Our Common Future* (1987), which recognised education as a critical driver of sustainability. Throughout the 1990s, the importance of teachers and teacher education institutions (TEIs) as agents of change was reiterated in reports to the UN Commission on Sustainable Development (UNCSD). In response, the UNCSD's 1998 Work Programme tasked UNESCO with developing guidelines to better engage TEIs in the sustainability agenda.

Over the past two decades, teacher education has emerged as a cornerstone for transformative change, largely shaped by initiatives such as UNESCO's Guidelines and Recommendations for Reorienting Teacher Education to Address Sustainability (2005). This seminal work, developed through the UNESCO Chair in Reorienting Education towards Sustainability at York University, laid a foundation for the systemic integration of sustainability into teacher education. It also catalysed the development of regional and global networks committed to Education for Sustainable Development (ESD).

Notably, Hopkins and Kohl (2019) assert that "*teacher education institutions fulfil vital roles in the global education community, for it is they that often bring change within education systems... and are perfectly poised to partner in Education 2030 and other ESD initiatives*" (p. 31). Their work underscores the evolving responsibilities of TEIs, particularly in aligning national education systems with international frameworks such as the Paris Agreement, the 2030 Agenda for Sustainable Development, and the Incheon Declaration. These agreements have not only elevated the status of education in addressing global challenges but have also positioned ESD as a key strategy for achieving the Sustainable Development Goals (SDGs), especially SDG 4.7.

Regionally, universities and UNESCO Chairs have contributed to this transformation through diverse initiatives. The University of Inland Norway's Centre for Collaborative Learning for Sustainable Development promotes sustainable lifestyles, while Leuphana University in Germany focuses on sustainability through communication and higher education. In Asia, Okayama University's leadership in the Asian Teacher Educators for Climate Change Education (ATECCE) initiative supports climate-responsive pedagogical practices across the region.

Building on these efforts, UNESCO's Unpacking Sustainable Development Goal 4: Education 2030 (2016) emphasised the link between Education for Sustainable Development (ESD) and Global Citizenship Education (GCED), calling for the development of competencies and values to address global challenges. This was reinforced by Reimagining Our Futures Together (UNESCO, 2021), which urged a rethinking of education's purpose in light of sustainability and equity.

Momentum continued with the 2022 Transforming Education Summit, which responded to the global education crisis by calling for system-wide reforms. A key outcome was the Greening Education Partnership (2024), aiming to make every learner climate-ready by 2030. The UN High-Level Panel on the Teaching Profession (ILO & UNESCO, 2024) further stressed investment in teacher capacity and professional development, especially for sustainability. Together, these initiatives affirm the central role of educators in advancing the SDGs.

Purpose

This publication offers a comprehensive framework for innovating TESD, developed through international collaboration under the JSPS Core-to-Core Programme. Drawing on output from the final joint seminar held in November 2024 (**Figures 1**), coordinated by Okayama University, the publication synthesises outcomes from years of partnership between universities, teacher educators, and international organisations.

Responding to the urgent need to reorient teacher education toward sustainability challenges and the SDGs (especially Target 4.7), it outlines five interconnected areas: competency, curriculum, pedagogy, assessment, and institutional context. Together, these elements provide practical guidance for teacher education reform, offering adaptable strategies suited to diverse educational contexts. The framework aims to support teacher educators and institutions in making gradual, meaningful progress toward embedding sustainability into their programmes and practices.

Target

This publication is designed for individuals and institutions actively shaping teacher education:

- **TEIs:** faculty, curricula designers, and leaders committed to mainstreaming ESD.
- **Policymakers and Education Stakeholders:** local, national, and regional authorities developing aligned strategies.
- **Teacher Educators and Trainers:** supporting teachers in gaining sustainability competencies.
- **Teachers and School Leaders:** integrating sustainability into practice.
- **International and Regional Organisations:** advancing sustainability education.

By addressing the needs of this diverse group, the publication aims to support the development of inclusive, high-quality, and sustainability-oriented teacher education across different countries.

Figures 1. Core-to-Core Programme final joint seminar (A: Opening lecture by Charles Hopkins, York University; B: Morning session; C: Afternoon session; D: Participants and panellists of the seminar).

Domains of Teacher Education for Sustainable Development (TESD)

We have identified five key, interconnected domains crucial for effective TESD: **competencies, curriculum, pedagogy, assessment, and institutional practice** These domains function as a cohesive system within the TESD framework, each reinforcing the others to create a robust and dynamic approach. Together, they offer a comprehensive roadmap for integrating sustainability into teacher education, guiding educators, institutions, and policymakers in this critical endeavour.

The TESD Cycle Model

(Refer to **Figure 2A**) This model illustrates the dynamic and iterative process of integrating sustainability into teacher education for both pre-service and in-service teachers, emphasising continuous development throughout their careers. The cycle begins with establishing clear competencies – the essential knowledge, skills, values, and attitudes teachers need to effectively embed sustainability in their practice. For pre-service teachers, this involves integrating sustainability into their initial training through courses, projects, and fieldwork. In-service teachers require ongoing professional development to stay current with the latest research and best practices.

These competencies then inform the curriculum, ensuring it equips teachers with the understanding to address environmental, social, and economic issues in their classrooms. This may involve revising existing curricula or developing new resources. Critically, it requires creating opportunities for teachers to reflect on their own values and beliefs about sustainability. Effective pedagogy brings the curriculum to life through active learning strategies that engage teachers in critical thinking, problem-solving, and collaborative learning around sustainability. This could include innovative methods like project-based learning, inquiry-based learning, and place-based education.

Finally, assessment provides feedback on teachers' progress in developing competencies and applying them in their teaching, fostering continuous improvement. This can include classroom observations, lesson plan analysis, student feedback, and self-reflection.

The Layers of Influence Model

(Refer to **Figure 2B**) This model places the student at the centre, surrounded by layers of influence that shape their learning experience and contribute to effective TESD. At the core is the teacher, whose competencies, pedagogical approaches, and commitment to sustainability are crucial. This is followed by the learning environment, encompassing the physical space, classroom culture, and available resources. A space conducive to learning about sustainability, with access to relevant materials and outdoor spaces, is essential. The school itself reflects its commitment to sustainability through its policies, curriculum, and overall ethos.

A whole-school approach, with visible integration of sustainability principles, creates a powerful context for learning. Beyond the school, the institutional context, including the policies and practices of TEIs and the broader educational system, plays a significant role. TEIs have a responsibility to

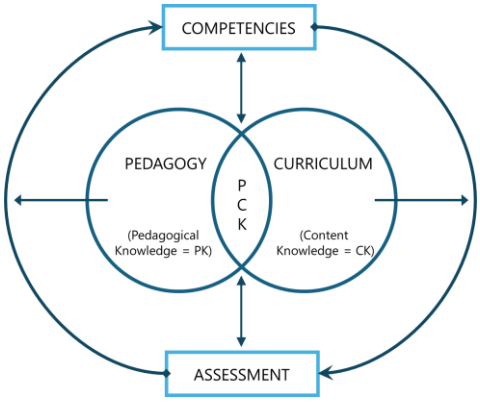
embed sustainability in their programmes. Finally, school coordination and leadership are crucial for creating a shared vision and providing support for implementation. It involves fostering collaboration among teachers, administrators, and community stakeholders. This layered approach emphasises the interconnectedness of these influences, recognising that each layer impacts the others to shape the student's learning experience.

The Fused Model

(Refer to **Figure 2C**) Having explored the cyclical nature of TESD and the layers of influence, the Fused Model provides a framework to understand how the five key domains dynamically interact at both the individual (teacher) and organisational (TEI) levels. This model emphasises the alignment between individual teacher development and the organisational structures that support it. At the individual level, teacher competency in ESD is shaped by the curriculum and supported by effective pedagogy and assessment. This development is nurtured by the institutional context.

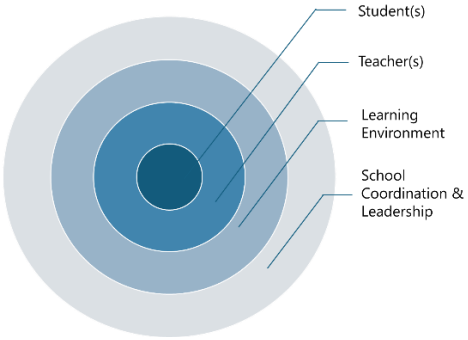
At the organisational level, the TEI's commitment to sustainability is reflected in its defined competencies for teacher education programmes. These competencies are woven into the curriculum and enacted through pedagogical practices and assessment strategies, all within a supportive institutional context. The Fused Model illustrates how individual teacher growth and organisational commitment to sustainability are intertwined and mutually reinforcing in achieving effective TESD.

2A



※PCK= Pedagogical Content Knowledge

2B



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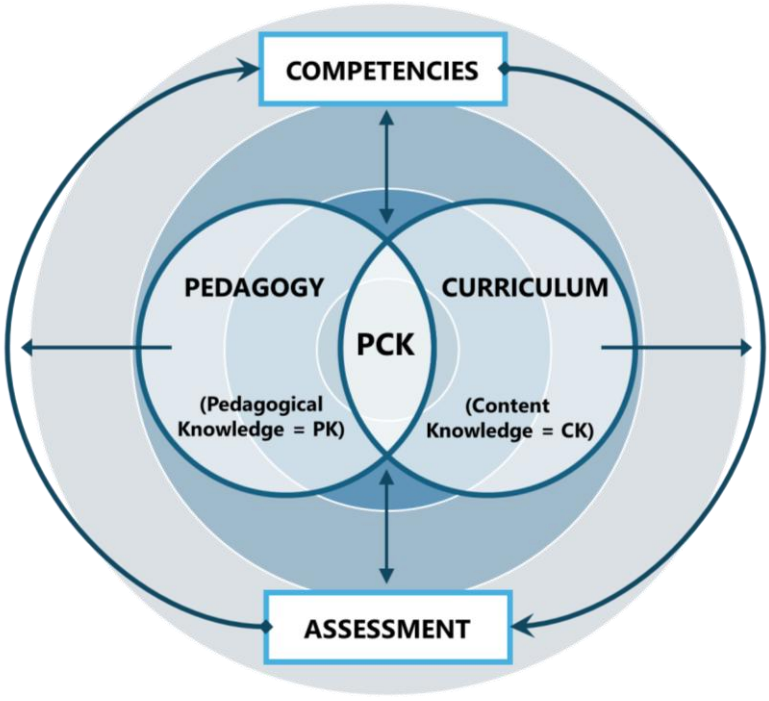


Figures 2 (2A: TESD cycle model; 2B: Layers of influence model; 2C: Fused model)

Domain 1: Competency

Introduction

TESD rests on the fundamental principle that competent educators are the driving force behind effective sustainability education. They are the architects of transformative learning experiences, guiding students to become critical thinkers, problem-solvers, and ultimately, agents of change for a sustainable future. Recognising this, competency takes its rightful place as the foundational domain within TESD, preceding considerations of curriculum, pedagogy, or assessment. After all, without capable and empowered educators, even the most innovative curricula or supportive institutional frameworks will fall short of their potential. But what constitutes "competency" in the context of sustainability education? This is where the complexity arises.

In TESD, developing competencies to drive sustainable change begins with a clear focus on teachers' competencies rather than student outcomes. To refine this focus, Rieckmann and Barth (2022) propose examining two key dimensions: the specificity of the target group—considering teachers' career stages and phases of education—and the relation between content knowledge (CK) and pedagogical content knowledge (PCK). This framework allows competencies to be mapped along these axes (**Figure 3**).

Specificity of the Target Group

TESD competencies are not one-size-fits-all. They need to be tailored to the specific needs and contexts of educators, considering their career stages (e.g., pre-service, novice, experienced) and phases of education (e.g., *early childhood, primary, secondary, tertiary*). A novice teacher, for instance, may require more support in developing foundational pedagogical skills, while an experienced teacher might benefit from specialised training in integrating latest educational model (such as *Artificial Intelligence* or *Future Scenario Workshop*) in their teaching.

The Interplay between CK and PCK

Effective TESD hinges on a strong foundation in both content knowledge (*CK/a deep understanding of sustainability concepts*) and pedagogical content knowledge (*PCK / knowing how to teach those concepts effectively*). This interplay is crucial. An educator might possess a wealth of knowledge about climate change, but without the pedagogical skills to translate that knowledge into engaging and meaningful learning experiences, their impact will be limited.

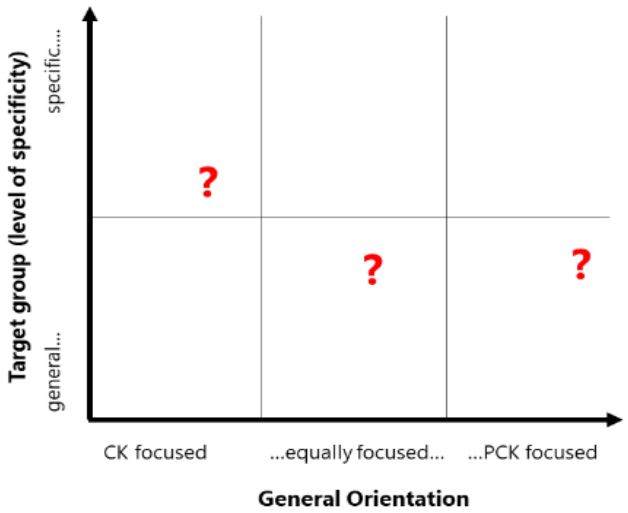


Figure 3. Heuristics for the analysis of TESD competence framework and model (adopted from Rieckmann & Barth, 2022)

Exemplary Competency Framework

The Asia-Pacific ESD Teacher Competency Framework (Okayama University ESD Promotion Centre, 2020), building upon our previous project in 2019 and further developed as an output of the Second Asia-Pacific Regional Meeting on Teacher Education for ESD held in Bangkok in 2019, outlines the essential skills and knowledge required for educators to effectively implement ESD. With the overarching goal of "Shaping Futures" by enacting ESD principles in the present to build a sustainable future, this framework is structured around three key competencies (**Figure 4**), each addressing a critical aspect of teacher competency for ESD (**Box 1**).

Capacity to Facilitate Learning

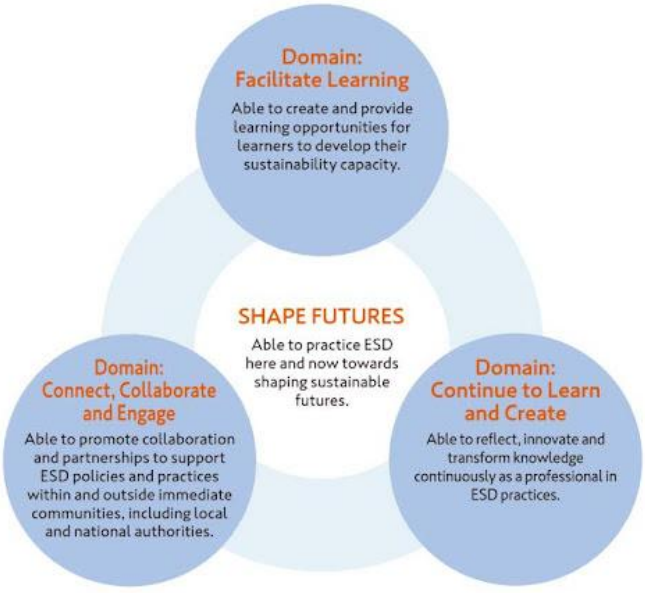
The first competency, focuses on the core pedagogical skills needed to effectively deliver ESD. This includes creating and providing diverse learning opportunities that empower learners to develop their sustainability capacities. It emphasises active learning strategies, critical thinking, and problem-solving approaches that enable students to engage with sustainability issues in meaningful ways.

Capacity to Connect, Collaborate and Engage

The second competency highlights the critical role of collaboration and partnership in advancing ESD. It recognises that effective ESD requires educators to connect with their communities, build partnerships with various stakeholders, and engage in collaborative efforts to support ESD policies and practices. This competency stresses the importance of networking, communication, and collective action in creating an enabling environment for ESD implementation

Capacity to Continue to Learn and Create

The third competency emphasises the need for continuous professional growth and development. It recognises that ESD is a dynamic and evolving field, requiring educators to constantly update their knowledge, skills, and practices. This competency encourages a reflective approach to teaching, where educators continuously innovate, learn from their experiences, and adapt their teaching to meet the emerging challenges and opportunities in ESD



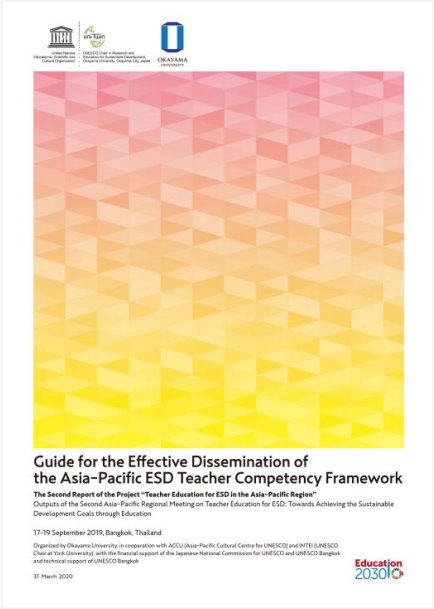


Figure 4. Left: Domains of the Asia-Pacific ESD Teacher Competency Framework. Right: Publications containing the framework

Box 1. Indicators of Asia-Pacific ESD Teacher Competency Framework (Hiroki Fujii, Okayama University, Japan)		
Domain	**Indicator**	**Descriptions**
Capacity to Create Learning	Agency	Engage with challenges as opportunities for personal and professional growth, demonstrating autonomy and accountability.
	Commitment	Embrace a strong sense of mission by approaching teaching with passion, purpose, and commitment.
	Collegiality	Build and sustain collaborative networks with colleagues to support cross-disciplinary and collective initiatives.
	Flexibility	Respond to unexpected challenges with proactive thinking by designing exploratory, inquiry-based learning experiences.
	Student-Oriented	Respond to unexpected challenges with proactive thinking by designing exploratory, inquiry-based learning experiences.
Capacity to Connect through Learning	Connection	Connect with local communities and stakeholders to co-create enriching and relevant learning opportunities.
	Collaboration	Facilitate collaborative learning among students to foster deeper connections and mutual understanding.
	Sharing	Contribute to a culture of professional growth by sharing knowledge and engaging in reflective dialogue with peers.
	Technology	Integrate digital technologies to connect learning environments with global networks and external partners.
	Action	Partner with businesses, NGOs, and other organizations to expand the societal and global impact of learning.
Capacity to Continue Learning	Open Eyes on Society	Stay informed about social and environmental trends and embed relevant developments into classroom practices.
	Inquiry-Based	Apply inquiry-based approaches that promote critical thinking, reflection, and problem-solving.
	Self-Improvement	Continuously improve teaching strategies and materials through a sustainability and ESD-focused lens.
	Capacity Building	Participate actively in professional development and peer learning to strengthen ESD competencies.
	Learning Together	Cultivate a culture of shared learning by discovering and growing alongside students in collaborative ways.

Recommendations

During our seminar, we identified a set of key competencies (see **Box 2**) essential for effective TESD. These include both general competencies—such as adaptability, critical thinking, and lifelong learning—and specialised competencies such as systems thinking, futures thinking, and the ability to inspire student action. While UNESCO (2017) publication "*Education for Sustainable Development Goals: Learning Objectives*" outlines core competencies for learners—such as systems thinking and critical thinking—our focus extends this by identifying the specific capacities educators need to facilitate and model transformative ESD. The UNESCO (2023) publication "*Recommendation on Education for Peace, Human Rights and Sustainable Development*" further affirms the critical role of educators in advancing sustainability, equity, and justice. Embedding these competencies in teacher education is essential for preparing educators to lead meaningful change in both classrooms and communities.

Box 2. Exemplary Teachers' Competencies and Recommendations for Teacher Education Institutions		
Category	**Examples**	**Recommendations**
General Competencies	Adaptability and Resilience	■ Design learning experiences that challenge assumptions and encourage flexibility. This might involve case studies, simulations, or real-world problem-solving activities that require teachers to adapt their thinking and approaches. ■ Provide opportunities for reflection and feedback. Encourage teachers to reflect on their experiences, identify areas for growth, and receive constructive feedback from peers and mentors. ■ Model adaptability and resilience. Teachers should exemplify these qualities in their own practice, demonstrating a willingness to embrace new ideas and learn from setbacks.
	Continue Learning How to Learn	■ Foster a culture of inquiry and experimentation. Encourage teachers to ask questions, explore new ideas, and try out different pedagogical approaches in a safe and supportive environment. ■ Provide access to diverse learning resources and opportunities. Offer a range of professional development opportunities, including workshops, online courses, conferences, and mentorship programmes. ■ Encourage collaboration and knowledge sharing. Create opportunities for teachers to learn from each other and share their experiences and expertise.
	Information Literacy	■ Integrate critical media literacy into teacher education curricula. Teach teachers how to evaluate information sources, identify bias, and recognise misinformation and disinformation, especially in the context of online media and AI-generated content. ■ Provide training on effective use of digital tools and technologies. Equip teachers with the skills to use technology for research, communication, collaboration, and creating engaging learning experiences. ■ Model responsible technology use. Teachers should demonstrate ethical and responsible use of technology in their own practice.
Specific Competencies	Futures Thinking	■ Integrate futures studies and value-based systems thinking into teacher education. Introduce teachers to tools and methodologies for envisioning future scenarios, identifying potential challenges and opportunities, and designing innovative solutions for a sustainable future. ■ Engage teachers in participatory futures activities. Facilitate workshops and projects where teachers can collaboratively explore future possibilities, develop scenarios, and create action plans for a sustainable future.
	Facilitate Learning Beyond Cognitive Domain	■ Provide training on experiential and emotional learning. Equip teachers with strategies to engage students' emotions, values, and senses in learning about sustainability. This might involve using storytelling, outdoor education, arts-based activities, and service-learning projects. ■ Encourage teachers to create action-oriented learning experiences. Support teachers in designing projects and activities that empower students to take action for sustainability in their schools and communities.

Domain 2: Curricula

Introduction

A robust TESD curriculum defines what educators need to teach to prepare students to address sustainability challenges effectively, aligning closely with the competencies they must develop. TEIs must design curricula that not only provide knowledge but also support the cultivation of key competencies. By addressing real-world issues, aligning with global goals, fostering interdisciplinary connections, and integrating diverse perspectives, TESD curricula ensure educators are equipped with both the knowledge and the skills to inspire and guide students toward sustainable futures.

A Two-Pronged Approach to TESD

Integration of sustainability into teacher education curricula can be achieved through a two-pronged approach. First, sustainable development topics and ESD methodologies should be seamlessly integrated into the existing framework of academic subjects within teacher education programmes. Sustainability should be a recurring theme in core courses such as science education, social studies education, mathematics education, language education, and arts education. For example, in science education courses, pre-service teachers can explore the impact of human activities on ecosystems and climate change, while social studies education can highlight into the social, economic, and political dimensions of sustainability.

Equally important is the introduction of cross-cutting modules and projects specifically focused on ESD. These modules should provide opportunities for pre-service teachers to actively engage with sustainability challenges through collaborative, real-world problem-solving. For example, they could collaborate to design a sustainability-focused curriculum for a local school, incorporating elements of outdoor education, community engagement, and action-oriented learning. Such projects foster critical thinking, teamwork, and a sense of responsibility towards sustainability, while also providing practical experience in designing and implementing ESD initiatives.

Interdisciplinary Frameworks

A key consideration for effective TESD integration is the use of interdisciplinary frameworks. Sustainability is not confined to a single discipline; it encompasses environmental, social, economic, and cultural dimensions. Therefore, it's crucial to break down traditional disciplinary silos and foster a holistic understanding of sustainability in pre-service teachers. Interdisciplinary frameworks encourage collaboration and knowledge sharing across different subject areas, enabling future teachers to see the interconnectedness of sustainability issues and develop integrated solutions.

This can be achieved by establishing interdisciplinary teaching teams, where faculty from various disciplines collaborate to develop and deliver ESD modules (**Box 3**). Another approach is to create learning communities or collaborative platforms where pre-service teachers from different subject areas can work together on ESD projects, sharing their perspectives and expertise.

Box 3. Contributions of University Faculty Expertise to the Interdisciplinary Approach in TESD
(Taro Harada, Okayama University, Japan)

Addressing interdisciplinary topics is a cornerstone of ESD. Exploring these topics within an area of expertise allows individuals to effectively train both in-service and pre-service ESD teachers. For instance (**Figure 5**), research in plant science can be applied through horticulture, which provides a comprehensive framework. Horticulture integrates not only fundamental plant science knowledge found in school curricula but also various sustainability-related aspects such as food production, traditional agriculture, economics, climate change mitigation, technological advancements, and the promotion of physical and mental well-being. Similarly, beekeeping offers an interdisciplinary lens, encompassing plant-insect interactions, biodiversity-driven ecosystem services, and the development of sustainable local industries. In both examples, collaboration with diverse stakeholders—including schools, public institutions, companies, and farmers—is vital. Universities and research institutes play a crucial role by supplying the latest knowledge and equipment, significantly enhancing the skills and competencies of teachers. This collaborative approach ensures that educators are well-prepared to successfully implement ESD in schools, fostering a deeper understanding of sustainability among students.

Figure 5. Photos taken during the inter-disciplinary module that include topic of "Horticulture and beekeeping" at Okayama University

Real-World Focus

Another critical aspect is ensuring a real-world focus in ESD modules and projects. By grounding these learning experiences in real-world contexts and addressing pressing sustainability challenges like disaster risk education (**Box 4**), climate change, and resource management, learning becomes more relevant and engaging for pre-service teachers. This approach allows them to connect theoretical concepts to practical applications and develop a deeper understanding of the complexities of sustainability issues.

For instance, pre-service teachers can investigate local environmental problems, analyse data on resource consumption in schools, and develop action plans to promote sustainability within their future classrooms and schools. This real-world focus not only enhances their understanding of sustainability concepts but also empowers them to become agents of change in their communities.

Practical Modules

Finally, hands-on learning is essential for effective teacher education for ESD. Practical modules should be developed to provide pre-service teachers with opportunities to apply their knowledge and pedagogical skills in real-world settings. These experiences bridge the gap between theory and practice, allowing pre-service teachers to develop confidence and competence in implementing ESD in their future classrooms. This could involve conducting environmental audits of schools to assess their environmental impact, designing sustainable solutions for school facilities to improve resource efficiency, or partnering with community organizations (**Box 5**) to implement sustainability projects that benefit the local community. Such experiences deepen understanding, foster a sense of responsibility, and provide valuable practical skills for future educators.

Box 4. Connecting TESD to Real World Issues through Disaster Risk Education (Patricia Mie Matsuo, University of São Paulo, Brazil)

Global contemporary issues such as climate change, water and food security, biodiversity, pollution, environmental justice, and disasters are increasingly in the everyday life of societies. In Brazil, the impacts of disasters such as floods, landslides, wildfires, heatwaves, and droughts are increasingly felt by society and schools across all regions. However, disaster prevention is not formally included in the country's national curriculum and there are few initial teacher trainings which addresses this issue, One of such practice is an interdisciplinary optional course available for future teachers of Natural Sciences at São Paulo University created in 2024.

Fortunately, over the past 10 years, various initiatives for continuing teacher education have been developed, primarily through collaborative initiatives between universities, research institutes, civil defence agencies, and faculty of teacher education. These training processes include, hands-on experiences in participatory methodologies, such as:

1. *Field trips to identify local potentialities and risks,*
2. *Risk mapping, mitigation strategies, and possible escape routes,*
3. *Rain monitoring using homemade rain gauges,*
4. *Interviews with residents affected by disaster.*

These actions aim to contribute to disaster risk perception and the development of a culture of prevention. They also seek to integrate these new school-based knowledge into local risk management systems. It is important to note that, being relatively new, these initiatives are often interrupted by political issues and the availability of financial resources.

Figure 6. Two in-service teacher training initiatives conducted in Brazil: a) coordinated in Angra dos Reis, Rio de Janeiro State and b) coordinated in Caraguatatuba, São Paulo State. Both programmes focus on equipping educators with the knowledge and skills necessary to effectively integrate disaster risk prevention strategies into their teaching practice

Box 5. An Approach to Incorporating Sustainable Development Goals (SDGs) into the Core Teaching Curriculum (Tomonori Ichinose, Manami Honzu, Miyagi University of Education, Japan)

With the 2020 revision of Japan's national curriculum, references to the SDGs began appearing in primary and secondary school textbooks. However, educators faced challenges in integrating them systematically, lacking the necessary framework and pedagogical approaches to effectively incorporate these global goals into their teaching. This highlighted a need for professional development to support teachers in navigating this new educational landscape.

In 2017, the Teaching Core Curriculum introduced elements such as "Comprehending the Significance of Collaboration between Educational Institutions and Local Communities," signalling a shift towards more holistic and interconnected learning experiences. Miyagi University of Education (MUE) responded to this call by developing an in-service teacher training programme focused on the SDGs.

A prime example of the outcome of this training is a place-based education (PBE) programme, developed by 5th-grade teachers who participated in MUE's training. This programme demonstrates the transformative potential of ESD when effectively implemented. By collaborating with local communities and integrating subjects including science, moral education, and Japanese language, the programme fosters critical thinking, problem-solving, and reflective learning in students. Students are encouraged to explore local sustainability challenges, connect them to the global context of the SDGs, and develop action-oriented solutions.

By equipping educators to design transformative, action-oriented learning experiences, these initiatives prepare a generation of students to address sustainability challenges. This approach not only enhances students' understanding of sustainability concepts but also empowers them to become active and engaged citizens in their communities.

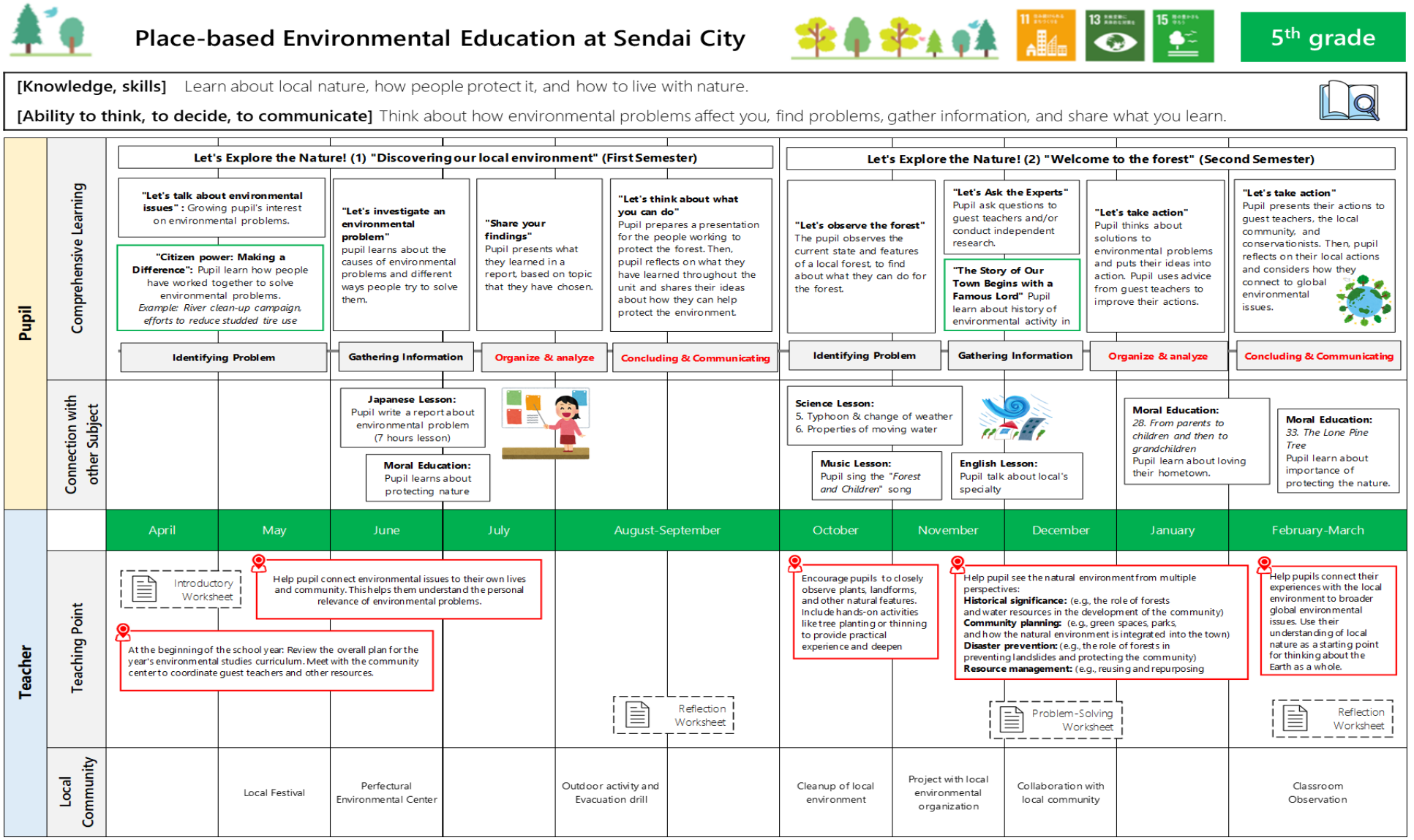


Figure 7. Place-based education lesson plan developed by teacher attending training by MUE

Recommendations

As detailed in **Box 6**, to innovate curricula in TESD, TEIs need to adopt a multifaceted approach that fosters interdisciplinary frameworks to encourage collaboration and knowledge sharing across disciplines; promoting a holistic understanding of sustainability; grounding learning experiences in real-world contexts and addressing pressing sustainability challenges to make learning relevant and engaging; and providing opportunities for pre-service teachers to apply their knowledge and skills through practical modules in real-world settings to deepen understanding and foster a sense of responsibility

Box 6. Principles and Recommendations to Innovate Curricula in Teacher Education

Principles	Recommendations
Interdisciplinary Frameworks	● Establish interdisciplinary teaching teams composed of faculty from various disciplines to collaboratively develop and deliver ESD modules. ● Create professional learning communities or collaborative platforms where pre-service teachers from different subject areas can work together on ESD projects, sharing their perspectives and expertise. ● Organise workshops or seminars that bring together faculty and pre-service teachers from different disciplines to discuss and explore the interconnectedness of sustainability issues.
Real-World Focus	● Integrate real-world case studies and problem-based learning activities into ESD modules, allowing pre-service teachers to analyse and address local sustainability challenges. ● Facilitate field trips and site visits to local communities, organizations, or ecosystems to provide pre-service teachers with first-hand experience of sustainability issues. ● Encourage pre-service teachers to conduct research on local environmental issues, analyse data related to resource consumption in schools, and develop action plans to promote sustainability in their future classrooms.
Practical Modules	● Develop practical modules that provide opportunities for pre-service teachers to apply their knowledge and skills in real-world settings, such as conducting environmental audits of schools, designing sustainable solutions for school facilities, or creating community gardens. ● Partner with local organizations and community groups to provide pre-service teachers with opportunities to engage in community-based sustainability projects. ● Incorporate service-learning components into ESD modules, allowing pre-service teachers to apply their learning while contributing to their communities.

Domain 3: Pedagogy

Introduction

With the TESD curriculum outlining the "what" and competencies defining the "how," pedagogy acts as the bridge between them, breathing life into sustainability education. TEIs must ensure their teaching methods effectively translate curriculum content and cultivate essential competencies including systems thinking and ethical decision-making. This necessitates a shift from traditional, teacher-centred approaches to more student-centred, experiential learning that fosters critical thinking, collaboration, and real-world problem-solving. By refining their pedagogical approaches, TEIs empower future teachers and educators to not only deliver impactful lessons, but also to inspire action-oriented learning and problem-solving in their students. The following recommendations offer key strategies for achieving this crucial alignment.

Transformative Pedagogies

TEIs must move beyond traditional teaching methods and embrace transformative pedagogies to effectively address the multifaceted challenges of sustainability. This requires a shift from passive learning to active engagement, where students are empowered to explore, question, and apply their knowledge in meaningful ways. Transformative pedagogies foster critical thinking, problem-solving, and collaborative learning, equipping future teachers with the skills and mindset necessary to inspire and guide their own students towards a sustainable future.

Project-based Learning

Project-based learning (**Box 7**) is a key component of this approach, providing students with opportunities to delve into real-world sustainability issues and develop solutions through collaborative inquiry. By engaging in authentic investigations, students not only deepen their understanding of sustainability concepts but also develop essential skills such as research, critical thinking, communication, and teamwork. This approach fosters a sense of ownership and agency, empowering students to become active contributors to sustainable solutions.

Place-based Learning

Place-based learning further enhances this transformative approach by connecting students to their local environment. By exploring sustainability challenges within their own communities, students develop a deeper understanding of the interconnectedness of social, ecological, economic and cultural systems. This fosters a sense of place and responsibility, encouraging students to become active stewards of their local environment and contribute to creating a more sustainable future for their communities. Practical modules (**Box 8**) and portfolio projects further enhance this transformative approach by allowing students to apply their knowledge and skills in authentic contexts, bridging the gap between theory and practice.

Value-based Education

Value-based education is another crucial aspect of transformative pedagogies, encouraging students to critically examine ethical dilemmas and develop responsible decision-making skills. By exploring diverse perspectives and engaging in ethical debates, students develop a deeper understanding of the values that underpin sustainability.

Box 7. Preparing Pre-service Biology Teacher Competency to Teach Sustainability Project-based Learning (Ari Widodo, Universitas Pendidikan Indonesia, Indonesia)

Pre-service biology teachers participated in an elective project-based course titled "Biology Education for Sustainability", designed to integrate sustainability into biology education. The course began with an introduction to the SDGs, ESD, and how biology lessons can contribute to promoting students' understanding, awareness, and action on sustainability. Participants worked in groups of two or three to identify biology topics in the school curriculum that could be linked to sustainability. These topics were then aligned with relevant SDGs, and the groups identified ESD learning objectives that their projects could achieve. After establishing the project framework, the groups designed sustainability-focused projects for school students and reached out to biology teachers who were willing to implement them in their classrooms. This course not only equipped pre-service teachers with the skills to design and implement sustainability projects but also emphasised the integration of biology, sustainability, and entrepreneurship.

Figure 8. Exemplary project guided by pre-service teachers (using black soldier fly larvae to process organic waste)

Box 8. Handprints For Change TESD Pedagogy for Inspiring Individual Actions (Sweta Purohit, Centre for Environment Education, India)

A Handprint, as the opposite of a Carbon Footprint, is climate-positive action or activity undertaken by students, teachers, and schools that go beyond reducing carbon footprints to also bringing tangible benefits in the immediate environment. It focuses on individual positive behaviours and actions for sustainability in daily lives. The Handprint approach offers teachers the pedagogy and active learning perspectives with tangible and positive impacts from students to communities to the society.

This teacher-facilitated inquiry-based active learning process includes the following steps: (1) Tune-in: Sharing real-world stories and experiences of climate change induced problems; (2) Find-out: Connecting local context, science, and curriculum; (3) Work-out: Deliberating possible solutions for sustainability with ethics and care; (4) Take-action: Taking individual or collective handprint action for change.

Some examples for teachers can be to apply this pedagogy on issues including– electricity wastage, polluted rivers and lakes, decline of birds and bees, plastic waste, water and sanitation, heat stress and floods, food and nutrition etc. When the handprint pedagogy (tune-in, find-out, work-out and take-action) is applied by students on such issues, it will deepen their knowledge, trigger critical thinking and promote action-learning for common good. Such issues can not only be connected to the curriculum and local context, but also to appropriate climate and sustainability actions at individual levels. This pedagogy will empower school students and teachers to become agents of change for a sustainable future by demonstrating behaviour change and leading decision-making processes within society.

Figure 9. Training of trainers on "Saksham Shala" i.e., Climate Resilient Schools emphasising handprint actions around clean, green, safe and sustainable actions at school level (an initiative led by UNICEF Gujarat and SSA, State Education Department of Gujarat India, with technical partnership of the Centre for Environment Education (CEE).

Value-based education fosters a sense of empathy, compassion, and justice, empowering students to make informed and responsible choices that contribute to a more sustainable and equitable world.

Nature-based Learning

Integrating nature-based learning and outdoor education provides invaluable opportunities for hands-on experiences in the natural world. By immersing themselves in nature, students develop a deeper appreciation for the interconnectedness of life and the importance of ecological balance. This fosters a sense of wonder and respect for the natural world, inspiring students to become advocates for environmental protection and sustainability.

Co-creating Futures

Recognising that sustainability is not just about understanding problems but also about envisioning and creating a better future, TEIs should foster collaborative learning environments where future educators actively participate in shaping sustainable solutions. Team-teaching courses with interdisciplinary perspectives can break down subject silos and provide a holistic understanding of sustainability challenges. This approach encourages educators to analyse complex issues from multiple angles and develop integrated solutions that consider the interconnectedness of social, economic, and environmental dimensions. By engaging in collaborative projects, educators can apply their knowledge in real-world contexts, fostering a deeper understanding of how different disciplines contribute to sustainable development. This collaborative approach not only enhances learning but also empowers educators to become active agents of change, equipped with the skills and knowledge to co-create a more sustainable future alongside their students and communities.

Reflective Practices

To foster ethical and responsible action in the field of sustainability, TEIs should integrate reflective practices into their pedagogical approaches. This involves encouraging educators to critically examine their own values, biases, and assumptions, particularly in relation to issues of inclusion, equity, and justice. By engaging in self-reflection and dialogue, educators can develop a deeper understanding of how their own perspectives and actions may impact their students and contribute to or hinder sustainable development. This process of critical self-reflection is essential for cultivating culturally responsive and socially responsible teaching practices that promote inclusivity and equity in the classroom and beyond. Reflective practices can be facilitated through various methods, such as journaling, group discussions, and case study analysis, providing educators with opportunities to grapple with ethical dilemmas and develop their capacity for ethical decision-making in the context of sustainability.

Recommendations

To effectively translate these pedagogical principles into practice, TEIs need to adopt a comprehensive approach that addresses various aspects of their programmes. **Box 9**. outlines key recommendations for integrating transformative pedagogies, collaborative learning, and reflective practices into teacher education for sustainable development. These recommendations aim to empower future educators with the knowledge, skills, and values necessary to effectively promote sustainability in their classrooms and communities.

Box 9. Principles and Recommendation to Innovate Pedagogy in Teacher Education	
Principles	**Recommendations**
Transformative Pedagogies	● Model transformative pedagogies in TEIs courses. Demonstrate active learning strategies, inquiry-based approaches, and collaborative projects within teacher education programmes. ● Provide training and support for diverse pedagogical approaches. Equip teacher educators with the knowledge and skills to implement project-based learning, place-based learning, values-based education, nature-based learning, and outdoor education. ● Integrate real-world sustainability issues into teacher education curricula. Design courses and assignments that engage pre-service teachers with authentic sustainability challenges and encourage them to develop solutions. ● Cultivate critical thinking and problem-solving skills in future educators. Embed activities and assessments that challenge pre-service teachers to analyse complex situations, evaluate evidence, and develop creative solutions to sustainability problems.
Co-Creating Futures	● Design collaborative learning environments within TEIs. Structure teacher education programmes to emphasise teamwork, peer learning, and knowledge sharing among pre-service teachers. ● Promote interdisciplinary approaches to sustainability education. Offer courses or modules that integrate perspectives from various disciplines to provide a holistic understanding of sustainability challenges. ● Facilitate partnerships with communities and organizations. Create opportunities for pre-service teachers to engage with local communities and organizations on real-world sustainability projects. ● Integrate futures thinking into teacher education. Provide pre-service teachers with tools and frameworks for envisioning and designing sustainable futures.
Reflective Practices	● Embed reflective practices throughout teacher education programmes. Incorporate self-reflection activities and assignments into courses to encourage pre-service teachers to examine their own values, biases, and assumptions related to sustainability. ● Facilitate critical dialogue on sustainability issues. Create spaces for pre-service teachers to discuss ethical dilemmas and diverse perspectives on sustainability challenges. ● Promote culturally responsive teaching practices. Equip pre-service teachers with the knowledge and skills to address issues of equity, inclusion, and justice in their future classrooms. ● Introduce reflective tools and methods. Train pre-service teachers to use journaling, group discussions, and case study analysis as tools for reflection.

Domain 4: Assessment

Introduction

To effectively implement the framework for developing and mapping competencies in TESD, it is essential to determine how to assess these competencies. A key consideration is whether the focus should be on evaluating teachers' competencies directly or on their ability to assess student learning in ways that align with ESD principles. Each approach has unique implications for developing teachers' skills and fostering an educational environment that supports the SDGs. Ultimately, effective assessment in TESD requires methods that reinforce these goals, ensuring that assessment practices support, rather than contradict, sustainable development.

The ESD Learning Assessment framework (Fischer et. al., n.d), as depicted in the diagram (**Figure 10**), provides a comprehensive guide for aligning assessment practices with the principles and aspirations of ESD. This framework emphasises the critical interplay between the purpose of assessment ('why'), the individuals involved ('who'), the methods employed ('how'), and the learning outcomes targeted ('what'), all within the context of specific learning environments.

Inner Alignment

Crucially, the framework highlights the importance of inner alignment, which focuses on ensuring coherence between the core elements of assessment. This involves carefully considering the learning objectives, identifying the most appropriate assessors *(self, peer, educator, or third party),* selecting diverse assessment methods *(e.g., observation, project-based assessments, performance tasks, portfolios),* and defining the specific competencies being assessed *(cognitive, behavioural, socio-emotional)*. By aligning these elements, assessment becomes an integral part of the learning process, providing valuable feedback and supporting learners in their journey towards sustainable development.

Outer Alignment

Furthermore, the framework emphasises the need for outer alignment, which connects assessment practices with the broader ESD principles and aspirations. ESD is characterised by its participative, normative, and integrative nature, promoting active engagement, critical thinking, and collaborative learning. To achieve outer alignment, assessment should be designed to embody these values, encouraging learners to participate in the assessment process, reflect on their values and attitudes, and connect their learning to real-world sustainability challenges. This might involve incorporating collaborative projects, reflective journals, or community-based activities into the assessment process.

Contextual Alignment

Finally, the framework stresses the significance of contextual alignment, recognising that assessment needs to be adapted to the specific needs and constraints of different learning environments. Contextual factors such as available time, resources, expertise, statutory requirements, educational level, and the size of the learning group all influence the design and implementation of assessment.

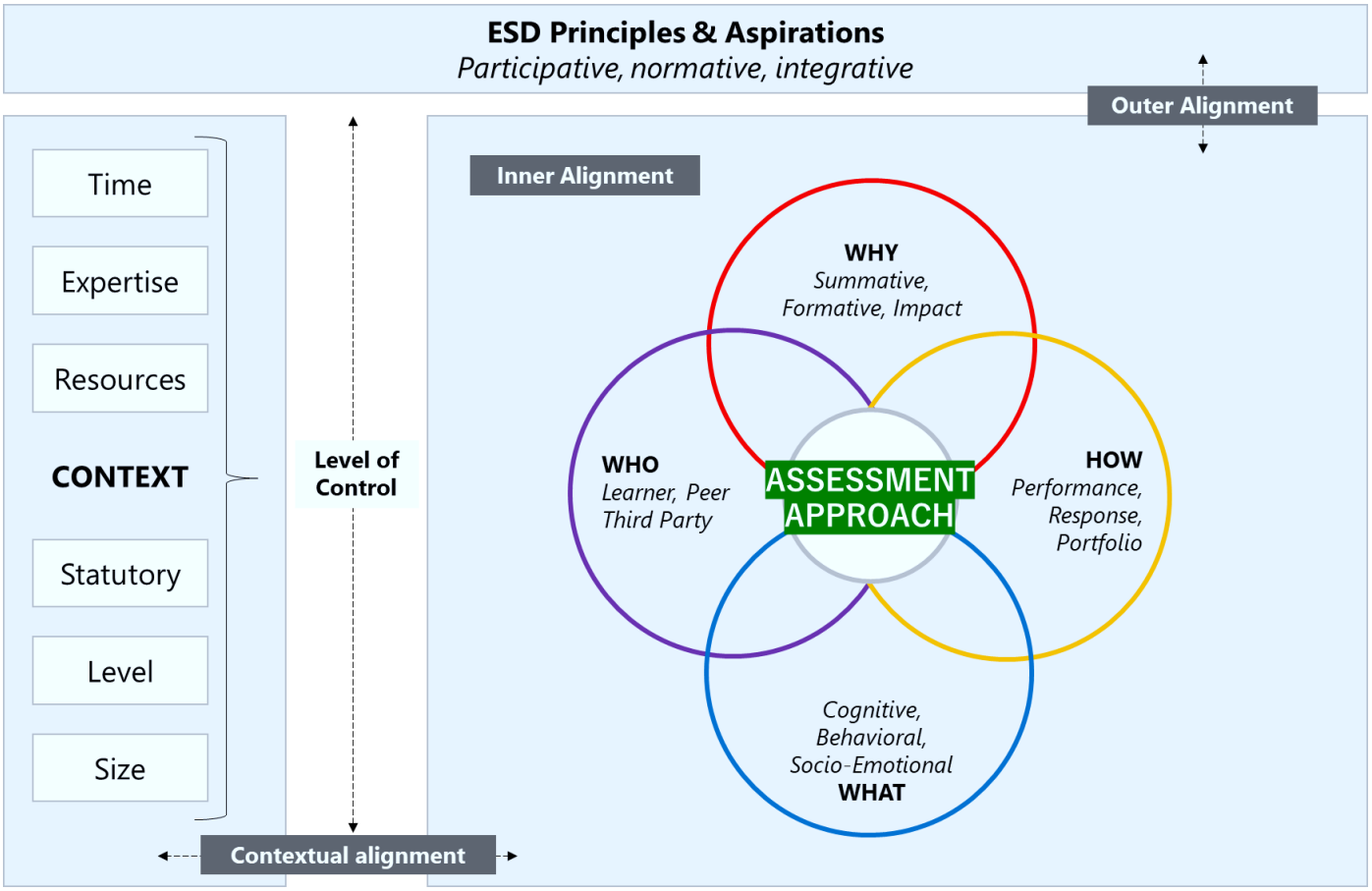


Figure 10. ESD learning assessment framework (Fischer et. al., n.d)

To illustrate this alignment process, consider two common assessment practices: traditional tests and reflective journaling. Tests often focus on summative assessment, measuring knowledge and problem-solving skills to determine if learning outcomes have been achieved. Reflective journaling, on the other hand, is frequently used as a formative assessment tool to encourage self-reflection and metacognitive awareness. However, both can be modified to better embody ESD principles. Tests can be enriched with real-world problems that demand creative solutions and critical thinking. Reflective journaling can be made more interactive through peer feedback and connected to broader learning outcomes and actions.

Specific Approaches to Assessment in TESD

To effectively assess teacher learning and growth, it is crucial to move beyond traditional evaluation methods and embrace a more comprehensive and nuanced approach. This involves incorporating diverse assessment strategies that capture the multifaceted nature of ESD competencies and their real-world application.

Direct observation of teachers in classroom settings or during fieldwork provides invaluable insights into their pedagogical practices and their ability to integrate sustainability concepts. Furthermore, engaging teachers in project-based assessments, such as change projects or community-based initiatives, allows them to demonstrate their understanding and application of ESD principles in authentic contexts.

Performance evaluations, conducted in simulated teaching scenarios, offer a valuable platform to assess teaching skills and the ability to seamlessly integrate sustainability into different subject areas. To foster a collaborative learning environment and strengthen community

engagement, peer and community-based evaluations should be integrated into the assessment process, providing diverse perspectives and enriching feedback. Finally, establishing a system of internal monitoring, utilising frameworks like Monitoring, Evaluation, Research, and Learning (MERL), enables ongoing assessment, identifies areas for improvement, and supports continuous learning and adaptation within the TESD programme.

Implementing Assessment in TESD

Implementing effective assessment practices in TESD requires careful consideration of several overarching principles. Assessments should prioritise social outcomes and the impacts of learning products to measure real-world applicability. This involves moving beyond assessing just knowledge and skills to also evaluating the impact of learning on attitudes, behaviours, and community engagement.

Furthermore, assessment should be disconnected from traditional grading systems, shifting the focus from scores to growth and meaningful feedback. This might involve exploring alternative assessment approaches such as narrative feedback, portfolio assessment, or self-reflection (**Box 10**). Encouraging teachers to view assessment as part of a lifelong learning process necessitates critical reflection on what, why, and how they assess. This involves continuously reflecting on what worked, identifying areas for adjustment, and adapting assessment practices to better support student learning and their own professional growth.

Box 10. Assessment for Learning
(Daniel Fischer, Leuphana University of Lüneburg, Germany)

At Leuphana University, the primary education teacher programme in the subject area of "integrated studies" (3rd main subject in German primary schools) is built on a simple yet powerful idea: let future teachers experience innovative approaches to assessment first-hand. Over the past few years, several change projects were launched. These projects focus on using assessment as a tool to guide and *facilitate* learning processes, not just *evaluate* the learning product at the end.
Two exemplary initiatives are the "ESD Meeting Space" and "Reflexivity Assessment" on the undergraduate level:

- The ESD Meeting Space is a 3-hour public event where student groups present their ESD projects and receive feedback from in-service teachers and professionals. This event meets a demand for networking and learning among ESD practitioners in the region, while also providing students with valuable feedback on their projects and their real-world viability. Notably, students can use and incorporate this feedback as they finalize their projects for submission.
- The Reflexivity Assessment is an assessment approach used in the first semester of the social studies track. Students write reflective essays on prompts that encourage self-awareness, exploration of preconceptions, and analysis of course materials. They then provide and receive peer feedback several times throughout the semester. The feedback is discussed in class to build consensus on both what good reflections and quality feedback look like.

The new assessment approaches across the curriculum are discussed each semester with students as part of structured study quality conversations, providing meaningful feedback to the lecturers and curriculum designers.

Figure 11. Top: Teacher students presenting their learning materials at the "ESD Meeting Space". Bottom: In-service teachers and ESD practitioners in discussion with students.

Recommendations

Box 11 highlights key recommendations to innovate assessment in TESD, emphasising the need for authentic, student-centred approaches that foster critical thinking, problem-solving, and real-world application of knowledge. These recommendations address key areas such as assessing social impacts, decoupling assessment from grading, promoting assessment as lifelong learning, and empowering teacher-led assessment development.

Box 11. Principles and Recommendations to Innovate Assessment in Teacher Education	
Principles	**Recommendations**
Assessing Social Impacts	● Develop tools and strategies for effectively assessing the social outcomes of ESD initiatives, such as changes in attitudes, behaviours and community engagement. ● Encourage educators to consider the broader social impact of their teaching and how to evaluate its effectiveness. ● Promote participatory approaches to assessment that involve students and community members in evaluating the social impact of ESD initiatives.
Decoupling Assessment from Grading	● Explore alternative assessment approaches that prioritise feedback and the learning process over traditional grading systems. ● Encourage the use of formative assessment strategies, such as self-reflection, peer feedback, and teacher observation, to provide ongoing support for student learning. ● Facilitate discussions on the purpose and limitations of grading in the context of ESD and explore ways to shift the focus towards learning and growth.
Assessment as Lifelong Learning	● Support teachers in developing their understanding and practice of assessment for ESD as a continuous process of learning and improvement. ● Provide professional development opportunities that focus on innovative assessment approaches and their role in promoting lifelong learning. ● Encourage teachers to engage in reflective practice and action research to refine their assessment strategies and better support student learning.

Domain 5: Institutional Practice

Introduction

Teacher education institutions (TEIs) play a pivotal role in shaping the future of education and, by extension, the trajectory of sustainable development. Building upon previous discussions regarding competency frameworks, curriculum design, pedagogical approaches, and assessment strategies, this section delves into the critical domain of institutional support and development for teachers and educators engaged in ESD. Recognising that effective ESD requires more than just individual teacher knowledge and skills, we shift our focus to the broader ecosystem within which teachers operate. This section explores how TEIs can foster collaborative learning environments, promote continuous professional development, and establish robust partnerships to empower educators in their ESD journey. By cultivating a supportive institutional framework, TEIs can ensure that teachers are equipped not only with the necessary competencies but also with the ongoing support and resources needed to thrive as agents of change for a sustainable future.

Community of Practice (CoP)

Teachers thrive in collaborative environments where they can learn from and with each other, engaging in a continuous exchange of ideas, resources, and best practices. Establishing professional learning communities (**Boxes 12-13**) provide a dedicated space for educators to share their knowledge, experiences, and challenges related to teaching sustainable development. This fosters a culture of collective learning and growth, where teachers can engage in open dialogue, reflect on their practices, and support one another in navigating the complexities of ESD. By actively participating in these communities, teachers develop a shared understanding of ESD principles and goals, creating a strong foundation for collaborative action.

Within these communities of practice, cross-curricular projects can be undertaken, encouraging teachers to move beyond subject-specific silos and explore the interconnected nature of sustainability. By bridging subjects like science, social studies, and the arts, educators gain a more holistic understanding of sustainability challenges and develop a wider range of pedagogical approaches.

Box 12. Infusing SDGs in Higher Education Classrooms through a Comprehensive and Interdisciplinary Teaching Toolkit (Charles Hopkins, Katrin Kohl, York University, Canada)

York University's SDGs-in-the-Classroom Toolkit was developed as a resource for instructors, to empower faculty from all disciplines to integrate the SDGs into their teaching. This toolkit provides academic information, practical tools, and resources tailored to assist instructors in creating meaningful connections between their subject matter and the global sustainability agenda. It is an open and interdisciplinary resource available to educators beyond York University and its content is continuously updated. The toolkit includes foundational sections introducing the concept of sustainability and the SDGs, discipline-specific materials, and teaching approaches that enhance educators' readiness to engage with students. Educational resources range from case studies, lesson plans, and activities to videos and blogs focused on individual SDGs. This wide range of materials enables to find context-specific materials applicable to diverse learning environments. Additionally, the toolkit encourages a Community of Practice (**Figure 12**) at York University, where those who are interested in the SDGs can collaborate and share experience. This community is supported by "Curricular Champions," whose innovative teaching examples serve as inspiration. For York University and their partnering institutions, the toolkit has become an effective model for embedding sustainability and the SDGs in the curriculum, ensuring that students gain critical awareness and skills needed to contribute to a sustainable future ahead.

Figure 12. Drawing Change of COP Graphic Sam Bradd, a graphic recorder from Drawing Change, visually documented a 3.5-hour brainstorming session in 2022. During this session, a Community of Practice discussed the significance of the SDGs to their work and teaching. They also explored their vision for the COP's purpose and actions, and identified potential next steps for achieving their goals.

Box 13. Professional Learning Community for Integrating Environmental Education into Existing Course (Sun-Kyung Lee, Cheongju National University of Education, Republic of Korea)

Cheongju National University of Education (CNUE), with support from the Ministry of Environment, is in its fourth year of implementing TESD. This initiative integrates environmental education and ESD into existing courses across various disciplines, including:

1. *Primary school subjects: Courses related to Korean language, mathematics, social studies, and science.*
2. *Liberal arts courses: Including those focused on contemporary societal issues, community investigation, and understanding global society.*
3. *Major-specific courses: Required courses for majors like Korean language teaching methodology, elementary mathematics teaching methods, chemistry in daily life, and environmental education theory and practice.*

Within each course, pre-service teachers (PSTs) actively engage with environmental topics through diverse activities: exploring literature (e.g., *selecting picture books with environmental themes*), investigating their local environment, advocating for change (e.g., *participating in policy simulations addressing climate change*), and engaging with their community (e.g., *visiting local initiatives balancing conservation and development, or taking field trips to Cheongju Zoo*). These activities culminate in practical projects allowing PSTs to apply their knowledge and skills.

Through these experiences, PSTs gain a deeper understanding of environmental issues, building both knowledge and the skills to effectively teach about them. The programme also fosters a strong community among professors, who share their experiences, teaching materials, and insights with each other. This collaborative network allows them to continually refine how they incorporate ESD into their future lesson, ultimately enriching the learning experience for all.

Figures 13. Professional Learning Community activities in CNUE, Republic of Korea

For example, a CoP might involve teachers sharing successful ESD lesson plans, discussing effective strategies for integrating sustainability into different subject areas, or collaborating on cross-curricular projects that address real-world sustainability challenges. This cross-pollination of ideas helps teachers move beyond subject-specific silos and embrace a more holistic and interconnected approach to ESD.

Furthermore, incorporating peer mentoring within these communities, where experienced teachers guide their newer colleagues through observation, co-teaching, or feedback, fosters a supportive learning environment and accelerates professional growth. This mentorship allows for the transfer of valuable knowledge and skills, ensuring that new teachers are well-supported in their journey to become effective ESD teachers, capable of providing quality education.

Progressive Development

TESD also necessitates a fundamental shift in perspective: recognising that teacher learning is not a one-time event, but rather a continuous journey that spans their entire career. This understanding necessitates cultivating a Life-long Learning Mindset among educators, encouraging them to embrace continuous improvement and adapt to the ever-evolving field of sustainability. Just as the concept of sustainability itself emphasises ongoing progress and

adaptation, so too must teachers engage in a dynamic process of learning and growth to effectively address the complex challenges of our world. To support this ongoing journey, structured pathways (**Box 14**) with clearly defined goals and milestones should be established. These pathways provide a roadmap for professional growth, outlining the knowledge, skills, and competencies that teachers need to acquire at different stages of their careers. This structured approach not only provides direction and clarity but also allows teachers to track their progress, identify areas for development, and set realistic goals for their professional advancement.

In-service training plays a vital role in facilitating this continuous learning process. Through regular workshops, courses, and training sessions, teachers are provided with valuable opportunities to deepen their knowledge and skills in specific areas of ESD. These training opportunities should be designed to address emerging trends, innovative pedagogical approaches, and the latest research in ESD, ensuring that teachers remain at the forefront of their field. By doing this, teachers can refine their teaching practices, explore new resources, and expand their repertoire of strategies for effectively integrating sustainability into their classrooms.

Box 14. The Use of a Progression Stairs For Integrated Development of a Teacher Education Programme (Robert Didham, University of Inland Norway, Norway)

The Faculty of Education at the University of Inland Norway (INN) developed a Progression Stairs document to support strategic alignment across the 5-year training programmes in basic teacher education and to facilitate a more integrated and cohesive approach in the planning of individual courses taught within these programmes. The INN stairs refer to eight key areas for professional development in teacher education, their context and expected progression. The eight areas include:

(1) *professional orientation* (See Table 1)*;*
(2) *practical training;*
(3) *digital competence;*
(4) *methodological knowledge;*
(5) *communicative skills;*
(6) *interdisciplinarity;*
(7) *assessment*
(8) *internationalisation.*

These eight areas are set into a matrix on the vertical axis, while the horizontal axis is divided into the 5 years of the programme's progression. For each year, a different topic is also in focus: year 1 is on the role of the teacher, year 2 is on the learners, year 3 is on the school, year 4 focuses on the subject, and year 5 on education's role in community and society. Through a collaborative process with many teacher educators, programme administrators, and student representatives, each area of this matrix was elaborated with key themes and target outcomes that should be supported and built upon in a scaffolded manner from year to year.

The use of the progression stairs allows courses to be planned with recognition of the expected outcomes that are supposed to be achieved within a given year of teaching. It also clarifies which types of outcomes the student teachers have also achieved in previous years and can be built upon in future teaching. Within individual subjects in teacher education, the courses have often been planned with sequence from one course to the next. By having the progression stairs as a strategic management tool, this allows for a more comprehensive and integrated approach between different subjects and across the entire study programme. It has also helped to strengthen the relationship between taught modules and praxis periods in more meaningful ways.

Table 1. Progression for the area of professional orientation in INN stairs for teacher education

Year 1	Year 2	Year 3	Year 4	Year 5
● The role of the teacher and identity as a teacher ● Didactics ● Professional community ● Relational competence ● Education and formation	● Differentiated instruction ● Socialisation and identity formation ● Diversity Professional ethics	● The school as an organisation ● Independent action and change competence	● The teacher as a professional practitioner ● Own teacher identity ● Global education, education and knowledge production	● The school in society with an emphasis on the global and local ● Academic and pedagogical innovation ● Lifelong learning

Furthermore, the availability of Micro-degree Programmes (**Box 15**) focused on sustainability topics offers a valuable pathway for teachers to gain specialised credentials and expertise. These focused programmes allow educators to delve deeper into specific areas of interest, such as biodiversity conservation. By acquiring advanced knowledge and skills in these areas, teachers can enhance their credibility as sustainability educators and further strengthen their ability to effectively integrate sustainability into their teaching practices. This not only benefits their own professional development but also equips them to become leaders and mentors within their schools and communities.

Networking and Partnerships

TESD requires a shift from traditional, isolated learning environments to a more interconnected and dynamic ecosystem. Open Schooling embodies this principle by actively engaging with the local community and bringing real-world sustainability challenges into the classroom. This approach creates authentic learning experiences for both teachers and students, fostering a deeper understanding of the complexities and nuances of sustainability issues. By partnering with local organizations, businesses, or experts, teachers can provide their students with first-hand insights, enriching their learning and fostering a sense of responsibility towards their community.

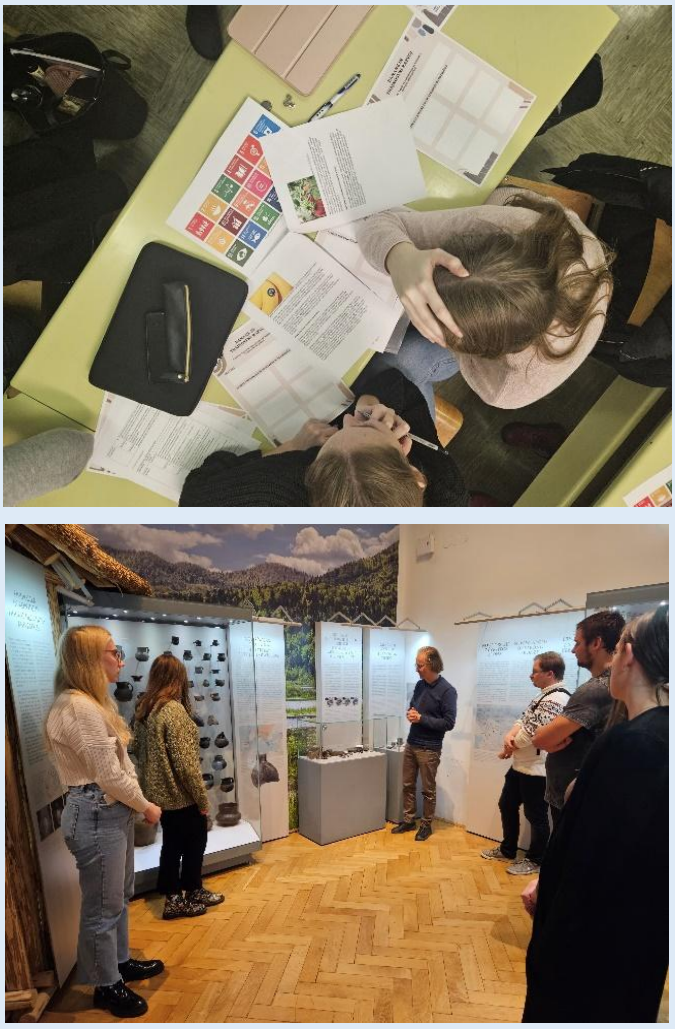
Box 15. Networking for Micro-credentials in TESD
(Gregor Torkar, University of Ljubljana, Slovenia)

Unlike macro-credentials such as diplomas or licenses, which require long and in-depth period of comprehensive study at accredited institutions and programmes, micro-credentials focus on specific skills and limited learning outcomes that can be achieved in a shorter period of time.

At the University of Ljubljana in Slovenia, micro-credentials help cultivate a culture of academic excellence and contribute to the modernization of full-time study programmes at all levels. These credentials facilitate the (rapid) acquisition of relevant knowledge and are in line with the University's commitment to quality education and adaptation to the challenges of the present. By providing targeted, competency-based learning experiences and meeting quality assurance standards, micro-credentials offer a solution to society's changing needs, such as sustainable futures.

In addition, micro-credentials promote innovative learning environments enhancing the value of conventional teaching methods. They are a rapid means of responding to the needs of society, whether to address environmental risks, to create an inclusive and tolerant society or to adapt to the challenges of the future with the so-called professions of the future.

The University offers various teacher education programmes to obtain micro-credentials, which aim to acquire competencies in the field of sustainable development. Its aim is to strengthen interdisciplinarity, authenticity, and transformative pedagogical practices in education that contribute to a more effective green and digital transition towards a sustainable society. Experts from various faculties (in addition to the Faculty of Education, also the Faculty of Social Sciences, the Biotechnical Faculty, the Veterinary Faculty, the Faculty of Fine Arts, etc.) and other stakeholders in education in Slovenia (e.g., Natural History Museum, Zoological Garden, primary and secondary schools, Forestry Institute) participate.



Figures 14. Top: PSTs learning about sustainable consumption; Bottom: PSTs learning about natural resources at museum

Furthermore, promoting Academia-industry Collaboration is essential for bridging the gap between theoretical knowledge and practical application in ESD. By connecting TEIs with businesses and organizations actively working on sustainability initiatives, teachers gain valuable practical knowledge and resources. This collaboration could involve internships where teachers can experience sustainability practices first-hand, guest lectures from industry professionals who can share real-world insights, or joint research projects that contribute to the advancement of sustainable solutions. Such partnerships enrich teacher education programmes and ensure their relevance to the evolving needs of a sustainable society.

Finally, facilitating networking opportunities for teachers is crucial for fostering continuous growth and innovation in ESD. Encouraging participation in conferences, workshops, and online communities allows educators to connect with colleagues, share experiences, and stay abreast of the latest research and best practices. These interactions provide valuable opportunities for professional development, enabling teachers to refine their pedagogical approaches, discover new resources, and contribute to the ongoing dialogue surrounding ESD.

Recommendations

To effectively promote ESD, TEIs need to cultivate a supportive and dynamic environment for educators. This involves fostering collaboration, facilitating connections with external partners, and promoting continuous professional growth. **Box 16** outlines key recommendations for TEIs.

Box 16. Principles and Recommendation to Innovate Practice within TEIs

Principles	Recommendations
Community of Practice	● Establish Professional Learning Communities (PLCs) focused on ESD: Create dedicated time and space for educators to collaborate, share resources, and engage in reflective practice. ● Facilitate cross-disciplinary projects within PLCs: Encourage teachers from different subject areas to work together on ESD initiatives, fostering a holistic understanding of sustainability. ● Implement peer mentoring programmes: Pair experienced ESD educators with newer colleagues to provide guidance, support, and feedback. ● Utilise online platforms and tools: Leverage technology to create virtual communities of practice, enabling collaboration and resource sharing beyond physical boundaries.
Networking and Partnerships	● Promote open schooling initiatives: Encourage collaboration between schools and local communities, bringing real-world sustainability challenges into the classroom. ● Facilitate partnerships with businesses and organizations: Connect teacher education programmes with industry professionals and organizations actively working on sustainability initiatives. ● Organise workshops and conferences on ESD: Provide opportunities for educators to network, share best practices, and learn from experts in the field. ● Support teacher participation in online communities and networks: Encourage engagement with virtual platforms and forums focused on ESD.
Progressive Development	● Establish clear pathways for professional growth in ESD: Define specific goals, milestones, and competencies for educators at different stages of their careers. ● Provide ongoing in-service training on ESD: Offer regular workshops, courses, and training sessions to deepen teachers' knowledge and skills in specific areas of sustainability. ● Develop micro-degree programmes focused on sustainability: Create specialised credentials for educators seeking advanced knowledge and expertise in specific areas of ESD. ● Support teacher engagement in lifelong learning: Encourage continuous professional development through self-directed learning, research, and participation in professional organizations.

Summary

This document outlines a comprehensive framework for Teacher Education for Sustainable Development (TESD), emphasising the crucial role of teachers and educators in driving sustainable change. It identifies five key, interconnected domains for effective TESD: competencies, curriculum, pedagogy, assessment, and institutional context.

Domain 1: Competency

Teacher Education Institutions (TEIs) should develop competency frameworks tailored to educators' career stages and phases of education. These frameworks should prioritise key competencies like adaptability, continuous learning, information literacy, futures thinking, and the ability to facilitate learning beyond the cognitive domain.

Domain 2: Curricula

TEIs should design interdisciplinary curricula that integrate sustainable development topics and ESD methodologies into existing academic subjects. They should also introduce cross-cutting modules focused on ESD. These curricula should emphasise real-world applications and practical modules.

Domain 3: Pedagogy

TEIs should adopt transformative pedagogies, such as project-based learning, place-based learning, and values-based education. They should also integrate nature-based learning and reflective practices to foster critical thinking and ethical decision-making in pre-service teachers.

Domain 4: Assessment

TEIs need to align assessment with ESD principles, emphasising social outcomes and decoupling assessment from traditional grading. Diverse assessment methods, including direct observation, project-based assessments, and performance evaluations, should be incorporated to capture the multifaceted nature of ESD competencies.

Domain 5: Institutional Practice

TEIs should foster a supportive institutional environment by establishing professional learning communities, promoting continuous professional development through structured pathways and in-service training, and building partnerships with external organizations to create a dynamic ecosystem for teacher learning and growth in ESD.

By embracing these five domains – competency, curriculum, pedagogy, assessment, and institutional context – TEIs can ensure that educators are well-equipped to effectively integrate sustainability into their teaching practices. This comprehensive approach will not only enhance the quality of teacher education but also empower students to become informed, engaged, and responsible citizens who are prepared to address the complex challenges of a rapidly changing world. Ultimately, investing in robust and comprehensive TESD programmes is an investment in a more sustainable and equitable future for all.

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Annex

Principles and Recommendations to Innovate TESD

Domain 1: Competency		
Category	**Examples**	**Recommendations**
General Competencies	Adaptability and Resilience	■ Design learning experiences that challenge assumptions and encourage flexibility. This might involve case studies, simulations, or real-world problem-solving activities that require teachers to adapt their thinking and approaches. ■ Provide opportunities for reflection and feedback. Encourage teachers to reflect on their experiences, identify areas for growth, and receive constructive feedback from peers and mentors. ■ Model adaptability and resilience. Teachers should exemplify these qualities in their own practice, demonstrating a willingness to embrace new ideas and learn from setbacks.
	Continue Learning How to Learn	■ Foster a culture of inquiry and experimentation. Encourage teachers to ask questions, explore new ideas, and try out different pedagogical approaches in a safe and supportive environment. ■ Provide access to diverse learning resources and opportunities. Offer a range of professional development opportunities, including workshops, online courses, conferences, and mentorship programmes. ■ Encourage collaboration and knowledge sharing. Create opportunities for teachers to learn from each other and share their experiences and expertise.
	Information Literacy	■ Integrate critical media literacy into teacher education curricula. Teach teachers how to evaluate information sources, identify bias, and recognise misinformation and disinformation, especially in the context of online media and AI-generated content. ■ Provide training on effective use of digital tools and technologies. Equip teachers with the skills to use technology for research, communication, collaboration, and creating engaging learning experiences. ■ Model responsible technology use. Teachers should demonstrate ethical and responsible use of technology in their own practice.
Specific Competencies	Futures Thinking	■ Integrate futures studies and value-based systems thinking into teacher education. Introduce teachers to tools and methodologies for envisioning future scenarios, identifying potential challenges and opportunities, and designing innovative solutions for a sustainable future. ■ Engage teachers in participatory futures activities. Facilitate workshops and projects where teachers can collaboratively explore future possibilities, develop scenarios, and create action plans for a sustainable future.
	Facilitate Learning Beyond Cognitive Domain	■ Provide training on experiential and emotional learning. Equip teachers with strategies to engage students' emotions, values, and senses in learning about sustainability. This might involve using storytelling, outdoor education, arts-based activities, and service-learning projects. ■ Encourage teachers to create action-oriented learning experiences. Support teachers in designing projects and activities that empower students to take action for sustainability in their schools and communities.

Domain 2: Curricula	
Principles	**Recommendations**
Interdisciplinary Frameworks	• Establish interdisciplinary teaching teams composed of faculty from various disciplines to collaboratively develop and deliver ESD modules. • Create professional learning communities or collaborative platforms where pre-service teachers from different subject areas can work together on ESD projects, sharing their perspectives and expertise. • Organise workshops or seminars that bring together faculty and pre-service teachers from different disciplines to discuss and explore the interconnectedness of sustainability issues.
Real-World Focus	• Integrate real-world case studies and problem-based learning activities into ESD modules, allowing pre-service teachers to analyse and address local sustainability challenges. • Facilitate field trips and site visits to local communities, organizations, or ecosystems to provide pre-service teachers with first-hand experience of sustainability issues. • Encourage pre-service teachers to conduct research on local environmental issues, analyse data related to resource consumption in schools, and develop action plans to promote sustainability in their future classrooms.
Practical Modules	• Develop practical modules that provide opportunities for pre-service teachers to apply their knowledge and skills in real-world settings, such as conducting environmental audits of schools, designing sustainable solutions for school facilities, or creating community gardens. • Partner with local organizations and community groups to provide pre-service teachers with opportunities to engage in community-based sustainability projects. • Incorporate service-learning components into ESD modules, allowing pre-service teachers to apply their learning while contributing to their communities.

Domain 3: Pedagogy	
Principles	**Recommendations**
Transformative Pedagogies	• Model transformative pedagogies in TEIs courses. Demonstrate active learning strategies, inquiry-based approaches, and collaborative projects within teacher education programmes. • Provide training and support for diverse pedagogical approaches. Equip teacher educators with the knowledge and skills to implement project-based learning, place-based learning, values-based education, nature-based learning, and outdoor education. • Integrate real-world sustainability issues into teacher education curricula. Design courses and assignments that engage pre-service teachers with authentic sustainability challenges and encourage them to develop solutions. • Cultivate critical thinking and problem-solving skills in future educators. Embed activities and assessments that challenge pre-service teachers to analyse complex situations, evaluate evidence, and develop creative solutions to sustainability problems.
Co-Creating Futures	• Design collaborative learning environments within TEIs. Structure teacher education programmes to emphasise teamwork, peer learning, and knowledge sharing among pre-service teachers. • Promote interdisciplinary approaches to sustainability education. Offer courses or modules that integrate perspectives from various disciplines to provide a holistic understanding of sustainability challenges. • Facilitate partnerships with communities and organizations. Create opportunities for pre-service teachers to engage with local communities and organizations on real-world sustainability projects. • Integrate futures thinking into teacher education. Provide pre-service teachers with tools and frameworks for envisioning and designing sustainable futures.

Reflective Practice	• Embed reflective practices throughout teacher education programmes. Incorporate self-reflection activities and assignments into courses to encourage pre-service teachers to examine their own values, biases, and assumptions related to sustainability. • Facilitate critical dialogue on sustainability issues. Create spaces for pre-service teachers to discuss ethical dilemmas and diverse perspectives on sustainability challenges. • Promote culturally responsive teaching practices. Equip pre-service teachers with the knowledge and skills to address issues of equity, inclusion, and justice in their future classrooms. • Introduce reflective tools and methods. Train pre-service teachers to use journaling, group discussions, and case study analysis as tools for reflection.

Domain 4: Assessment	
Principles	**Recommendations**
Assessing Social Impacts	• Develop tools and strategies for effectively assessing the social outcomes of ESD initiatives, such as changes in attitudes, behaviours and community engagement. • Encourage educators to consider the broader social impact of their teaching and how to evaluate its effectiveness. • Promote participatory approaches to assessment that involve students and community members in evaluating the social impact of ESD initiatives.
Decoupling Assessment from Grading	• Explore alternative assessment approaches that prioritise feedback and the learning process over traditional grading systems. • Encourage the use of formative assessment strategies, such as self-reflection, peer feedback, and teacher observation, to provide ongoing support for student learning. • Facilitate discussions on the purpose and limitations of grading in the context of ESD and explore ways to shift the focus towards learning and growth.
Assessment as Lifelong Learning	• Support teachers in developing their understanding and practice of assessment for ESD as a continuous process of learning and improvement. • Provide professional development opportunities that focus on innovative assessment approaches and their role in promoting lifelong learning. • Encourage teachers to engage in reflective practice and action research to refine their assessment strategies and better support student learning.

Domain 5: Institutional Practice	
Principles	**Recommendations**
Community of Practice	• Establish Professional Learning Communities (PLCs) focused on ESD: Create dedicated time and space for educators to collaborate, share resources, and engage in reflective practice. • Facilitate cross-disciplinary projects within PLCs: Encourage teachers from different subject areas to work together on ESD initiatives, fostering a holistic understanding of sustainability. • Implement peer mentoring programmes: Pair experienced ESD educators with newer colleagues to provide guidance, support, and feedback. • Utilise online platforms and tools: Leverage technology to create virtual communities of practice, enabling collaboration and resource sharing beyond physical boundaries.
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Recommendations for Innovating Teacher Education for Sustainable Development: An International Perspective

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