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Teacher education for the green transition and sustainable development

Analytical Report

Education and Training

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EUROPEAN COMMISSION

Teacher education for the green transition and sustainable development

Analytical Report

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2023 Directorate-General for Education, Youth, Sport and Culture
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ABOUT EENEE

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Executive summary

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The move to a greener future requires that we all learn to live and work in more sustainable ways. Teacher professional learning has been identified as one of the most significant catalysts for bringing innovation and sustainability into our education systems, and thus equipping learners to contribute to this transition.

Importantly, in June 2022 the European Union (EU) has adopted a Council Recommendation on learning for the green transition and sustainable development. This Recommendation formally calls for learning for sustainability (LfS) to become a key priority area in education policies and programmes, and for support to be given to educators through training and professional development in this area. Learning for sustainability is concerned with building the knowledge, skills, values and attitudes to engage with the major issues threatening both people and planet.

This analytical report reviews documented research and good practices in relation to effective teacher education for sustainability, with the purpose of informing policy decision-making and frameworks in this area. Its findings and recommendations have been drawn from an extensive literature review, and are supported by a Key Informant Group that has helped to identify blind spots and check the validity of the research and experiences presented.

Current LfS experiences in schools and teacher education

Although LfS is not a curriculum priority in most jurisdictions, its coverage, scope and depth in schools have improved significantly over recent years. However, various obstacles still hinder the process of embedding LfS into school education. These include the structuring of curricula around single subjects, and the greater emphasis currently placed on the cognitive domain of sustainability in comparison to socio-emotional or action learning. Currently, only individual champions and some eco-schools are taking the lead by considering more transformative forms of learning. This is no surprise, since most teachers have not been trained to design, facilitate and assess learning experiences of this nature.

Although teachers are generally aware and committed to teaching for sustainability, many do not feel ready to do so. Current LfS efforts in teacher education tend to be isolated and fragmented, instead of being mainstreamed into existing professional learning programmes for teachers, or in day-to-day practice. In initial teacher education (ITE) programmes, LfS often takes as the form of one-off curriculum development projects, and occurs primarily in geography and science courses. In continuing professional development (CPD) programmes, it is often characterised by one-time, theoretical and decontextualised sessions for groups of individual teachers seeking to improve their teaching practice.

Many teachers are eager to continue learning about sustainability through professional development. Although they are aware that opportunities in this area exist in their countries, they recognise that they have not taken these up. Thus, it is important to assess what is preventing them from engaging in sustainability training, as well as whether and how their participation is incentivised and recognised.

The review also highlights the key role that teacher educators play in guiding teachers at all stages of their careers. Despite this, some countries often neglect to identify this key group at policy level, or fail to give them the professional development support they need.

Teachers and competences for the green transition

Over recent years, numerous sustainability competence frameworks for teachers have been developed and piloted. However, these have had little impact on teacher education to date. Their complexity and divergence from dominant practice make them difficult to embed into an already densely packed teacher education curriculum.

Designing teacher education that includes LfS competences requires existing frameworks to be adapted so that they consider micro-contexts (individual teachers or teacher candidates and programmes), meso-contexts (institutions), and macro-contexts (education and social systems). Most studies have concluded that professional development involving substantial contact hours over a long period of time is more effective in developing teacher competences. Also, teachers learn most effectively when programmes are content focused, use active learning, support collaboration, are school-based, use modelling of effective practice, provide mentoring support, and offer opportunities for feedback and critical reflection.

Catalytic entry points to change teacher education

This report proposes eight catalytic points and actions that can provide some of the core pathways for changing the provision and mainstreaming of LfS in teacher education:

1) **LfS as a political and policy commitment:** this report identifies that political commitment and leadership at the highest levels has proven to be catalytic in the drive to change and embed LfS into teacher education. A connected or 'whole-of-government' approach to LfS enhances the reach of policies. Similarly, the alignment of initiatives with national policy agendas or priorities is seen as increasing the chances of successfully embedding LfS into teacher education.

2) **Professional competences and standards – driving quality throughout schools:** embedding LfS into teacher professional standards is one of the most effective ways to mainstream sustainability and promote quality learning experiences. Establishing expectations and pathways for teachers to develop competences in LfS over the course of their careers is also an impactful way to embed learning about sustainability in schools.

3) **Recognition and reward – incentivising and motivating teachers:** recognition schemes can incentivise educators to delve into or deepen their engagement with LfS. The inclusion of LfS criteria in role descriptions and the responsibilities of positions has also been shown to be effective in upscaling sustainability learning efforts. It incentivises teachers and teacher educators to seek professional development in this area, and offers recognition of their expertise in this area.

4) **Micro-credentials and the certification of learning:** micro-credentials provide new avenues and great potential for driving LfS in schools and teacher education in the near future. Further experimentation is necessary regarding how to develop and use micro-credentials in LfS; the challenge is to provide micro-credentials that are flexible and relevant, and which offer equal opportunities to certify professional competences, so that the certification is relevant and comparable between Member States.

5) **Resources for a sustainable future:** the value of developing teacher resources to support LfS is well recognised, and has been shown to be key to mainstreaming educational initiatives in schools. National agencies that are seeking to reorientate the course of teacher education towards sustainability could consider developing or adapting resources. Such resources must clearly and explicitly identify objectives that align with teachers' needs in this area, and should be based on extensive piloting and cycles of improvement.

6) **Changing together - collaborative inquiries and peer learning:** LfS networks and platforms have proved instrumental in activating a cultural change both in schools and in teacher education, especially where there is a lack of dedicated support from government or of sub-regional opportunities in relation to LfS. Participatory research approaches and change academies have also been identified as providing ideal platforms for institutions to challenge their perceptions and misconceptions regarding sustainability, as well as to clarify what it means to create authentic learning opportunities in this area.

7) **Framing LfS as educational innovation or renewal:** efforts that articulate the wider value of LfS in education and to learners, beyond immediate concerns with the environment and sustainability, can deepen the engagement of teachers and educators. Such efforts are effective in reaching those teachers who are yet to commit to sustainability, but who have an interest in educational quality or creating better opportunities for students. In addition, initiatives that connect LfS with the reform of educational pedagogies more broadly, and with other educational agendas such as the digital transition, have greater chances of success.

8) **Fresh insights and visions - futures education and new technologies:** research suggests that connecting teachers with research institutions and groups engaging in with futures and digital learning projects can inspire these teachers to rethink their practices in the light of sustainability. Such approaches offer significant potential to shape learning experiences in LfS and to consider alternatives futures with the help of new technologies. However, it must be recognised that while some teachers are captivated by digital innovation, others fear the changes that technology might bring.

Recommendations

The report proposes the following recommendations, framed primarily for policy makers:

- **Recommendation 1. Celebrate** by visibly showcasing political leadership and policy commitment towards LfS by specific EU Member States, within the context of teacher education. Such examples will attract the attention of others to this agenda. Similarly**,** promote a 'whole-of-government' response to LfS that leads to integrated policy and use of resources. This could be achieved by documenting and celebrating best practice.

- **Recommendation 2. Convene** authorities, agencies and professional groups to consider how best to embed LfS into professional standards or competence frameworks of teachers. Integrate LfS into definitions of what it is to be a qualified and effective teacher. Establish expectations, evaluation systems and pathways for teachers to develop and demonstrate competences in this area. It is important that this is achieved through collaborative processes securing the involvement of the teaching profession.

- **Recommendation 3. Promote** the use of self-evaluation approaches and reflective practice tools to drive the development of teachers' competences in LfS. This should be

carried out by establishing networks of teachers, evaluators and 'critical friends' that encourage deep reflection and challenge current practices. Consideration should be given to generating guidelines and tools in this area.

- **Recommendation 4. Recognise** best practice in schools, colleges and teacher education, as well as outstanding educators in LfS, through the use of award schemes. A European-wide competition would not only motivate engagement but also trigger conversations about what constitutes best practice in this area. Member States could establish their own processes and nominate candidates, encouraging them to consider what best practice in LfS looks like.

- **Recommendation 5. Create,** through grants and funding schemes, spaces for teachers and teacher educators to grow LfS projects through teacher collaboration and peer-learning. Encourage authorities and agencies to provide similar collaborative learning pathways at national and sub-regional levels.

- **Recommendation 6. Incentivise** teachers to develop their competences and experiences in LfS. Include sustainability criteria into role descriptions, the responsibilities of positions, and in career progression profiles. A publication that captures the best of these examples could help to inspire others.

- **Recommendation 7: Support** teacher education providers through targeted schemes that provide funding, networking platforms and other resources to assist them in integrating LfS into their professional education and development offerings. Such efforts should be aimed at initial and practising teachers, as well as headteachers and education leaders.

- **Recommendation 8. Encourage** the certification of LfS training through micro-credentials. These micro-credentials should be flexible, relevant, offer equal opportunities to teachers, and be transferrable. The European Commission could work alongside relevant stakeholders to support experimentation and piloting in this area.

- **Recommendation 9. Advance** the development of resources for teacher education providers by promoting efforts that address LfS as a pedagogical strategy through a whole-school approach. Work with stakeholders to ensure that these resources are relevant to teachers' needs in this area (and not simply environmental objectives), and are based on extensive piloting and cycles of improvement.

- **Recommendation 10. Develop** guidelines and a set of criteria to evaluate the effectiveness of LfS professional development programmes and resources offered by teacher education providers. Encourage the adaptation of these guidelines at national and sub-regional levels, and for the particular stakeholder groups.

- **Recommendation 11. Raise awareness** of the importance of multi-stakeholder platforms that provide professional learning opportunities and facilitate access to LfS materials, especially where there is a lack of dedicated support from government or of sub-regional opportunities in relation to sustainability learning.

- **Recommendation 12. Invest** in participatory action research and change academies that enable stakeholder groups to develop and implement strategic actions with regard to LfS in policies, programmes and practice. Encourage national authorities, professional bodies and other stakeholders to support these processes.

- **Recommendation 13. Define** the value of LfS to learners, and demonstrate how it can contribute to meeting core educational priorities. This will attract the attention of those teachers who are not yet engaging with sustainability, but who may be curious to learn more.

- **Recommendation 14. Connect** programmes and funding schemes that encourage better alignment between the digital and green transitions in teacher education, as a way of increasing the uptake of LfS by teachers. Encourage authorities and agencies to do likewise.

- **Recommendation 15. Inspire** greater engagement with LfS by encouraging teachers and teacher educators to work with research institutions and groups engaging with futures and metaverse learning projects. Form partnerships that will encourage teacher education providers to experiment with these areas, and explore ways to transgress the boundaries of current educational approaches.

Definitions

Catalytic entry point is understood as a focal point from which actions are shown to have a ripple effect across the teacher education system.

Continuing professional development (CPD) is a process by which practising teachers enhance their personal and professional competences through active and contextualised forms of learning, inquiry and reflection. The terms 'continuous professional learning' or 'in-service education/training' are also used to refer to this process of teacher development. There are many different types of CPD providers, including higher education institutions; ministries, authorities and other public bodies responsible for education; schools; private businesses; associations; and other non-commercial organisations.

Decolonisation of education involves examining the limitations and biases of the current curriculum and educational experiences, to identify power relationships in learning and knowledge.

Embedding refers to efforts that seek to integrate sustainability into learning, management and administrative systems, so that all learners have the opportunity to experience LfS, regardless of their year group, class or programme selected. The terms 'embedding' and 'mainstreaming' are often used interchangeably. The latter term recognises that some relevant practices exist, but may currently be limited to the margins.

Green transition refers to policy measures and collective actions that will lead societies to address the sustainable development challenge in a just and inclusive way. In the EU, the European Green Deal (2020) constitutes the key transition strategy. This seeks to address climate change, boost the economy through green technology, and cut pollution. The green transition is both a challenge and a priority for education.

Initial teacher education (ITE) is the basic and compulsory period of training for a teacher to develop the key competences needed to perform their role effectively in the classroom, school and/or wider community. Such education is mostly offered by teacher education institutions, colleges, institutes, universities and schools.

In-service teacher refers to a teacher who holds a teaching qualification and is already teaching and creating learning experiences.

Interdisciplinary learning enables teachers and learners to make connections between subjects and disciplines by exploring clear and relevant links across the curriculum. It supports the use and application of what has been taught and learned in new and different ways. Interdisciplinary learning provides opportunities to deepen learning; for example, by addressing complex questions, exploring an issue, solving problems, or completing a final project.

Learning for sustainability (LfS) is an approach to life and learning that engages people in envisioning and transitioning towards a more sustainable future. It encompasses sustainability education, sustainability learning, education for sustainable development (ESD), environmental education, and other concepts aimed at transforming education towards sustainability. These terms are used interchangeably throughout the report.

Pre-service teacher refers to a teacher candidate or student teacher who is enrolled in a teacher education programme and pursuing a teaching qualification, licence or certification.

Sustainable development recognises that societies must strive "to meet the needs of present communities without compromising the ability of future generations to meet their own needs" (UNGA, 1987). Achieving sustainable development requires more than simply technical and scientific solutions, and involves fundamental changes in how we think and live. It is often mistaken as being solely about environmental matters, when in fact it centres upon quality-of-life issues that connect environmental, socio-cultural and economic concerns. In this report, the terms 'sustainable development' and 'sustainability' are used interchangeably.

Teacher educator is a term used to refer to a university or school educator or a college or community trainer tasked with developing pre-service or in-service teachers.

Teacher education (sometimes known as teacher training) is a term used to describe the development of prospective or existing teachers. It includes references to policies, procedures and provisions designed to develop teachers' professional competences so that they can effectively create or facilitate learning in the classroom, school and wider community. The term can include professional development activities during the initial, induction and in-service training of teachers, as well as informal learning opportunities that can occur through peer interaction and networking.

Transformative pedagogies consist of active learning approaches that question teacher-centred dynamics. They empower students by giving them choice and control over aspects of the learning exchange. Terms often associated with this form of learning include 'action learning', 'participatory learning' and 'holistic learning'. These pedagogies are regarding as being crucial to LfS.

Whole-school approach seeks to embed sustainability across an institution, and adopts a systemic view of education as creating opportunities for sustainability in living and learning. By adopt this approach, institutions connect what students learn through the curriculum with what is practised by the school through its management, operations and procurement as well as outreach. The whole-school approach also seeks to take learning outside of the classroom by engaging students in school decisions and involving them in projects within local and global communities.

Chapter 1. Context and background

The policy landscape

The European Green Deal is an ambitious plan to fight climate change and stop environmental degradation (European Commission, 2020a). It aims to make Europe climate neutral by 2050, with a set of interconnected goals that seek to transform every aspect of society and the economy. The Green Deal recognises that each sector must contribute to achieving transformational change and that education and learning have a key role to play in helping learners develop and strengthen their sustainability competences.

The contributions of education and learning to advancing the green transition are also recognised by other key European Union (EU) policies. These include the Biodiversity Strategy for 2030 (European Commission, 2021), the EU Skills Agenda (European Commission, 2020b), and the European Education Area Council Resolution (Council of the EU, 2021a). This policy landscape presents a consistent and connected approach to learning for the green transition. Importantly, the EU has recently adopted a Council Recommendation on learning for the green transition and sustainable development (Council of EU, 2022b), which urges member states to:

- make learning for sustainability (LfS) a key priority area in education and training policies and programmes;
- provide LfS opportunities at all levels of education and in all settings;
- provide infrastructure, resources and tools to implement LfS; and,
- support educators through training and professional development in this area.

At the global level, there has been a significant push for change arising out of the Agenda 2030 for Sustainable Development, and its Sustainable Development Goals (SGDs) (UNGA, 2015). In parallel, the United Nations Educational, Scientific and Cultural Organization (UNESCO) Strategy on Education for Sustainable Development (ESD) for 2030 (UNGA, 2020), and the Framework for the Implementation of the United Nations Economic Commission for Europe (UNECE) Strategy for ESD from 2021 to 2030 (UNECE, 2022a) continue to strengthen policy levers and extend the role of education and learning in advancing change towards a sustainable future.

The Berlin Declaration on ESD (UNESCO, 2021a) notably recognises that education and learning are fundamental not only to achieving SDG 4 on quality education, but also acting as anchors for the rest of the SDGs. This is best understood through the approach promoted by LfS, which seeks to engage people and communities in life and learning processes that help them envision and transition towards a more sustainable world. Keywords that are commonly used to define LfS are: participative, interdisciplinary, iterative, lifelong, futures-oriented, and values-based (Sterling, 2014). The Council of the EU (2022b) describes it as the:

> "learning and teaching we need for personal, societal and environmental well-being now and in the future. It can be understood as an umbrella under which all subjects and disciplines have a contribution to make. Learners need to understand the interconnectedness of economic, social and natural systems and

move from awareness to individual and collective action and empowerment." (p.8)

Transforming education and learning

LfS seeks to change the way we view learning content, outcomes, pedagogy, learning environments and assessment (UNESCO, 2020). It employs learning approaches that promote emancipatory pedagogical strategies, such as critically reflective thinking, systems thinking, participatory learning and interdisciplinary learning, but also more disruptive learning pedagogies, such as futures thinking, place-based learning, transformative learning, and learning for action (Sterling, 2012; Tilbury, 2011; Tilbury & Wortman, 2004). These pedagogies are needed to enable people to develop the capabilities necessary to effectively address issues such as climate change. They challenge the traditional teacher-student relationship, and call on educators to rethink the learning dynamic. LfS requires that we move beyond adding content to the curriculum and questioning pedagogical practices, to shifting educational principles and pedagogical approaches so that they are more learner-centred and learner-driven. Research confirms that the latter is not yet common practice in education (Reid et al., 2021). These educational perspectives are also advocated by other 'new' cross-cutting educational priorities such as digital education and media literacy. LfS differs from these, however, in that it engages the learner in clarifying values, creating a vision and taking action for a better future.

More than three decades of research attest to the value of adopting a whole-institution/whole-school approach to taking LfS forward (Mogren et al., 2019). Such an approach helps to connect student learning with what is practised by the institution or school through its management, operations, procurement and outreach (Tilbury & Galvin, 2022). It also involves taking learning outside the classroom by engaging students in school decisions, community projects and global initiatives (Henderson & Tilbury, 2004).

Teacher education as the priority

The literature consistently suggests that although structures and processes differ between countries, teacher education is the most significant catalyst for introducing sustainability innovation and reshaping educational learning opportunities across the education system (Ferreira et al., 2009; Fischer et al., 2022; UNGA, 2020). Evidence confirms that teacher education has a positive impact on student sustainability learning (Andersson, 2017; Kadji-Beltran et al., 2014; Kostoulas-Makrakis, 2010) and increases teachers' motivation and willingness to embrace sustainability in their classrooms (Andersson et al., 2013). Ultimately, effective teacher education for sustainability is a key stepping stone for the green transition, as it translates directly into the development of sustainability competences of citizens – who can, in turn, advance the transition towards sustainable development (Fien & Maclean, 2000). It is for this reason that teacher education for sustainability is considered the 'priority of priorities' (UNESCO-UNEP, 1990).

In past years, there has been a clear increase in demand for initiatives that prepare teachers in LfS, and a growing perception that the process of embedding sustainability into teacher education is underway (Bourn et al., 2017). Evidence suggests that an increasing percentage of teacher education institutions worldwide are experimenting with how to integrate LfS into teacher education (McKeown & Hopkins, 2014; UNESCO, 2014). Notably, Fischer et al. (2022) undertook a recent review of the literature and found that there has been a rise in the amount of innovative research published in the area of teacher education for sustainability. This focuses on five types of enquiry: designing learning environments, understanding learner attributes, measuring learning outcomes, promoting systems

change and advancing visions in the field of teacher education for sustainability. This report will present some of the findings of this work by highlighting current practice and concerns in the field.

Despite progress having been made, the approach by which LfS has been integrated into Initial Teacher Education (ITE) and Continuing Professional Development (CPD), and the extent to which this has been achieved, have been questioned by many critical voices. Critics claim that sustainability learning remains an aspiration, rather than an experience that is commonly present in teacher education (Ferreira et al., 2009; Wals, 2009). Agreement exists within the international community that there is an urgent need to increase efforts, in order to position LfS away from the margins and into the mainstream (McKeown & Hopkins, 2015). According to Ferreira et al. (2007, 2012), this requires going beyond the simple addition of LfS into the curriculum and implies a wide-scale reorientation of the entire teacher education system towards sustainability. These authors advocate for a whole-of-system approach to teacher education that involves a deep, contextual understanding of the nature and process of change, which should lead to LfS becoming an integral part of policies, core curriculum and everyday pedagogical activities.

Whereas at the institutional level we can find promising case studies of schools and teacher education institutions adopting whole-school approaches to sustainability (see Mathie & Wals, 2022), only a handful of initiatives currently address change across the wider education system. The most promising effort to date comes from Australia. The 'Embedding Change Model' (Ferreira et al., 2019) has been piloted in numerous teacher education institutions, and has demonstrated change for sustainability within and across the education system. Ferreira et al. (2007) justify the absence of these types of approaches by pointing to the complex nature of the education system. This complexity necessitates a comprehensive understanding of the particular contexts within which teacher education operates, and the barriers that emerge when challenging the status quo.

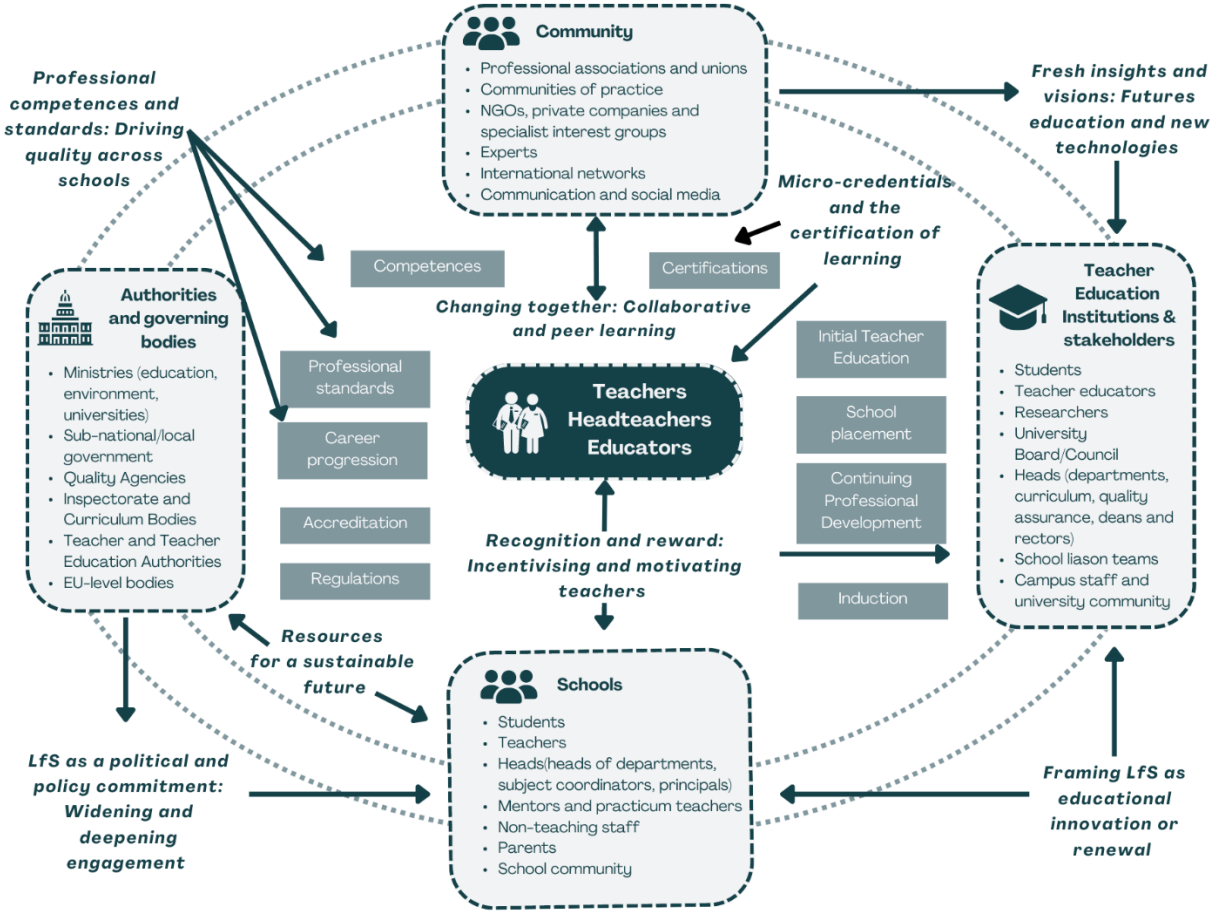
The teacher education system

This research reviews the documented studies and initiatives relating to teacher education for sustainability; some of these are outlined above and help to identify avenues for the advancement of learning and education for sustainability in EU policy and practice. In researching and reviewing this work, it has become necessary to define the teacher education system and identify the multiple agencies and stakeholders involved (see Figure 1).

The authors of the report acknowledge that the components of the system will vary between EU Member States, as every country (and region) will possess its own distinctive structures, processes and practices. However, significant commonalities do exist, and these enable the authors to map the system in ways that are relevant across the European region. This map can help policymakers address the needs of diverse stakeholders, identify gatekeepers that can influence teacher education practice, and define the catalytic entry points (shown in *italics*) to the teacher education system. In this study, we refer to catalytic

entry points as focal points at which actions have been shown to have a ripple effect across the system. These are further described in Chapter 5.

Figure 1. Teacher education system and catalytic entry points for mainstreaming LfS



Those engaged in mainstreaming LfS in teacher education are encouraged to map their own system, perhaps using Figure 1 as a guide. The map could be adapted to highlight the key influencers in the system, depicting their relationships using thin or bold lines. Equally, components of the system could be moved around the map to denote how central they are in determining the provision of teacher education; the latter will vary between countries and sometimes at sub-regional level.

Chapter 2. Scope and methodology

Aim and scope

The overall aim of this analytical paper is to review documented research and good practice relating to effective teacher education for sustainability, with the purpose of informing policy decision-making and frameworks in this area. Particular attention is paid to identifying enablers and obstacles.

The research focuses its attention on teacher education and development as it relates to primary and secondary school teachers. It extends its review to the development of teachers' competences in relation to LfS, with a special emphasis on identifying supportive policies, frameworks and resources that can easily be used and scaled up by EU Member States.

Case studies, primarily from Europe, have been selected to showcase efforts relating to governance, quality frameworks, teaching standards, implementation mechanisms, networks and support initiatives that advance the embedding of sustainability in teacher education (see Appendix 1). These case studies were not chosen to represent best practices, but as examples that can help illustrate different entry points into the teacher education system, and which could potentially effect positive change in teacher education for sustainability.

This chapter describes the objectives and methodological approaches of the study. A snapshot of current policy and practices relating to teacher education in LfS is provided in Chapter 3. Chapters 4 and 5 describe the professional development opportunities and catalytic entry points that could transform teacher education, enabling it to contribute to the green transition. Lastly, a set of recommendations is proposed that builds upon the key messages arising from this review and considers the diversity of actors engaged in the teacher education system.

Research methodology

The findings and recommendations of this report have been drawn from a literature review based on two main types of source material. First, the authors examined a selection of recently published scholarly articles in journals addressing LfS issues and themes. Second, they collected key evidence from recent reports, policy documents and position papers published by the European Commission, UNESCO, UNECE, and OECD.

To identify peer-reviewed papers that discuss LfS practices in school and teacher education, several searches were performed using the Education Resources Information Center (ERIC) and Google Scholar databases. These search engines were selected after careful review and consideration. An initial screening of the literature included a general search of the titles, abstracts and keywords of journal articles using terms such as 'teacher education' OR 'teacher training' AND 'learning for sustainab*' OR 'education for sustainab*' OR 'environmental education'. To narrow down the search and to research particular sections of the report, more specific keywords were used ('schools' AND 'sustainab*'; 'whole school approach' AND 'sustainab*'; 'continu* professional development' AND 'teacher' AND 'sustainab*'; 'principal' AND 'sustainab*'; 'teacher educator' OR 'teacher trainer' AND 'sustainab*'; etc.). In addition, other references and papers were included through citation chasing. Articles were selected by taking into consideration their quality and contribution to assessing, critiquing and synthesising key literature. Certain articles describing particular case studies were also selected to illustrate key points of importance.

All of the articles selected have enabled the authors to describe key perspectives within the area and to identify future pathways, rather than merely describing the literature available in the field.

The report has been guided and informed by the experience of the authors, who have expertise in the areas of teacher education and sustainable development and have been engaged in informing policy frameworks and practices for more than three decades. Their knowledge and experience have guided the selection of publications and ensured that the review is comprehensive. The Key Informant Group (KIG) has played an important role in identifying any blind spots the authors may bring to the study, and in checking the validity of the research and experiences presented. Members of the KIG were consulted at the start of this research, when the authors sought their advice on the framing of the study, as well as in the selection of case studies. These informants also provided a peer review of the final report.

In addition, the work was guided by the European Commission contact points Ulrike Pisiotis and Deirdre Hodson, as well as Hanna Siarova from PPMI. The authors are grateful to them as well as to the members of the KIG (see Appendix 2) and the key contact points for the case studies (see Appendix 3), who were also consulted. Thanks are also extended to the members of the School Learning for Sustainability Working Group, which met in Budapest in November 2022 to discuss the findings presented in this report.

Limitations

The findings of this study should be viewed in the light of certain limitations:

- The report primarily focuses on, although it is not limited to, Europe. This means that some relevant peer-reviewed literature and examples of good practice from outside Europe may not have been included.
- The findings of the paper are primarily based on secondary data accessed through a literature review. Thus, the authors' subjectivities in the interpretation of other authors' work must be recognised. Collecting primary data – for example, through interviews – would have helped the authors to provide a more accurate or detailed description of practices in teacher education for sustainability.
- Due to time limitations, only two databases were screened, and only a selected number of papers were reviewed in-depth.
- Although more than 200 languages are spoken in Europe, given the scope of the study, publications mostly in English were considered.
- At the time the study was conducted, new initiatives were taking root, such as the first funded Erasmus+ Teacher Academies – three of which focus on teacher competences related to sustainability. The authors acknowledge that in a few years, richer data will be available from these examples.

Key Informant Group

The KIG was set up at the beginning of the review to:

- help frame the study and define its boundaries;
- identify key literature and case studies;
- review and provide feedback on the first draft version of the report; and

- validate findings and help formulate recommendations.

The experts that comprise this KIG are mostly based in Europe and have been selected for their first-hand knowledge and expertise in teacher education, professional learning and/or sustainability (see Annex 2). Efforts were made to recruit a diverse group with experience from across government, university, school and NGO sectors, as well as to provide wide geographical representation across Europe. An international expert from Australia was also included, given her invaluable international expertise and unique perspective on the topic covered. The members of the KIG were asked to participate in an online meeting in July 2022, during which the study was presented and its key ideas discussed. Online communication was then maintained throughout the writing process and the written reviews of KIG members informed the final version of the report.

Chapter 3. What *is*: an overview of LfS experiences in schools and teacher education

Overview of current school experiences

This section provides an overview of the environment currently faced by teachers in relation to LfS. It is important to understand this context when considering the provision and experiences of teacher education, as there is a dialectical relationship between school practices and teacher education outcomes.

Multiple international efforts (e.g. the UN Decade of Education for Sustainable Development [DESD]) have influenced the development of national policies on LfS (Clayson, 2013; Mulà & Tilbury, 2009, 2011; UNESCO, 2014). In addition, social movements have questioned the purpose and practices of educational institutions in times of climate emergency (Kvamme et al., 2022). For example, the Friday for Futures movement and school strikes have seen students calling for a rethink of curriculum priorities and the embedding of climate learning opportunities (Lotz-Sisitka & Rosenberg, 2022).

A recent European study reveals that although LfS has not yet become a priority focus in education, its coverage, scope and depth have improved significantly over recent years (Mulvik et al., 2021). However, the research has detected great variation in the ways in which LfS is addressed by national policies and practised in schools across the region. This implies that learners have diverse and unequal experiences depending on the country in which they are educated or the school they attend. As a result of these factors, their learning and ability to address sustainability will vary (European Commission, 2022b).

The research of Mulvik et al. (2021) points to approximately one-third of EU Member States favouring an interdisciplinary approach to LfS in primary and secondary education. These authors§ also highlight that over half of EU countries have defined competence frameworks or learner outcomes to frame their goals and experiences in relation to sustainability. Meanwhile, only a small number view the curriculum as an important component of a whole-school approach to sustainability. This could be explained by the realisation that embedding sustainability into the culture of a school is a complex endeavour (Gough et al., 2020) that requires committed educational leadership teams (Mogren & Gericke, 2016, 2019). Another explanation might be that curriculum content is determined at a central level, while whole-school approaches are driven by actors internal to the school.

As a general trend, primary education schools appear more open and less constrained in engaging with innovative interdisciplinary sustainability practices. Secondary schools, meanwhile, appear to be better positioned to more deeply explore fundamental questions regarding the social structures and agency we require for a green transition (European Commission, 2022b). However, the structuring of curricula around single subjects, especially in secondary education, appears to be a key obstacle to further embedding the interdisciplinary nature of LfS that is advocated in policy documents (Annan-Diab & Molinari, 2017). Cross-cutting sustainability themes are usually approached via selected subjects, or delivered as separate ones. Frequently, sustainability issues feature in geography or natural science subjects, but in an increasing number of EU countries they are included in transdisciplinary areas such as citizenship or outdoor learning (UNESCO, 2021b).

Learner-centred and action-focused learning opportunities, including participation in action projects and other active pedagogies, are seen as key to the delivery of LfS in school

curricula. These pedagogical approaches engage learners in group discussions and critical reflection, but also in more hands-on activities that help them to connect what they learn with real-life issues, and to understand the impact of actions in the community (Concina, 2019). There is little evidence that such learning approaches are common practice. Equally, the findings from several curriculum reviews (UNESCO, 2019, 2021b) confirm that greater emphasis is given to the cognitive domain of sustainability in comparison to its socio-emotional and action domains. This appears to be accentuated progressively from pre-primary to upper-secondary education.

As Scott & Gough (2003) suggest, educational processes that only raise awareness and focus mainly on understanding concepts and risks are not appropriate to engage learners in sustainability. Hoffman (2021) alerts us that problem-oriented learning can have negative psychological impacts on students, including anxiety and apathy regarding change. A focus on cognitive and technical aspects is associated with learning 'about' sustainable development, which tends to favour transmissive pedagogies (Sterling, 2014). These are not compatible with the type of deeper, critical, emotional and embodied education associated with learning 'for' sustainability. Most frequently, it is only individual champions and some eco-schools that take the lead in considering more transformative forms of learning. This is no surprise, as most teachers have not been trained to design, facilitate and assess learning experiences of this nature (Bourn & Soysal, 2021).

Generally, there is wide recognition of how eco-programmes, student clubs, competitions and annual sustainability or environment weeks help complement curriculum learning. Extra-curricular activities, often carried out in partnership with NGOs and other local community actors, are seen as powerful in raising the interest and engagement of learners and school staff (Rushton & Batchelder, 2020) and, in particular, involving students in decision-making processes within schools (Cincera and Krajhanzl, 2013). The evidence also suggests that LfS projects are more likely to take place and be successful in contexts where schools have greater autonomy to secure the interests of families and the participation of community stakeholders in school initiatives (Benavot, 2014).

According to Lotz-Sisitka & Rosenberg (2022), policy with regard to education for sustainability should be seen as a learning process in and of itself, and should be open to ongoing reflection and review. The reality is that there is a lack of assessment frameworks facilitated by governments to help understand which practices are effective, evidence-based, and worth scaling up (Reid, 2018). Without such frameworks, schools and teachers are left without a compass to guide their actions. They may also perceive LfS as not being a strategic priority. In many cases, interested schools and teachers use assessment tools provided by external actors who are trying to fill the existing gap (e.g. 'Green Flag', 'Jump into Sustainable Lifestyle self-assessment tool', 'ENSI Quality Criteria for ESD-schools', etc.). According to Benavot (2014), expecting local schools to assume this responsibility makes no sense, and only increases disparities between schools and unequal opportunities for learners. In addition, these tools are useful for measuring the progress of implementation at school level. At classroom level, little support is provided to teachers willing to assess sustainability learning outcomes, including those relating to emotions and agency or interdisciplinary topics, which require alternative assessment methods. Assessing learners' sustainability competences is important to avoid perpetuating practices that address sustainability superficially or do not offer real value or have a real impact on students' sustainability learning (Cebrián et al., 2020; Mulà et al., 2022; Wiek & Redman, 2022).

Overall, the literature review carried out for this report suggests that while there is a clear political commitment to reorienting school curricula towards sustainability, LfS practice in schools tends to be inconsistent and uncoordinated. Moreover, due to the lack of status

given to sustainability in curricula, and the emphasis on exam performance which gives preference to traditional pedagogical approaches, the implementation of learning for sustainability hinges on the motivation of and support from many different actors and institutions. No alignment exists across the system, and thus school teachers and leaders are required to look at, think about, reimagine and shape educational practices in the light of sustainability and the structures that exist in schools. Various authors have noted a tendency to frame LfS conservatively, and an absence of exciting opportunities to learn 'for', rather than 'about' sustainability (Glackin & King, 2020; Stevenson, 2007). However, it is important to note that new and positive practices are emerging that demonstrate the need to continue rethinking curriculum plans, reviewing funding priorities, and better equipping educational practitioners to challenge current practices (Aikens & McKenzie, 2021).

Overview of current teacher education experiences

Teachers are ideally placed to mainstream LfS, but many of them lack the insights, confidence, experience and/or support to facilitate learning in this area. Others lack the motivation and/or enthusiasm to do so (Bürgener & Barth, 2018). A recent study explored teachers' readiness for sustainability education, considering their motivations, skills and opportunities to support the development of learners' sustainability competences (UNESCO & Education International, 2021). Based on the responses of over 58,000 teachers globally, the study demonstrates that although teachers are generally aware and committed to teaching for sustainability, a quarter of them do not feel ready. This lack of preparedness has also been detected in pre-service teacher education. Dahl (2019) reports that although the majority of the 578 students surveyed from seven higher education institutions felt well prepared for work as qualified teachers, they expressed concerns about their ability to teach sustainability. These findings have direct implications for the expectations and requirements set for teachers, as well as on how they are prepared, accredited and encouraged throughout their professional careers.

To begin with, although sustainability might feature in school curricula, LfS is not a mandated component of teacher education in most countries (UNESCO, 2014). It can therefore be easily overlooked, as evidenced by key studies and position papers in this area. For example, the 2016 Global Education Monitoring (GEM) Report highlighted little progress towards the integration of LfS into teacher education in UN member states, from 2 per cent in 2005 to 8 per cent in 2013 (UNESCO, 2016). In the EU, at the present time, available data show that many Member States have included sustainability into teacher education, but mostly as an elective offering in initial education (Mulvik et al., 2021); teachers are rarely requested to engage in professional development in this area. In countries or regions where this is a requirement, the training tends to cover specific aspects of sustainability in the curriculum, leaving more in-depth preparation as a personal choice (Mulvik et al., 2021). A few exceptions exist, in which LfS is included or embedded into the professional teacher competence frameworks or standards that teachers are expected to meet. Thus, in the majority of Member States, LfS is not yet considered an important dimension of effective or quality teaching.

Moreover, research shows that current LfS efforts in teacher education tend to be isolated and fragmented, instead of mainstreamed into existing teachers' professional learning programmes or day-to-day practice. As Evans (2017) describes, in ITE, learning for sustainability takes place as one-off curriculum development projects and occurs primarily in geography and science courses. Any steps forward are usually taken by champions of a discipline who feel a personal commitment and sense of duty to create opportunities within the curriculum for students to learn for sustainability (Bronwyn et al., 2016). Similarly, CPD is often characterised by theoretical, one-time, decontextualised sessions for groups

of individual teachers seeking to improve their teaching practice (Boeve-de Pauw et al., 2022). Darling-Hammond et al. (2009) demonstrate that this type of training has little or no impact on the improvement of teaching or student learning.

There is a proposal to shift the focus of teacher education from individual capacity building to organisational learning, in the context of sustainability (Mulà et al., 2017). Teacher education too often centres on learning how to integrate sustainability into individual subjects that relate to social and environmental studies, rather than using interdisciplinary approaches and addressing it as a whole-school experience (Timm & Barth, 2020). A clear example of this is in teachers' initial training, where sustainability is very rarely included in courses on educational leadership, psychology or sociology– thereby neglecting the potential for its school-wide implementation (European Commission, 2022b). In CPD programmes, teachers might be taught about the need to connect sustainability in different subject areas, but without any practical opportunities to understand what an interdisciplinary approach looks like in practice, and how it depends on the quality and dynamics of school-teacher collaboration and teamwork (Nórden, 2016).

In addition, pre- and in-service teachers often lack the confidence to connect curriculum requirements with practical learning opportunities on school grounds, gardens or facilities. This is unsurprising, given that during training, many students do not have the experience of creating LfS opportunities in practice during school practicums or placements, due to the lack of mentors or educators with LfS experience (Robertson et al., 2020). This is an important issue that must be addressed, as a lack of alignment between the motivations, enthusiasm and intentions of pre-service teachers, and the visions and practices of their placement schools and mentors, can have a negative effect on the development of sustainability practices among early-career teachers (Barnes et al., 2021; Buchanan, 2012; Ormond et al., 2014). Practice-based learning has also been identified as critical when designing CPD programmes. Such learning requires the planning of intensive, long-term engagement initiatives in which teachers, with support from their school leaders, can work in teams to implement their specific action plans (Redman et al., 2018). Promising examples of CPD programmes in sustainability that include sophisticated action learning and solutions-based approaches have recently been published in the literature (e.g. Boeve-de Pauw et al., 2022; Bürgener & Barth, 2018; Redman et al., 2018). The studies demonstrate positive results in relation to the improvement of teachers' self-efficacy and practices in LfS.

Studies show evidence of how sustainability is best developed in schools when teachers have experienced LfS during their professional learning journeys (Boeve-de Pauw et al., 2015; Olsson et al., 2022). They also confirm that giving insufficient emphasis to sustainability during ITE results in lower rates of participation in LfS-related CPD (Mulvik et al., 2021). These are important points, because the implementation of sustainability in schools is highly dependent upon teachers who are currently in service (Redman et al., 2018), and therefore on their previous experience and willingness to continue learning in this area. Furthermore, Popova et al. (2016) remind us of the importance of supporting early-career teachers, as teachers appear to experience the most significant improvements in their teaching skills during the first five years.

One positive finding from a recent study is that most teachers feel a desire to continue learning about sustainability through professional development (UNESCO & Education International, 2021). Although they are aware that opportunities in this area exist in their countries, they recognise that they have not taken these up. Thus, it is important to assess what prevents teachers from engaging in sustainability training (e.g. access to, or the cost, quality or attractiveness of CPD programmes) as well as whether and how they are incentivised and recognised. Regarding the latter, research indicates that including LfS into

CPD as part of teachers' career progression and promotion paths is important in order to advance the sustainability agenda in schools, as well as to evaluate the use of time and school schedules to increase opportunities for professional learning and collaboration (Darling-Hammond et al., 2017; OECD, 2019a). The teacher education literature also shows that professional development is best achieved when schools possess CPD plans (Motiejūnaitė-Schulmeister et al., 2021) and school leaders encourage their staff to participate in training that is specifically linked to school needs and developments (OECD, 2019b). Thus, CPD in sustainability is partly conditioned by the commitment of educational leadership teams to mainstreaming LfS across the school and creating a culture of sustainability (Kadji-Beltran et al., 2013, 2017; Mogren & Gericke, 2019). Hence, the training of school leaders must be considered (Cebrián et al., 2022; Zachariou et al., 2013), though it is currently not a priority (European Commission et al., 2018).

Another critical area identified in the literature is a lack of pedagogical resources to help teachers perform their practice more effectively. Plenty of resources and materials are available online, but direct support for schools and teachers is especially needed to critically assess and identify those age-appropriate materials that can influence sustainability education and quality learning outcomes. To fill the gap in support, multilateral organisations, NGOs and researchers have developed resources for schools and teachers (e.g. 'TeachSDGs', 'Sustainable Development Goals – Resources for educators', etc.). However, without active teacher professional learning, these resources, which are mostly content-rich and available in English, are unlikely to have an impact on school practice (Kwauk & Iyengar, 2021).

Lastly, one cannot forget the role that teacher educators play in supporting and improving the quality of teaching (Liston et al., 2008). Teacher educators guide teachers at all stages of their careers, model good practice, and engage in research that enables a better understanding of teaching and learning (European Commission, 2012). In some countries, teacher educators – particularly those working in higher education institutions – are in a unique position to influence educational policy, research and practice. They can also influence a whole-of-sector approach in sustainability, and mobilise networks and key stakeholder groups (Huang et al., 2022) – yet some countries often neglect to identify this group at policy level, or fail to get them the professional development support they need (European Commission, 2013).

Across the EU, there is increasing recognition of the need to define teacher educators' competences and to better support their recruitment and selection as well as their professional learning and accreditation. This can be extended to sustainability, as there is a need to build teacher educators' capacities in LfS (Mulà et al., 2017). As yet, however, few countries have effective professional development frameworks to support and guide teacher educators in sustainability learning (Bourn et al., 2017; INEE, 2015).

In conclusion, it is important to note that teacher education operates within a system that extends from schools to policy level. Although all of the documentation reviewed stresses the critical teachers play in achieving sustainability goals and ambitions, this recognition must be accompanied by an awareness that the ultimate responsibility for change lies with the various components of the education system, and not on individual educators (Kwauk & Iyengar, 2021). As Day (2017) states, teachers have a responsibility to ensure they teach to the best of their abilities, but governments must enable societal changes across all sectors. Furthermore, the role of school leaders has been identified as being critical, as they can support a vision and culture of sustainability through their daily actions and decisions.

Chapter 4. What *could be*: teachers for the green transition

Teacher competences in LfS

GreenComp, the EU reference framework for sustainability competences, maps out the knowledge, skills and attitudes that individuals need for the green transition. It sets out 12 competences, clustered into four areas (see Table 1) that are relevant for all learners, regardless of age, educational level and learning setting. The framework marks a shift away from what is *taught* (sustainability content) to what is *learned* (sustainability learning outcomes), and can serve a wide range of purposes, including the design of teacher education programmes, certification or assessment (Bianchi et al., 2022).

Table 1. GreenComp areas and competences

Areas	Competences
Embodying sustainability values	1.1 Valuing sustainability
	1.2 Supporting fairness
	1.3 Promoting nature
Embracing complexity in sustainability	2.1 Systems thinking
	2.2 Critical thinking
	2.3 Problem framing
Envisioning sustainable futures	3.1 Futures literacy
	3.2 Adaptability
	3.3 Exploratory thinking
Acting for sustainability	4.1 Political agency
	4.2 Collective action
	4.3 Individual initiative

Note: adapted from Bianchi et al. (2022)

The debate over professional teacher competences in LfS features prominently in both educational theory and research (Bürgener and Barth, 2018). Significant efforts have been made to define LfS competences in recent years; many of these seek to guide the professional development of educators.

One of the first frameworks released was developed as part of a European project led by the Environment and School Initiatives (ENSI), in which teachers were perceived as individuals, citizens and members of an educational institution (see Sleurs, 2008). Some years later, in response to the UN Decade of Education for Sustainable Development (DESD), UNECE (2012) launched its competence framework for educators, which has greatly influenced the debate and subsequent work around LfS competences. New models have been published later as part of research efforts that offered complementary perspectives (Bertschy et al., 2013, Cebrián & Junyent, 2014; Rauch & Steiner, 2013), and which built upon widely accepted learner competences (e.g. Wiek et al. 2011; Rieckmann, 2018; UNESCO, 2017). The competence palette developed by the partners in the 'Rounder Sense of Purpose' project (Vare et al., 2019) tries to simplify and operationalise the UNECE competences, and has been used in various teacher education contexts to build teachers' understanding and practice in LfS. The latest effort is that of Timm & Barth (2020), who propose different types of teacher competence profiles. The various contributions and the differences between them are documented in Table 2 below.

Table 2. LfS teacher competence frameworks

Frameworks	**Description**
Competencies for ESD teachers (CSCT) Model (Sleurs, 2008)	• Developed by a European group of education experts working in 15 teacher education institutions. • Three overall competences: *teaching, reflecting/visioning* and *networking.* • Five competence domains: *knowledge, systems thinking, emotions, ethics and values, and action*. • Provides a holistic and complex view of a teacher who is an individual, a citizen and a member of a school.
UNECE ESD Competence Framework (UNECE, 2012)	• Developed by the 'Expert Group on Competences for ESD' to support the professional development of educators. • A set of 39 competences gathered under three essential characteristics: *holistic understanding, envisioning change, and achieving transformation.* • Four pillars of education, as defined by Delors et al. (1996): *learning to know, learning to do, learning to be, and learning to live together*. • The clustering of competences using Delors (1996) presents a meaningful set of categories that reflect a wide range of learning experiences.
ESD-specific Professional Action Competency of Teachers in Kindergarten and Primary School (Bertschy et al., 2013)	• A set of competences defined in the context of the research project ZMiLe. • Serves the development of teacher education programmes and initiatives specifically for early childhood and primary education teachers. • Proposes the consideration of aspects of motivation and volition as well as knowledge and ability. • The framework helps to connect the debate about ESD competences with the broader discourse about teachers' professional competences.
The KOM-BiNE Competence for ESD in Teacher Education Model (Rauch & Steiner, 2013).	• An Austrian project, part of a large-scale EU project. • Defines competences in relation to: *knowing, acting, valuing, feeling, communicating, reflecting, visioning, planning, organising* and *networking*. • The framework places importance on teachers' feelings, actions and context.

ESD Professional Competences for Teachers (Cebrián & Junyent, 2014)	• A theoretical framework for teachers' professional competences in ESD. • Eight key components: *visioning future/alternative scenarios*, *contextualising, working and living with complexity*, *thinking critically*, *decision-making, participating* and *acting for change, clarifying values, establishing a dialogue between disciplines,* and *managing emotions and concerns.* • Complexity is the component underpinning the proposed framework.
UNESCO's Cross-cutting key competencies for achieving all SDGs (Rieckmann, 2018)	• Inspired by Wiek et al. (2011, 2015). • Proposes eight competences: *systems thinking; anticipatory, normative, strategic, collaborative and critical thinking; self-awareness, and integrated problem-solving.* • Builds upon one of the most widely accepted sustainability competence frameworks internationally.
Rounder Sense of Purpose (Vare et al., 2019)	• A framework developed by a group of European project partners, designed for all educators, working at any level, who wish to embed LfS. • The framework includes 12 competences: *systems, futures, participation, attentiveness, empathy, values, transdisciplinarity, creativity, action, criticality, responsibility and decisiveness.* • Competences have rich descriptions and are broken down into learning outcomes.
Timm and Barth (2021)	• A research study that proposes two types of teachers and considers their LfS competences: - teachers who function as change agents by interacting with students (in-class teachers); and - teachers who function as change agents by inciting institutional change (structure-oriented teachers). • Recognises that both types of teachers are necessary when implementing change for sustainability in school settings.

These competence frameworks support the idea that teachers are not only the designers and facilitators of teaching and learning processes, but are also change agents within their educational institutions and the education system itself (Barth & Kater-Wettstädt, 2021). Teachers should be motivated and capable of understanding, interpreting and engaging with sustainability values and transformative pedagogies. They should feel confident about transcending boundaries (disciplines, learning spaces, settings, etc.) and dealing with

moral, ethical and wicked issues. They should also accept uncertainty, complexity, and unexpected outcomes (Wals, 2020). In addition, teachers should be able to adapt the curriculum, taking into account learners' needs, concerns and visions for the future, generating hope and enabling positive action and change.

The literature shows how these frameworks have been used in different contexts. For example, the CSCT competences (Sleurs, 2008) were piloted in more than 10 teacher education institutions as a model for designing and implementing courses. The UNECE competences inspired 11 out of the 32 national higher education institution professional development initiatives analysed by Mader et al. (2014). Bertschy et al. (2013) inspired Bürgener & Barth (2020) to design an open learning environment based on the idea of 'living labs' for student teachers studying at Lüneberg University (Germany). Experiences with the 'Rounder Sense of Purpose' competences have been recently published in a book (Vare et al., 2022). However, it is important to note that although guidelines and tools have been developed to support these frameworks, they have so far had little impact on mainstreaming teacher education practices. This may be due to their complexity and level of detail of the competences, which sometimes make them inoperable and difficult to assess in an already crowded teacher education curriculum (Vare, 2022).

Further efforts and research are needed to explore ways in which competences can be fully embraced and used by national agencies and institutions so that they can have an impact on teachers' professional development. This includes, for instance, how they can be included into quality systems and processes (e.g. institutional reviews, external evaluations, formative evaluation) as well as career progression and promotion plans, and how they can be used as the basis to design professional development plans and programmes. It is also important to study how these competences are developed through transformative pedagogies and (trans)formative assessment in different settings, including in online education (Mulà et al., 2022).

Although various scholars have criticised the competence frameworks as being too instrumentalist and market-oriented (Edwards, 2016), other experts – especially those from the global North – have reinforced the idea that sustainability and LfS competences are concerned with values and freedom (Brundiers et al., 2021; Shephard et al., 2019). Competence-based education has been widely endorsed because it is seen as a powerful starting point from which to leverage pedagogical transformation and stimulate changes in educational institutions (Sterling et al., 2017). A good example of this is the 'Digital Competence Framework for Educators (DigCompEdu)' (Redecker, 2017), which has been used in many teacher education programmes and has led to the development of SELFIE for Teachers – a self-reflection tool for teachers to reflect upon and measure their digital skills across six areas.

Nonetheless, as noted in a recent publication by UNESCO (2022a), the design of teacher education programmes should, in addition to the development of LfS competences, consider educational spaces in which teachers can develop qualities and values alongside abilities. Such a focus will help to move away from traditional, rigid views of education that privilege content development and are preoccupied with defining learning objectives and testable outcomes, towards more open conceptualisations of teaching and learning that are concerned with learning processes, local issues and values-based education (Wals et al., 2022).

Developing LfS competences through teacher education

In order for teachers to develop and mobilise these competences in LfS, countries and regions need to establish coherent educational systems that view teacher education

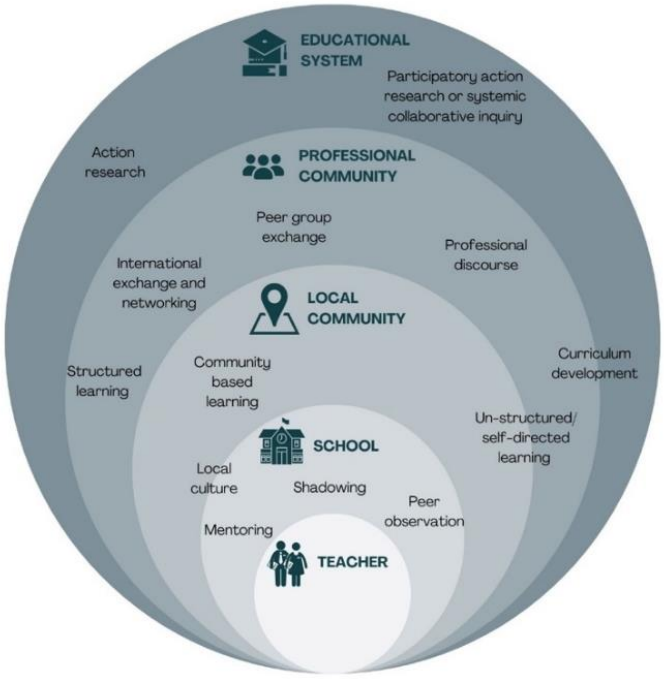
structures and policies as a continuum of teacher professional development (Musset, 2010), and embed LfS into all of a teacher's career stages. Systems that prioritise sustainability education in ITE recognise that initial training can help to lay the foundations for teaching quality. During ITE, teacher candidates should develop a solid basis of knowledge and skills that they will need in order to put sustainability learning into practice in schools and start constructing a professional identity in this area (Qi et al., 2021). However, expecting pre-service teachers to be ready-made professionals after completing their initial training is not realistic (OECD, 2019a, 2019b). Instead, education systems must create continuous learning structures and conditions for teachers to continue learning and growing as LfS practitioners from their first days in school and throughout their professional careers. CPD is vital for teachers to share experiences with their peers and broaden their perspectives, as well as keeping up to date with research, tools and practices (OECD, 2017) – especially with regard to a fairly new and changing field such as LfS.

Teacher education research has established that teachers need time to develop competences and embrace new practices. Most studies have concluded that CPD which involves substantial contact hours over a long period of time are more effective (Darling-Hammond et al., 2009). In addition, teachers learn most effectively when the programme is content-focused, uses active learning, supports collaboration, is school-based, uses modelling of effective practice, provides mentoring support, and offers opportunities for feedback and reflection (Darling-Hammond et al., 2017). The practice-based reflective practitioner approach is also relevant for ITE programmes to address the theory-practice divide (Cheng et al., 2010).

The above findings are useful for the design of teacher education programmes in LfS. However, they take a reductionist or cause-and-effect approach, assuming that by offering programmes based on these design principles, teachers will automatically develop key LfS competences and change their practice. According to Opfer & Pedder (2011), it is difficult to generalise about what works best in teacher education, as learning depends not only on teacher education initiatives, but also on the uniqueness of the participants, the moment at which the programme takes place, the context, and more.

Thus, designing teacher education with LfS competences in mind implies the need to recognise that there is no one set 'recipe' that will serve everyone, everywhere. Instead, it requires a systems thinking approach that considers micro contexts (individual teachers or teacher candidates and programmes), meso contexts (institutions), and macro contexts (education and social system) (Opfer & Pedder, 2011). Figure 2 attempts to capture some of these complex interactions within teacher education.

Figure 2. Professional learning contexts



Note: adapted from Réti (2022)

Pre-service and in-service teachers have different motivations, commitments, starting points and previous experiences with regard to sustainability. Research in this area emphasises the need for flexible and personalised paths, as teacher education is not a linear process, but rather a chaotic one (Strom & Viesca, 2020) that involves working with non-traditional actors within teacher education such as researchers in higher education faculties, environmental NGOs, media literacy organisations, youth groups, etc. Different ranges of learning opportunities, such as those illustrated in Figure 2 and further elaborated in Table 3, can contribute to supporting the development of pre- and in-service teachers' competences in LfS. As previously mentioned, these should be understood as part of a complex system that requires careful analysis.

Table 3. Learning opportunities that can support the development of pre- and in-service teachers' LfS competences

Learning opportunities	What do these opportunities look like in practice?
Structured learning	• Structured learning can be theoretical, although active methodologies may be used depending on issues such as time, space or number of participants. Learning can take place online or face-to-face, and usually leads to an attendance certificate or contributes to attaining a wider educational certificate. • Can take the form of a module, seminar or a workshop for teachers or teacher candidates.
Un-structured/self-directed learning	• Involves personal and individual engagement on the part of teachers or candidates. • Can include activities such as listening to podcasts; engaging in conversations marked with hashtags; keeping up with educational news through media, social media, etc.; liaising with education experts; engaging in online education courses, communities or networks, etc.
School-based learning	• Learning takes place in the school and allows a greater focus on the actual contexts and needs of teachers/teacher candidates, students or their schools. • Can include methodologies such as: - *Mentoring*: a more experienced teacher supervises an early-career teacher or teacher candidate, and provides guidance and assistance relating to the profession and workplace. - *Peer observation*: teachers observe each other and reflect upon their own practice. They can share good practices and provide feedback to one another. This could also take place through micro-teaching in ITE. - *Shadowing:* one teacher follows another over a period of time. This can support novice teachers in understanding how a school works, and what it means to be an educator who takes on LfS.
Peer group exchange	• Supports exchange between teachers and/or teacher candidates from different schools or educational institutions. • Allows the sharing of LfS practices and the provision of feedback to one another. • Can occur in the context of the teaching practicum, including, for example, joint reflection through video-recorded lessons.
International exchange and networking	• Both pre- and in-service teachers have opportunities to visit, work or study in schools and educational centres in other countries – for example, through the eTwinning and Erasmus+ programmes. Thus, once teachers and teacher candidates return home, they can introduce what they have learned into their own classrooms and assignments. • In ITE, Collaborative Online International Learning (COIL) experiences are now more common. These types of initiatives bring teacher students and teacher educators together across cultures to learn, discuss and collaborate.

Community-based learning	• Refers to a wide variety of initiatives and methods used to enable teachers and student teachers to connect what is being taught in schools with their surrounding communities, including local institutions, history, literature, cultural heritage and natural environments. • Community-based learning is also motivated by the belief that all communities have intrinsic educational assets and resources that educators can use to enhance learning experiences for students.
Action learning	• Enables teachers and teacher educators to explore their practice or a school situation more deeply, in order to understand and improve the quality of learning processes. • Empowers practitioners with new knowledge and understanding about how to embed sustainability into school and classroom practices through a participatory approach.
Participatory action research or systemic collaborative inquiry	• Refers to a systematic co-learning process in which a group of teachers investigate their professional practice using classroom-based information, students' responses to learning, literature, and shared experiences. • Provokes deep critical reflection, and leads to new understandings and practical responses.

Note: adapted from Réti (2022) and Merlo (2022)

Key challenges and questions for future practice

The present review of literature regarding current LfS experiences in school and teacher education gives rise to a number of questions that need to be addressed if we are to learn our way to a greener and sustainable future. These questions have guided the selection of case studies, catalytic points and recommendations identified in the coming chapters of this report:

Q1. How can teacher education contribute to reorientating education to assist with the green transition?

Q2. What policy and structural conditions facilitate these shifts in teacher education, which in turn help to mainstream sustainability in education?

Q3. How can we better align national and regional policy ambitions with practical experiences on the ground? What tools can assist with this task?

Q4. What type of partnerships and networks are needed to enable this alignment to occur?

Q5. How are LfS competences best developed in ITE and through CPD?

Q6. What existing teacher education opportunities serve the needs of LfS?

Q7. What processes and resources have been effective in mainstreaming LfS in teacher education?

Q8. How can professional learning opportunities in sustainability be embedded into the continuum of teacher education?

Q9. How can we excite and motivate teachers to embed LfS into their practice?

Chapter 5. Changing teacher education: catalytic entry points

There is no magical framework or policy mix that can be applied in every situation or context. This is why, in this section, we propose a series of catalytic points and actions that can provide some of the core pathways for changing the provision and mainstreaming of LfS in teacher education. The catalytic entry points and actions identified have emerged from the literature review, and in response to the questions that arose from it.

It is worth noting that:

- The catalytic entry points should not be considered in isolation; the way in which they interact with the components of the teacher education system is important when considering strategies or actions to advance LfS.
- Not all of these leverage points will apply equally in all countries, as this will depend on the policy context, teacher education structures, and on the current opportunities available to advance this agenda.
- To better understand the catalytic points proposed, each one is illustrated with at least one case study, which can be accessed via Appendix 1. A full collection of the case is presented in a separate document entitled: *'Learning from thirty years of experience: Case studies in teacher education for sustainability'* (see Tilbury & Mulà, 2023).

LfS as a political and policy commitment

1. Political commitment and leadership at the highest levels have proven to be catalytic in the drive to change and embed LfS in teacher education.
2. The influence of international agencies and frameworks is visible, and provides a source of motivation for national bodies, teacher educators and teacher education providers as well as educators.
3. Policy development processes that are inclusive and seek dialogue with stakeholders have been shown to enhance the adoption of LfS practices in teacher education.
4. A connected or 'whole-of-government' approach to LfS increases the reach of policies. Similarly, aligning initiatives with national policy agendas or priorities is seen to increase the chances of success in embedding LfS in teacher education.
5. Creating spaces for mutual policy learning and review across the teacher education system can also prove catalytic, and can help the changes sought to take root.
6. Researchers should be seen as 'critical friends' and not just 'experts' in the policy implementation process, as they can play a role in strengthening the impact of teacher education policies.

- **Political commitment:** in Italy, acknowledgement at the highest levels of government that education and schools are critical to the green transition has served to motivate and drive numerous teacher development initiatives (see Case study 2). Evidence suggests that this is not unique to Italy, and that high-level leadership or championing of the agenda can have a catalytic impact – especially if efforts focus on providing a statement of purpose or offering a renewed vision for education (McKenzie & Benavot,

2022; UNESCO, 2014). The Italian case study documents how political commitment served to give purpose and clarify, and to motivate engagement. The statements of purpose were accompanied by relevant policy instruments and the allocation of over EUR 1 billion to 'RiGenerazione Scuola' which seeks to embed climate change education across school and teacher professional development.

If this level of commitment and leadership is sustained over time, then a deep and coherent response to sustainability in teacher education is possible. In Scotland, the government has placed LfS at the heart of education. Over the years, it has developed ways to inspire and motivate teachers to address it in schools (see Case study 5).

- **Calls from international agencies:** LfS has been consistently identified as a key policy priority by UNESCO (2020) and UNECE (2022a) and more recently by the European Commission (2022a) and the Council of the EU (2022b). These calls have translated into specific policy actions at national level, and resulted in investments in key initiatives.

  For example, last year, the government of Romania made a commitment towards education for a green, digital and fairer society. It allocated a large amount of resources to the education and training of teachers. The President of Romania established the 'Working Group on Education for Climate and Environmental Changes', which brings together representatives of the President's Office, the Ministry of Education, the Ministry of the Environment, Waters and Forests, as well as education institutions, students, teachers, parents and NGOs. The Working Group released a report containing a series of proposals for 2022-2030 to support the introduction of climate change and environmental education into the Romanian educational system. The National Education Act was also amended to include environmental competences within primary and lower-secondary education, impacting the provision of initial training for teachers across the country.

- **International frameworks:** a key driver of national policies towards LfS is a desire to align with international frameworks and agreements (Aikens et al., 2016). National efforts have been catalysed in the past by the Rio Declaration and Agenda 21, the Kyoto protocol, and more recently by the 'Agenda 2030 for Sustainable Development'. Commitments to reducing carbon emissions and addressing the challenges of waste and biodiversity have also prompted a growth in the number of LfS policies.

  In response to broader awareness and concern arising from international climate agreements as well as a social awakening to these international issues, the Spanish Ministry for Ecological Transition and Demographic Challenge joined forces with the Ministry for Education and Training to release a new strategy in early 2022. Under the plan, stakeholders from schools, field centres, teacher education and universities have re-energised and redirected resources towards learning for environmental sustainability. The strategy was developed via a collaborative process that helped to connect efforts, pool resources and strengthen perceptions of the policy among stakeholders.

  Well documented in the literature is the impact of the Decade of Education for Sustainable Development (DESD) on national education policies and the inclusion of sustainability learning opportunities. DESD evaluations confirm its influence on national policies and its shaping of national dialogues in ESD (see UNESCO, 2014; Wals, 2009). It is important to note, however, that a few countries are reticent to generate national

responses to these global frameworks, perceiving them as global impositions or aligned with neo-liberal political discourses (González-Gaudiano, 2007).

- **Permission or justification:** the study also found that many current LfS policy efforts tend to be high-level, and may not be directed at or specific to teacher education. However, these overarching policies consistently provide motivation and justification for teacher education providers to develop LfS policies at an institutional level (see Cheeseman et al., 2019).

- **Policy development process:** the impacts of policy development processes in facilitating or hindering systems change for sustainability is widely recognised in the literature. Processes that bring stakeholders together increase cooperation and improve policy uptake (Van Poeck et al., 2014).

  In Belgium, for example, the Flemish government led an engagement process during the DESD and concluded that the consultation platform that had been established was key to generating valuable dialogue regarding the purpose and outcomes of education. The latter is perceived to have increased the outreach and adoption of the strategy (Van Poeck et al., 2014).

- **Alignment with other key policy agendas:** in Australia, it was noted that there was resistance to the adoption of LfS due to the preoccupation of teacher educators and educators with priority mandates (Smith & Stevenson, 2017). Successful policy efforts have united policy agendas at a high level. For example, in Spain, the national government brought together resources for research and change associated with two policy priorities – the digital and green transitions. This resulted in significant interest from teacher educators and researchers, who saw value in combining efforts in this area. This approach resolves the dilemma that teachers and teacher educators frequently face: choosing between implementing LfS, or responding to other competing education policies that usually receive greater priority (UNESCO, 2021b).

- **Whole-of-government:** LfS actions intersect with the role of several different government ministries and departments. It is therefore unsurprising to find that when national efforts link together several ministries and agencies, or adopt a whole-of-government approach, policy effectiveness increases (Morrison & Lane, 2005; UNESCO, 2020, 2021a). In Hungary, a collaborative effort between ministries and agencies helped to set national expectations and developed effective implementation mechanisms (see case study 5).

- **Creating spaces for policy learning across the teacher education system:** when spaces for interaction and learning are created for policymakers, teachers, researchers and students during policymaking, curriculum development and teacher education reforms, the depth of the changes and the success of the initiatives increases. Teachers move policy into practice (Summers, 2015); students bring their sustainability concerns and share their learning experiences outside school (see UNECE, 2022b); researchers support policymaking by providing context-based information (Rickinson & McKenzie, 2021).

- **Policy research:** a growing body of literature is investigating the relationship between research and policy in environmental and sustainability education (see Læssøe et al., 2013; Rickinson & McKenzie, 2021; Van Poeck & Lysgaard, 2015), which should be considered in order to strengthen the role of LfS in the development of teacher education policy. The material published stresses that LfS policy research should go beyond generating and using evidence to mobilise policy by providing rich descriptions

to develop locally relevant policies (Rickinson & McKenzie, 2021). Researchers should be seen as 'critical friends' in the policymaking processes, and not as 'experts', as usually occurs (Van Poeck & Lysgaard, 2015).

Professional competences and standards: driving quality throughout schools

1. Embedding LfS into teacher professional standards provides one of the most effective ways to mainstream sustainability and promote quality learning experiences. This is best achieved by integrating LfS into definitions of what it means to be a qualified and effective teacher.
2. Uptake is greater when professional standards and competences are seen through a developmental rather than a regulatory lens, and the process of defining them is driven/owned by the teaching profession.
3. Establishing expectations and pathways for teachers to develop competences in LfS during their careers is also an impactful way of embedding sustainability learning into schools.
4. Self-evaluation approaches can provide meaningful ways to engage teachers in improving their practice. Reflective practice questions can drive the development of teachers' capabilities in this area.
5. (Online) portfolios that encourage educators to collect evidence of their practice and reflect upon their developmental journey have been proven to help deepen the quality of LfS practices in schools.
6. To be effective, standards and competences in LfS need to be specific yet flexible. This is important in being able to suit the roles and expertise of various educational professionals such as special needs teachers, kindergarten teachers, subject teachers and others. Flexibility also offers opportunities for professional dialogue in the area of LfS.

- **Setting expectations:** many governments and regulatory bodies around the world have developed teacher competence frameworks or standards to regulate the teaching profession and ensure that all teachers are well prepared and ready to teach (McMahon, 2018). Establishing expectations and pathways for teachers to develop competences in LfS during their careers has proven to be an impactful way of embedding LfS into schools (see case studies 2 and 5).

- **Teacher competences:** teacher competences are statements describing what teachers should value, know, and be able to do. In the EU, 28 education systems use competence frameworks to define what a candidate teacher should have mastered by the end of ITE (European Commission, 2015).

  The introduction of competence-based frameworks was initiated more than 20 years ago, but continues to spark controversial debates in education (Ferreira et al., 2006). However, in some contexts, these frameworks have triggered positive educational changes and have proved to be useful in helping teachers and teacher educators to understand what knowledge, skills and engagement opportunities are needed to create effective sustainability learning.

- **Professional standards:** these provide clarity of expectations, and support teachers in planning their professional learning and career development (Ingvarson, 2002).

Embedding LfS into teachers' professional standards provides one of the most effective ways to mainstream sustainability in schools. This is best achieved by embedding LfS into definitions of what it means to be a qualified and effective teacher.

One study analysed 103 teacher education programmes in Pakistan, before and after the integration of sustainability education into national accreditation standards for teacher education programmes. The study concluded that the change led to widespread adoption by teacher education institutions of education for sustainability concepts and practices (Mirza, 2015).

Scotland took the significant step of embedding LfS across its existing professional standards for teachers, irrespective of what point individuals are at in their professional career journey (see Case study 5). This development arose from a commitment to make LfS an entitlement for learners, and led to it becoming a professional requirement for all teachers registered in the country. Teachers in Scotland thus need to demonstrate that the professional values, skills, knowledge, understanding and actions in their practice are compatible with a sustainable world and part of an effective whole-school commitment.

- **A whole-of-system approach to standards:** the professional *s*tandards identified by the General Teaching Council of Scotland (GTCS) (2021, 2022) deepened the commitment to embed LfS across school-based and national professional development, professional recognition processes, as well as within ITE institutions (Christie et al., 2019). This was assisted by their whole-of-system outlook, with standards for 'Headship' and 'Middle Leadership' also being defined. Scotland places strategic responsibility on school leaders and managers "to establish and model a coherent, progressive and holistic LfS vision and ethos that supports planning across the curriculum, professional learning and collegial practice" (GTCS, 2021). Mirroring its holistic approach across the teacher education system, the Scottish standards call for school leaders to demonstrate a whole-school approach to LfS in their schools.

- **Trustworthiness and ownership:** standards and competence frameworks are most effective when they are trustworthy (McMahon, 2018) and specific yet flexible – this is possible thanks to the involvement of teachers and actors. If frameworks offer opportunities for adaptation (Ceulemans, 2017; Sachs, 2003) and professional dialogue (Clinton et al., 2016), they are more likely to be adopted. In LfS, this is also seen as important in suiting the roles and expertise of various educational professionals such as special needs teachers, kindergarten teachers, subject teachers and others.

- **Engagement and development:** come educators do not engage with standards or competency discourses, in the same way that they avoid teaching desired learning outcomes for learners (Coles et al., 2017), because they are ideologically opposed to having these predefined rather than arising out of educational processes (Bourke et al., 2018; Coles et al., 2017). Research indicates that uptake is greater when professional standards are viewed through a developmental lens rather than a regulatory one, and when the process of defining such standards or competencies involves ownership on the part of teacher and teacher education circles (see Darling-Hammond et al., 2013; Education International & UNESCO, 2019; Forde, 2016; Koster & Dengerink, 2008; Mahony & Hextall, 2000; Sachs, 2003).

  It is also important to note that countries in the European Higher Education Area (EHEA) must have national/regional quality standards for accrediting teacher education programmes. These standards must be based on, or comply with, the European Standards and Guidelines (ESG) (see ENQA et al., 2015). The ESG does not include LfS

or sustainability issues (Junyent et al., 2017; Tilbury et al., 2019); thus, it is unsurprising that a study recently undertaken across the EHEA concluded that only one country, the UK, has included LfS in its national quality framework for higher education (Janssens et al., 2022). To a lesser extent, sustainability is also present in quality frameworks of Estonia, the Holy See, Romania, Sweden, Switzerland and Ukraine.

- **Self-evaluation and reflective practice approaches:** these techniques have been shown to be effective in engaging teachers to improve their practice (Crehan, 2016). Scotland's experience demonstrates how reflective practice questions can drive the development of teachers' capabilities in this area, as well as school improvements (GTCS, 2022). Equally, online portfolios in Hungary have served to encourage teachers and support staff to collect evidence of their practice and to reflect on their developmental journey – a process that has been helpful in the development of competences and the deepening of LfS practices in schools.

- **Career journey:** in Hungary, LfS is identified as a competence to be acquired and/or developed through the career progression process. This has encouraged teachers, as well as those who support the education journey in schools, to aspire to develop these abilities (see Case study 2). These competences are accompanied by indicators which help teachers to identify how to effectively respond to the call for evidence associated with demonstrating a particular competency (see Educational Authority of Hungary, 2019). The success of the Hungarian experience may also be attributed to the development of guidelines and advice tailored to each level of progression, specialist subject or area of practice (Réti et al., 2022). This has proved key to the effective engagement of teachers.

  The prompt and positive response in Hungary to this initiative could be explained by the fact that one-third of educators in general education are part of an ESD network that has been in existence since 2000, and which uses quality criteria to drive sustainability learning work. This means that teachers already have experience of working with indicators, and are more likely to be responsive to this approach.

  Also worth noting is that pre-service teachers are introduced to the e-portfolio and related competences during their initial teacher education courses. In addition, these competences and indicators have become a compulsory part of final examinations or output requirements for novice teachers.

Recognition and reward – incentivising and motivating teachers

1. Some awards recognise and celebrate best practices and outstanding teachers and/or teacher educators. These recognition schemes can incentivise educators to delve into or deepen their engagement with LfS.
2. There are also reward schemes that support teachers in collaborating rather than competing, by providing funding for educators. Such funding enables teachers to buy time in their busy schedules to grow collaborative projects and/or create pathways that support whole-of-institution approaches to LfS.
3. The inclusion of LfS criteria into role descriptors and position responsibilities has also been shown to be effective in upscaling sustainability learning efforts. It incentivises teachers and teacher educators to seek professional development in this area, and provides recognition of expertise in it.

4. Some recognition systems or approaches can cause stress for teachers rather than creating opportunities to learn. Formative tools that go beyond standard summative assessments, such as portfolios, classroom observations by peers or self-evaluation schemes are less daunting and better aligned with the (trans-)formative assessment practices that support LfS.

- **Reward and celebrate:** certain national and international organisations recognise and annually celebrate the leading practices of outstanding teachers and/or teacher educators. Some of these organisations reward innovative practice and attainment in LfS in schools, universities, and communities (e.g. the FEE Teacher Award for school teachers, Young Environmentalist Awards Mentor of the Year Award, Green Gown Awards). Other bodies recognise innovation in schools or institutions that contribute to sustainability (e.g. green school awards, higher education rankings such as 'GreenMetric' or 'Times Higher Education'). These recognition schemes can incentivise teachers and teacher educators to delve into or deepen their engagement with LfS. Recognition systems are particularly popular with mid-career teachers or those teachers in the late stages of their careers who are seeking new challenges to maintain their motivation. The professional learning needs of such teachers are often overlooked (Booth et al., 2021).

- **Collaboration not competition:** reward schemes also exist that support teacher collaboration rather than competition. For example, in the UK, the Quality Assurance Agency has offered grants to university teachers and teacher educators to buy time in their busy schedules to grow collaborative projects in LfS. AdvanceHE UK, meanwhile, has provided seed money to those interested in developing collaborative projects and pathways that support whole-of-institution approaches to LfS.

- **Teacher career aspirations:** the inclusion of LfS criteria into role descriptions and position responsibilities has been shown to be an effective means of upscaling sustainability education efforts (see Chimier & Tournier, 2019a; Ryan & Tilbury 2014). It incentivises teachers and teacher educators to seek professional development in this area (Crehan, 2016), and has proven to be an important strategic move at the University of Gloucestershire (UK), where the role descriptions for certain key positions contain requirements and responsibilities regarding LfS.

  Both Scotland and Hungary expect teachers to demonstrate capabilities in the area of LfS as they progress through their careers. For example, to move from senior teacher to master teacher, a teacher should demonstrate a complex understanding and experience in LfS. Once the level of master teacher is achieved, the teacher should be able to engage in training that supports him/her to mentor other teachers, for instance. Other responsibilities could include developing in-service CPD courses on sustainability education; promoting communities of practice and peer-learning in LfS; engaging in participatory action research; and opening the classroom to other teachers to observe how sustainability education can come to life.

- **Formative vs summative recognition approaches:** teacher careers usually follow standardised summative assessments and use tools such as exams, inspections and student achievement records. These assessment methods tend to cause stress for teachers rather than opportunities to learn (Crehan, 2016). The alternative is to use formative tools outside of standard summative assessments, such as portfolios, classroom observations by peers or self-evaluation tools (Chimier & Tournier, 2019b). These methods are less threatening and are better aligned with the (trans-)formative assessment practices that support LfS.

Micro-credentials and the certification of learning

1. Micro-credentials provide a record of learning outcomes that have been acquired following a small volume of learning (Council of the EU, 2022a). Importantly, micro-credentials are owned by the learner, can be shared, and are portable. They are underpinned by quality assurance following agreed standards in the relevant sector or area of activity.
2. The Council of the EU has set out guidance for the use of micro-credentials across Europe, and acknowledges their potential for advancing the digital and green transitions. Micro-credentials provide new avenues and great potential to drive LfS in schools and teacher education in the near future.
3. Micro-credentials can be delivered by a variety of providers in formal, non-formal and informal settings, and could be included as part of ITE certification, thus assisting the reorientation of teacher education towards sustainability.
4. Experience of micro-credentials in teacher education so far indicates that they need to be inclusive and offer a palette of options for teachers so that they are motivated to engage with this professional development pathway.
5. Further experimentation is necessary on how to develop and use micro-credentials in LfS. The challenge is to prove micro-credentials that are flexible, relevant, and which offer equal opportunities for certifying professional competences so that such certifications are comparable and relevant across the EU Member States.

- **Micro-credentials:** these are an approach to professional learning that is growing in popularity around the world (UNESCO, 2022b), but which has so far remained relatively unexplored in the area of teacher education for sustainability. Micro-credentials offer a record of learning outcomes acquired following a small volume of learning (Council of the EU, 2022a). These outcomes are assessed against transparent and clearly defined criteria. Importantly, micro-credentials are owned by the learner, can be shared, and are portable. They are underpinned by quality assurance following agreed standards in the relevant sector or area of activity (Brauer & Korhonen, 2022). Micro-credentials can be standalone or may be combined to attain larger credentials. This pathway offers great potential and new avenues to drive LfS in schools and teacher education in the near future.

- **Great potential:** the Council of the EU (2022a) has set out guidance for the use of micro-credentials across Europe to ensure quality and transparency in their development, and to encourage their uptake across the EU. The Council acknowledges the potential of micro-credentials in advancing the digital and green transitions and has funded, via Erasmus+, various initiatives that explore pathways in this area. At the same time, it recognises the challenges involved in creating micro-credentials that are flexible, relevant, and which that offer equal opportunities for certifying professional competences (Brauer & Korhonen, 2022) so that such certifications are comparable and relevant across the Member States (UNESCO, 2022b).

- **Certifying competences:** micro-credentials can be delivered by a variety of providers in formal, non-formal and informal settings, and could be included as part of ITE certification, thus assisting the reorientation of teacher education towards sustainability. In the EU, a micro-credential must include a series of standard elements to guarantee its quality (see Council of the EU, 2022a). Typically, teachers earning a

micro-credential will demonstrate that they meet the assessment criteria, using what they have learned in the teaching or specific learning programme that is attached to the micro-credential. They will send evidence of their competence, which can include videos, critical reflections and other artefacts. Often, micro-credentials come with (open) digital badges, which are visual symbols or representations recognising their accomplishment. These are seen as powerful tools for teachers to construct their portfolios in a digital format, allowing them to display and make visible their professional (LfS) competences (Brauer & Korhonen, 2022).

- **Trial experiences:** some experiences from trials in the use of micro-credentials in teacher education show that they can motivate teachers to participate in professional development programmes and support them to identify their learning needs.

  The Erasmus+ 'Teacher Academy for Sustainable Future Educators' (EduSTA) is creating digital badge-driven professional recognition pathways in which teachers can develop and demonstrate their sustainability education competences. The project considers the implications of sustainability competences in the context of curriculum development, pedagogical design and the assessment of micro-credentials in LfS, in the context of the five partners engaged in the project (see Case study 8).

  Key Sustainability Competences (KSCs) are promoted and certified through the EduSTA initiative, which is developing tools for ITE and CPD. Its experiences so far point to micro-credentials and the badge-based competence recognition system being an innovative and important means of building capability in LfS. Recognising the prior learning of educators is also an important aspect of this work, and the badge system provides transparent assessment for those who feel they have already mastered certain sustainability education competences. Those involved in EduSTA have also learnt the importance of catering for diversity – especially in relation to the contexts and opportunities to demonstrate competences. Producing a diverse palette of educational options with regard to teachers' sustainability competences, as well as opportunities for digital open badge-driven learning pathways, is proving key to attracting teachers to further their capabilities in this area.

- **Experimentation:** continued experimentation and research on how to develop and use micro-credentials in LfS is necessary in order to harness their potential for teacher education. In the US, many states are carrying out trial projects that use micro-credentials for teacher development, as these can be aligned easily with teacher standards and support different professional learning pathways (DeMonte, 2017). Scholars who have considered micro-credentials have concluded that they offer new pathways for teachers to develop themselves professionally, as well as enabling self-driven learning (Berry et al., 2016). Nonetheless, critical voices note that micro-credentials build on and encompass discourses of employability and undermine the principles of coherence, sequence and hierarchy in education programmes (Wheelahan & Moddie, 2021). These concerns are important to take on board, as the problem of atomising LfS competences has also been raised by scholars (Brundiers et al., 2020; Wiek et al., 2015).

Resources for a sustainable future

1. The value of developing teacher resources to support LfS is well recognised and has been shown to be key to mainstreaming educational initiatives in schools.
2. The internet has led to an explosion of resources becoming available to teachers, and has heightened tensions between access and quality. While these readily accessible and free materials have facilitated engagement with LfS, teachers must invest time to assess and judge their quality. National agencies and those seeking to catalyse LfS efforts could provide guidelines, criteria or professional development opportunities to assist with this task.
3. Most of the resources available are either thematic (e.g. relating to climate change) or pedagogical (e.g. problem-based learning). Only a selected number of materials offer a connected approach that aligns LfS and pedagogy in ways that support evidence-based understanding in this area.
4. National agencies that are seeking to reorientate the course of teacher education towards sustainability could consider developing resources. These must have specific explicitly defined objectives that align with teachers' needs in this area, as well as being based on extensive piloting and cycles of improvement.
5. For resources to be catalytic in their impact, their content and the activities that they ask teachers to engage in or adopt need to embrace the principles of effective teaching and learning that are necessary to reorientate education practice for sustainability.

- **Resources:** many resources are available on the internet that can be used by teachers who are interested in integrating sustainability into their teaching, from massive open online courses (MOOCs) to lesson plans. At the time of writing this report, the UNESCO resource bank 'Sustainable Development Goals – Resources for educators' included 273 pedagogical resources, ideas for classroom activities and multimedia resources detailing how best to embed LfS into primary and secondary teaching and learning.

- **Access and quality:** an international survey asked teachers about resource support, and only one-fifth of respondents reported having access to LfS materials (UNESCO & Education International, 2021). Other studies point to how a lack of resources (not only regarding LfS) is the largest obstacle to the implementation of professional development, emphasising that many times teachers have to pay for their classroom materials (Darling-Hammond et al., 2017).

  The existing tension between access and quality is well recognised (McKeown, 2014). While readily accessible and free materials and guidelines have facilitated the incorporation of LfS issues into teaching, teachers have to invest time to assess and judge the quality of these resources. Some initiatives, such as the bank of resources from UNESCO mentioned above, have carried out a careful assessment of their materials, but it is not possible to continuously check all of the resources that are created and posted online. Instead, UNESCO (2014) has called for guidelines on the design and evaluation of materials to assist teachers in making these decisions. National agencies can offer frameworks, as well as professional support, to schools and teachers so that they can identify which resources support positive change in schools and student learning (Kwauk & Iyengar, 2021). They can also encourage teacher education institutions to take these on board (McKeown, 2014).

- **Thematic vs pedagogical entry points:** one review of some of the existing resources points to how most of what is available is either thematic (e.g. focusing on climate change issues) or pedagogical (e.g. seeking to engage learners in problem-based learning). Only a limited number of resources offer an integrated approach that aligns the 'what' and 'how' of LfS in ways that support evidence-based understanding in this area.

  Worth highlighting is the 'Teaching and Learning for a Sustainable Future' multimedia teacher education programme (see Case study 3) that changed the course of teacher education for sustainability and has engaged hundreds of participants around the world. Although this particular resource dates back to 2002, much can be learned from its development, design and use.

  The success of this resource can partly be attributed to the specificity of its objectives and the way in which its modules promote active learning approaches. Despite having different authors and entry points, there is consistency and clarity across the modules. This has been achieved through extensive piloting in schools and cycles of improvement in earlier versions of the resource.

  The case study offers key replicable principles for success to those seeking to develop effective resources in this area. For example, the resource is very explicit about the actual professional development needs of teachers it seeks to address. These include the design and teaching of interdisciplinary approaches, as well as how to deal with teaching complexity and values in sustainability. A learning journal supports reflective practice and ongoing professional development.

  Also key to its success is the way in which it integrates the principles of effective teaching and learning necessary to reorientate education practice for sustainability. The 'medium' used for learning promotes and reinforces the 'message', which as embedded and consistently promoted throughout the resource.

- **Catalytic impact:** national authorities and agencies that are seeking to reorientate the course of teacher education towards sustainability could consider identifying and translating/adapting relevant existing materials, as well as developing their own resources. These materials need to specifically and explicitly identify objectives that align with the needs of teachers in this area, and be based on extensive piloting and cycles of improvement. For resources to be catalytic in their impact, their content and the activities they ask teachers to engage in or adopt need to embrace the principles of effective teaching and learning necessary for reorientate education practice for sustainability.

Changing together: collaborative enquiries and peer learning

1. Promoting and nurturing a collaborative culture in sustainability learning is a challenge for both schools and teacher education institutions. LfS networks and platforms have proved instrumental in activating this cultural change.
2. Documented practice and evaluations of networks testify to the value of a multi-stakeholder approach in promoting locally relevant education.
3. Where there is a lack of dedicated support from government or of sub-regional opportunities in LfS, networks have been proven to help facilitate access by educators to the learning materials and other resources needed in local and regional contexts.
4. Peer-to-peer learning can also provide non-threatening experiences that allow experimentation and learning. These approaches support creativity and create safe spaces in which teachers do not feel pressured to perform sustainability actions.
5. The lack of progress in embedding LfS into schools and teacher education could be attributed to teachers' lack of experience and expertise in effecting change. LfS requires educators to change learning dynamics and influence education practices beyond the classroom. Building skills for change and leadership among educators is vital. Initiatives that enable educators to come together to plan and map strategies for change have a longer-lasting impact. Preparing teachers to lead change is an important aspect of the mainstreaming process.
6. Participatory research approaches and change academies provide ideal platforms for institutions to challenge their perceptions and misconceptions about sustainability, as well as to clarify what it means to create authentic learning opportunities in this area. They provide impetus and motivation and can ripple changes across the teacher education system. Those intending to reorientate teacher education towards sustainability should consider investing in these impactful approaches.

- **Learning together:** most examples cited so far in this report are addressed towards individual teachers. Evidence points to the value of collaborative learning processes and the potential of networking to mainstream LfS in schools and teacher education institutions (European Commission, 2022a). Working together with other practitioners and stakeholders such as environmental NGOs, media literacy organisations, youth groups and others provides unique professional learning experiences for teachers and teacher educators interested in gaining LfS skills. However, promoting and nurturing a collaborative learning culture in sustainability is a challenge for both schools and teacher education institutions. LfS networks and platforms have proved instrumental in activating teachers' collaborative learning.

  Examples of collaborative platforms and networks that are positively supporting teachers' work in the area of sustainability include over 170 Regional Centres of Expertise on Education for Sustainable Development (RCEs) around the world. Documented practice, as well as numerous evaluations of the RCE network, testify to the value of a multi-stakeholder approach and to the promotion of locally relevant education (Fadeeva & Mochizuki, 2007; UNESCO, 2014; UNU-IAS, 2020).

- **Lack of national support and incentives:** evaluations also suggest that collaborative platforms and networks are particularly important in countries where there is a lack of dedicated support from government or of sub-regional opportunities

in LfS (UNESCO, 2017). In such environments, collaborative platforms and networks facilitate access by educators to learning materials and other resources needed in local and regional contexts (Scoullos, 2018).

The experience of MEdIES (see Case study 4) illustrates how an NGO operating in the Mediterranean region has been involved in teachers' CPD since 1992, and has engaged just under 10,000 teachers and teacher educators. Its efforts have been particularly impactful in countries where national engagement or opportunities in LfS are limited or lacking. MEdIES explicitly recognises that schools and training institutions require support in order to transition towards sustainability. The NGO offers workshops based on active learning and place-based strategies to develop knowledge and understanding about issues of natural resources, and helps teachers build networks that help them to take learning outside the classroom. Teachers and teacher educators in some countries are reliant on non-formal actors like MEdIES to build teachers' capacities in LfS and to secure funding for teacher education programmes (Bourn et al., 2017).

- **External collaboration and access to expertise:** networks and collaborative platforms outside school enhance opportunities for dialogue, which is essential to the professional development of teachers in the area of LfS. Documented practice reveals how in Sweden, upper-secondary school teachers have engaged in external 'open-minded collaborations' with university experts and NGOs, that have helped teachers to stop viewing complex and wicked issues as problematic to teach, and to tackle them confidently in their classrooms. The efforts of these teachers have become award-winning, as they supported students in becoming informed and active democratic citizens (Sund, 2013).

  Similar experiences can be found in Italy, where education authorities have built a 'Green Community' initiative. Breaking away from the traditional in-service course offering, Italian efforts have been focused on creating a community of technical experts and professionals that can assist schools in addressing learning needs for sustainability, as well as helping the school transition to a greener future (see Case study 1). The initiative has also engaged the national broadcaster to extend the work of schools in this area. Broadcasting corporations have substantial experience in communicating and presenting complex material in ways that are accessible. These types of partnerships increase the effectiveness of teacher development initiatives.

- **Peer-to-peer learning:** peer learning can provide non-threatening experiences that allow educators and teacher educators to experiment and learn from each other's successes. These approaches support creativity and create safe spaces in which teachers do not feel pressured to perform or achieve. This can take a variety of forms, either through formal networks in which educators and teacher educators journey together towards the attainment of shared goals, or through informal exchanges in their communities of practice (Kennedy, 2011; Vangrieken et al., 2015). These approaches have been shown to lead ultimately to positive impacts on teachers, institutions and student learning, as they maximise capacity, increase engagement and accelerate whole-school actions for sustainability (Tilbury, 2011).

  The experiences of the International Network of Teacher Education Institutions (INTEI) confirm the value of peer-to-peer learning approaches. For more than 25 years, the INTEI has promoted the scaling up of LfS in teacher education policies, programmes and practices (McKeown, 2012). During this time, the network has provided spaces for motivation, experimentation and support. Evaluations have documented how its members have successfully implemented teaching and learning initiatives into ITE and

CPD programmes, and have had an impact on policy and practice beyond their own institutions (McKeown & Hopkins, 2007) (see Case study 9).

- **Learning through and for change:** the quest for whole-school approaches to sustainability requires changes to the ways in which teachers view and engage with the school community – becoming active agents of school change. The literature confirms that embedding LfS into teacher education means teachers need to learn approaches to sustainability that are transformative rather than adaptive (Evans, 2020). This requires teachers to learn for change, as they go beyond including thematic examples in a course or learning opportunity, to becoming involved in curriculum and school development.

  Diverse experiences have demonstrated the power of participatory enquiries (often termed 'action learning', 'participatory action research' or 'change academies') to help educators learn 'through' and 'for' change. These approaches involve teachers working in teams to seek changes for sustainability in schools and teacher education institutions. National authorities that are keen to mainstream LfS across schools and teacher education should consider prioritising such learning experiences, as they have shown to be among the most effective ways of transforming education towards sustainability. However, these initiatives require time, space and funding in order to be effective.

- **Change academies:** the University Educators for Sustainable Development initiative (UE4SD) has shown how change academies can assist with the attainment of significant milestones along the educational transformation journey (see Case study 6). Sustainability education has been around since the early 1990s, but leaders of the UE4SD project have understood that the lack of progress may be attributed to one key factor: namely, those driving LfS agendas often have little experience of educational change (Ryan & Tilbury, 2013). However, LfS requires educators to have the ability to change learning dynamics and influence education practices beyond the classroom, and thus to shape the priorities and plans of education providers. Building skills for change and leadership among educators is vital. The UE4SD project created spaces for teams from the same school, college or university to come together to plan and map strategies for change. This is an important aspect of the mainstreaming process. It has provided tangible insights into how effective professional development for change can take place; through UE4SD's Academy, new formats have been explored that are different from those traditionally adopted. The initiative acknowledged that different learning opportunities are needed in order to think through how change in education systems can happen, and how best to engage colleagues, students and professional partners with LfS in an institutional or school context.

- **Participatory action research:** also worthy of note is the work undertaken by the Australian Institute in Education for Sustainability (ARIES), which used participatory action research to leverage change across the teacher education system. This well-documented initiative embedded change and transformed the presence of sustainability in teacher education. It was initially piloted in seven higher education institutions, which identified key agents of change in the system (Ferreira et al., 2007; Ferreira et al., 2019).

  Similarly, in Ontario (Canada), faculties of education and their communities of practice have succeeded in influencing teacher education, extending LfS across the province. One teacher educator has described how she was able to work with others to move from having a small extra-curricular LfS programme, to building a robust programme for pre-service teachers, as well as infusing sustainability into a diversity of courses

and elective modules, organising an annual conference on LfS that was open to the whole community, and hosting more than 20 co-curricular LfS events each year (Inwood, 2020). Mapping the teacher education system and identifying key agents of change within it was seen as an important contributor to this success.

Other examples of such teacher change initiatives include the Baltic and Black Sea Circle (see Salite, 2015) or the Caribbean Network for ESD (see Down & Nurse, 2007), which have had documented impact. Many of these have been inspired by the work of the INTEI (see Case study 9), and demonstrate how peer-to-peer learning goes hand in hand with the planning and implementation of change strategies for sustainability in education.

- **Mapping change journeys:** participatory action research and change academies have proven effective in mainstreaming LfS, as they allow institutions to understand where they are on their journey and to define a map of actions that can take them where they want to go. Also of note is the 'Sustainability Starts with Teachers' initiative, a UNESCO-led capacity-building programme in sustainability for teacher educators in Southern Africa. This engages participants in defining change projects at their own institutions, with a focus on teaching practice improvements, assessment, integrating culture and indigenous knowledge into the curriculum, community engagement, and science and technology innovations for sustainability. Whole-of-institution responses to sustainability are sought. Recently, the programme has also launched an online course for participants to understand the complexity of LfS, as well as assist with the design of their change projects.

- **Authentic learning and systemic change:** what has been learned from these experiences is that participatory research approaches and change academies provide ideal platforms for institutions to challenge their perceptions and misconceptions about sustainability, as well as clarify what it means to create authentic learning opportunities in this area. They provide impetus and motivation and can lead to changes that can have important ripple effects across the teacher education system (Christoforatou, 2021; Rauch et al., 2021). Evidence points to how those intending to reorientate teacher education towards sustainability should consider investing in these approaches.

Framing LfS as educational innovation or renewal

1. Efforts that articulate the value of LfS to education and learners can deepen the engagement of teachers and educators. They are effective in reaching teachers who are yet to commit to sustainability, but who have an interest in educational quality or creating better opportunities for students.
2. Connections need to be made not just in terms of framing, but also in the way that initiatives are communicated to stakeholders. This will assist in extending the impacts of efforts beyond individual teachers, to supporters and leaders.
3. In addition, initiatives that connect LfS to the reform of educational pedagogies more broadly, as well as to other educational agendas, have a greater chance of success. Such initiatives are effective in helping leadership teams to see how LfS contributes to meeting the core priorities of the school or institution.
4. Many initiatives show how aligning LfS with the digital transition has extended the appeal of and interest in sustainability among educators and schools. Both LfS and

the digital transition involve a whole-school perspective, and can inform each other in terms of overcoming barriers to innovation.

- **Value of LfS to education:** efforts that articulate the value of LfS to education and learners (and not just to the environment) are seen to deepen the engagement of teachers and educators (see Kapitulčinová et al., 2015). Such efforts are especially effective in reaching teachers who are yet to commit to green agendas, but who have an interest in educational quality or creating better opportunities for learners (Lambrechts et al., 2017).

  The literature shows how achieving this engagement is not simply a matter of connecting agendas but also of articulating the value of LfS to education and learners (Ryan & Cotton, 2013). Clearly articulating the ways in which sustainability learning principles relate to existing practice appears key to the success of many initiatives, as not all teachers have yet committed to the green agenda, but most have an interest in educational quality or creating better opportunities for learners.

- **Aligning agendas:** equally, initiatives that tie sustainability learning to the reform of educational pedagogies more broadly, as well as to other educational innovation agendas, have a greater chance of success. Such initiatives are effective in engaging leadership teams who, as a result, can see how LfS contributes to meeting the core priorities of the organisation or institution.

  The UE4SD initiative documents how mainstreaming the LfS agenda requires the engagement of leadership teams. The project found that this often means aligning LfS with the core priorities of the organisation or institution, which may include improving literacy, global education, curriculum reform, pedagogical innovation or 'whole-person' education (see Case study 6).

  The UE4SD initiative was framed using language that appealed to those not traditionally associated with LfS. This made it clear that the initiative intended to improve education and not just address sustainability. This meant that university leaders found it easier to engage and align it with institutional change priorities that included pedagogical innovation, student engagement and core competences. This resulted in 55 higher education institutions, organisations and associations across 33 countries becoming engaged in the reorientation of learning and teaching towards sustainability.

- **Digital transition:** the 'Teaching and learning for a sustainable future' resource also embraces alignment (see Case study 3). In this case, the alignment is with supporting the adoption of digital tools and technologies in schools – an agenda that has been gathering traction more recently with the aspirations related to the digital transition. Many initiatives demonstrate this alignment between LfS and the digital transition, and how it has extended the appeal of and interest in sustainability among educators and schools. Both LfS and the digital transition involve a whole-school perspective, and can inform each other in terms of overcoming obstacles to innovation.

Fresh insights and visions: futures education and new technologies

1. Parallels can be drawn between the opportunities and challenges involved in implementing the digital and green agendas in schools. Connecting these efforts in teacher education can support the mainstreaming of LfS.

2. Research suggests that connecting teachers with research institutions and groups engaged in futures and digital learning projects can inspire teachers to rethink their practices in the light of sustainability.
3. Futures education creates opportunities to enhance perceptions, embrace complexity and create the new sense of agency required to attain these futures. It has been shown to capture the interest of teachers and learners, enabling deeper engagement with the concept of sustainability.
4. The metaverse offers great potential to go beyond the ways in which educators teach today, as immersive learning experiences can change how we structure and plan education. Stepping into 'metaworlds' could facilitate the visualisation of learning scenarios in which complex socio-ecological challenges are explored collaboratively. Students can step into other's shoes, or imagine a different future. Such visualisations have the potential to transform LfS in schools and teacher education.
5. The potential to shape learning experiences in LfS and to consider alternative futures using new technologies is significant. However, it must be recognised that while some teachers are captivated by innovations such as the metaverse, others fear the changes that technology might bring.

- **Finding parallels and connections:** significant parallels can be drawn between the opportunities (and challenges) that surround engaging educators in the digital transition and the uptake of LfS by schools. New technologies can bring fresh perspectives and engagement, and the alignment of both agendas in teacher education can support the mainstreaming of sustainability learning. Specifically, research suggests that connecting teachers with research institutions and groups that are engaged in futures and digital learning projects can inspire teachers to rethink their practices in the light of sustainability.

- **Futures dimensions:** an increasing recognition that our futures are shaped by decisions made in the present underpins calls for a shift in educational pedagogies and processes in teacher education. By becoming more conscious of how our understanding of the future influences current decisions, both in a professional and personal context, we can make choices that are better informed and less shaped by biases and mistaken assumptions (CIFS, 2021). It is within this context that interest in futures education and literacy is on the rise (see Miller, 2018). Futures education provides the means to not only question assumptions about the future and to seek alternative visions for the attainment of sustainability, but also to create opportunities to enhance perceptions, embrace complexity and create the new sense of agency needed to attain these futures (Julien et al., 2018; Kazemier et al., 2021). This explains why and how futures education can capture the interest of teachers and learners and enable deeper engagement with the concept of sustainability.

- **Gaining traction:** futures education is not a new concept in sustainability education, as it has been associated with LfS since the 1980s (see Hicks, 1998); however, it has gained ground over the last decade. The UNESCO expert review of education for sustainable development identified futures thinking as a core element of learning (Tilbury, 2011), More recently, the EU's 'GreenComp' has included it as a core competence (Bianchi et al., 2022).

  In 2019, the UNESCO Chair for Futures Literacy was launched at Hanze University of Applied Sciences (Netherlands), providing a platform to conduct research and supporting teacher educators and educational professionals to further explore the

theory and practice of futures education. The Chair offers various training opportunities, including participation in Futures Literacy Labs. These 'learning by doing' workshops enable participants to reveal, reframe and rethink the assumptions they use to imagine futures.

- **Pedagogy for change:** those engaged in the decolonisation of education are also supportive of these new approaches, as they are seen as challenging socially dominant narratives that pre-empt particular futures determined by small groups within society (Lotz-Sisitka, 2017). Proponents of decolonisation call for the democratisation of the future through the approaches of futures literacy and futures thinking. These empower learners to better understand the role of the future in what they see and do at present. Being futures literate empowers the imagination, and enhances our ability to prepare, recover and invest as changes occur (CIFS, 2021). Those seeking to catalyse change in teacher education could promote the pedagogies for change that underpin futures education, as well as considering the opportunities it offers to democratise the future.

- **New frames and insights:** the Copenhagen Institute for Future Studies (CIFS) brings together a group of experts seeking to join up the agendas of technological transition, sustainable development, and the development of educators as future practitioners. Their experiences document how researchers can play an important role in inspiring and empowering teachers to engage with the digital transition, and in parallel consider the future of learning (see Case study 7). The case study shows how futures thinking is best practiced as a social process and through frames of collective intelligence in which cognitive assumptions can be questioned and worldviews challenged. It demonstrates how arts and culture provide ideal platforms for interrogating the , as they help to explore beyond ordinary, national, materialistic paradigms, providing a complement to the science already taught in schools. Through these channels, learners can view or create alternative ways of knowing and being.

- **The metaverse:** the metaverse is also drawing the attention of futurists and those concerned with learning about the future. The metaverse is an immersive internet experience supported by virtual reality or augmented reality technology. Analysts suggest that it will transform the ways in which educators currently teach, as immersive learning experiences will completely change how we structure and plan education (Cortés, 2022). Stepping into 'metaworlds' can facilitate the visualisation of learning scenarios in which complex socio-ecological challenges are explored collaboratively. Students can step into other's shoes to understand how other people's living conditions differ from their own. They can experience what it might be like to live in a green smart city (see Case study 7). The potential to transform learning experiences in LfS and to consider alternative futures is significant. However, we must recognise that while some teachers are captivated by innovations such as the metaverse, others fear the changes that technology might bring to education. It is also important to remain cautious and critical about the use of new technologies in education. This is especially relevant given the social and ethical concerns linked to artificial intelligence, as well as the risks that arise from social media concerning the exploitation of data and people's privacy and security. It is essential that a healthy scepticism is associated with the application of new technologies, and that digital literacy is developed alongside teachers' critical reflective practice.

Chapter 6. Recommendations

This research study has pointed to a number of key needs and identified a series of catalytic entry points that can support change for sustainability. Informed by these findings, the following recommendations identify steps that could be taken at policy and practice level to strengthen the embedding of LfS across teacher education. The recommendations are primarily intended for policy makers at local, regional, national and European level. These stakeholders in the teacher education system, previously identified in Figure 1, are key gate-keepers as well as agents of change, as they have a role in providing the frameworks, conditions and means to promote LfS in teacher education.

Please note that some recommendations are relevant to numerous stakeholder groups, as mainstreaming LfS in teacher education requires a whole-of-sector and multi-stakeholder approach. It is also important to highlight that the extent of change and the specific tools required to support this change will depend on local scenarios, the experience of stakeholders in LfS, and the policy frameworks in place.

- **Recommendation 1. Celebrate** by visibly showcasing political leadership and policy commitment to LfS within the context of teacher education. This will attract the attention of others to this agenda. Similarly, promote a whole-of-government response to LfS that leads to integrated policy and use of resources. This could be achieved by documenting and celebrating best practice in EU Member States and beyond. *(Ministries, agencies and governing bodies).*

- **Recommendation 2. Convene** authorities, agencies and professional groups to consider how to embed LfS into professional standards or competence frameworks for teachers. Integrate LfS into definitions of what it means to be a qualified and effective teacher. Establish expectations, evaluation systems and pathways for teachers to develop and demonstrate competences in this area. It is important that this is achieved through collaborative processes involving the teaching profession. *(Ministries, agencies and governing bodies; teacher education providers; schools)*

- **Recommendation 3. Promote** the use of self-evaluation approaches and reflective practice tools to drive the development of teachers' competences in LfS. This should be carried out by establishing networks of teachers, evaluators and 'critical friends' that encourage deep reflection and challenge current practices. Consideration should be given to generating guidelines and tools in this area. *(Ministries, agencies and governing bodies; teacher education providers; schools)*

- **Recommendation 4. Recognise** best practice in schools, colleges and teacher education, as well as outstanding educators in LfS, through the use of award schemes. A European-wide competition would not only motivate engagement but also trigger conversations about what constitutes best practice in this area. Member States could establish their own processes and nominate candidates, encouraging them to consider what best practice in LfS looks like. *(Ministries, agencies and governing bodies; teacher education providers; community stakeholders; schools)*

- **Recommendation 5. Create**, via grants and funding schemes, spaces for teachers and teacher educators to grow LfS projects through teacher collaboration and peer-learning. Encourage authorities and agencies to provide similar collaborative learning pathways at national and sub-regional levels *(Ministries, agencies and governing bodies; teacher education providers and stakeholders; schools).*

- **Recommendation 6. Incentivise** teachers to develop their competences and experiences in LfS. This can be achieved by including sustainability criteria in role descriptions, the responsibilities of positions, and in career progression profiles. A publication that captures the best of these examples could help to inspire others *(Ministries, agencies and governing bodies; professional bodies and unions).*

- **Recommendation 7: Support** teacher education providers through targeted schemes that provide funding, networking platforms and other resources to assist them in integrating LfS into their professional education and development offerings. Such efforts should be aimed at initial and practising teachers as well as headteachers and education leaders *(Teacher education providers).*

- **Recommendation 8. Encourage** the certification of LfS training through micro-credentials. These micro-credentials should be flexible, relevant, offer equal opportunities to teachers, and be transferrable. The European Commission could work alongside relevant stakeholders to support experimentation and piloting in this area. *(Higher education institutions; community stakeholders; schools; teacher education providers)*

- **Recommendation 9. Advance** the development of resources for teacher education providers by promoting efforts that address LfS as a pedagogical strategy through a whole-school approach. Work with stakeholders to ensure that these resources are relevant to teachers' needs in this area (and not simply environmental objectives), and are based on extensive piloting and cycles of improvement. *(Ministries, agencies and governing bodies; teacher education providers; schools; community stakeholders)*

- **Recommendation 10. Develop** guidelines and a set of criteria to evaluate the effectiveness of LfS professional development programmes and resources offered by teacher education providers. Encourage the adaptation of these guidelines at national and sub-regional levels, and for the particular stakeholder groups. *(All)*

- **Recommendation 11. Raise awareness** of the importance of multi-stakeholder platforms that provide professional learning opportunities and facilitate access to LfS materials, especially where there is a lack of dedicated support from government-dedicated, or of sub-regional opportunities in relation to sustainability learning. *(All)*

- **Recommendation 12. Invest** in participatory action research and change academies that enable stakeholder groups to develop and implement strategic actions for LfS with regard to policies, programmes and practice. Encourage national authorities, professional bodies and other stakeholders to support these processes. *(All)*

- **Recommendation 13. Define** the value of LfS to learners, and demonstrate how it can contribute to meeting core educational priorities. This will attract the attention of those teachers who are not yet engaging with sustainability, but who may be curious to learn more. (*Schools; teacher education providers; community stakeholders)*

- **Recommendation 14. Connect** programmes and funding schemes that encourage better alignment between the digital and green transitions in teacher education, as a way of increasing the uptake of LfS by teachers. Encourage authorities and agencies to do likewise. *(Ministries, agencies and governing bodies)*

- **Recommendation 15. Inspire** greater engagement with LfS by encouraging teachers and teacher educators to work with research institutions and groups engaging with futures and metaverse learning projects. Form partnerships that will encourage teacher

education providers to experiment with these areas, and explore ways to transgress the boundaries current educational approaches. (*Schools; teacher education providers; community stakeholders).*

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Appendices

Appendix 1. Case studies

The case studies referred to in the text are available in a separate document entitled *'Learning from thirty years of experience: Case studies in teacher education for sustainability'* (Tilbury & Mulà, 2023):

Case study 1. Green Community Initiative: Italy

Case study 2. Career Progression and Assessment Tools: Hungary

Case study 3. Resources for Change: Teaching and Learning for a Sustainable Future (International)

Case study 4. MEdIES Regional Capacity Building: NGO Partnership (Mediterranean)

Case study 5. Embedding LfS into Teachers Professional Standards: Scotland

Case study 6. The University Educators for Sustainable Development Initiative: (European)

Case study 7. Futures Education: Denmark

Case study 8. EduSTA: Micro-Credentials for Educators (European)

Case study 9. The International Network of Teacher Education Institutions (INTEI) (International)

Appendix 2. Key Informant Group

Jaume Ametller (Catalonia)

Jaume is an Associate Professor *Science Education* at the Faculty of Education and Psychology of the University of Girona. Since 2019, he has been the Director of the MIF Programme (Initial Teacher Education Improvement Programme), supported by the General Directorate of Universities and the Government of Catalonia. He is also Director of the University's Institute of Education, which supports the professional development of educators at all levels of education (from early childhood to university) and provides advice on issues regarding educational planning, research and pedagogical innovation in the province of Girona.

Antje Brock (Germany)

Antje Brock has been a researcher at Institut Futur since October 2015 and is part of the team that is developing a framework and monitoring the implementation of ESD in Germany. Previously, she was a research assistant at Bielefeld University, where she worked as a lecturer in educational sciences. She is also a board member of the German Early Career Scientists in Future Earth and a member of the Environmental Justice Institute.

Jo-Anne Ferreira (Australia)

Jo-Anne is Head of School and Dean (Education) at the University of Southern Queensland. Previously, she was Professor of Sustainability Education (La Trobe University) and Director, Centre for Teaching and Learning, and Academic Director, SCU Online (Southern Cross University). Her recent research focuses on systems-based change in teacher education and the strategies and techniques deployed by environmental and sustainability educators to empower learners to become environmental citizens.

Evgenya Kostadinova (Bulgaria)

Evgeniya is the Head of Curricula and Study Contents Directorate at the Ministry of Education and Sciences in Bulgaria. She has an expertise in and has engaged in national and European policy development in the area of pre-school and school education, teacher development and international relations. She has been a member of various international policy expert groups on sustainability learning and democratic citizenship, including the UNECE Steering Committee on Education for Sustainable Development, the Council of Europe Working Group on the Reference Framework on Competences for Democratic Culture, the Standing Group on Indicators, Working Group on Schools, EC Education Committee, etc.

Vicki Malotidi (Greece)

Vicki is a senior education programme officer at the Mediterranean Information Office for Environment, Culture and Sustainable Development (MIO-ECSDE) on Education for Sustainable Development, a non-profit Federation of 133 Mediterranean NGOs working in the fields of the environment and development. Vicki is responsible for the professional development of educators and the development of pedagogical resources in ESD.

Michela Mayer (Italy)

Michela is a recognised national and international expert in the field of LfS with strong experience in evaluative research, comparative research and action research. She was a member of the Italian UNESCO commission for ESD and the ENSI International network Steering Committee. As President and founder of ENSI, she was involved in various projects aimed at developing teachers' competences in LfS. As Researcher at the Italian National Institute for the Evaluation of the Educational System (INVALSI), in 2000 she carried out a National Survey on Environmental Sustainability competences involving 50,000 students. As founder and member of the steering committee of the IASS – Italian Association for Sustainability Science, over the last six years she has been involved in national and European projects relating to the development of competences in environmental sustainability among formal and non-formal educators.

Jacqueline Morley (Scotland)

Jacqueline joined the General Teaching Council, Scotland Education Team as Education Advisor (Professional Learning) in 2014. Her work includes a key focus on support for professional development structures and learning, as well as professional review processes with a focus on LfS. She is invested in professional development strategies and systems that impact education. She has worked extensively on CPD and leadership support, with a particular emphasis on coaching and developing a mentoring culture supported by action learning work. She has worked on various Headship panels. She currently works with accredited teacher education models for sustainability.

Elaine Nevan (Ireland)

Elaine is the Executive Director of ECO-UNESCO, an NGO that supports education for sustainability and learning across Ireland, with a particular focus on youth development, secondary education and teacher education. She is a member of the Advisory Group on Education for Sustainable Development at the Department of Education, Ireland, and a Ministerial Appointee to the Environmental Protection Agency.

Cristina Olteanu (Romania)

Cristina is an adviser on European Affairs at the General Directorate for International Relations and European Affairs at the Ministry of Education of Romania. She is a national focal point for the UNECE Education for Sustainable Development Steering Committee. She is actively involved in the European affairs sector in relation to the negotiation of various documents on education and training of the Committee on Education and the European Council – Education section.

Mónika Réti (Hungary)

Mónika is a policy officer at the Department of Content Development in Public Education of the Ministry of Interior. She has been a member of various policy expert groups on sustainability learning in Hungary and Europe, including the UNECE Education for Sustainable Development Steering Committee. During her career, she has participated in large-scale STEM education and sustainability projects (involving research and development activities), which have provided her with a broad view of international trends in these fields.

Appendix 3. Case study informants

- **Eveliina Asikaninen**
  School of Professional Teacher Education, Tampere University of Applied Sciences (Finland)

- **Grandi Gianluca**
  Ministry of Education (Italy)

- **Charles Hopkins**
  UNESCO Chair in Reorienting Education towards Sustainability, York University (Canada)

- **Katrin Kohl**
  Executive Coordinator to the UNESCO Chair, York University (Canada)

- **Nicklas Larsen**
  Senior advisor at the Copenhagen Institute for Future Studies (CIFS) and UNESCO Chair on Anticipatory Leadership & Futures Capabilities (Denmark)

- **Vicky Malotidi**
  Senior Project Officer, MIO-ECSDE (Greece)

- **Michela Mayer**
  Steering Committee of the Italian Association for Sustainability Science (Italy)

- **Ian Menzies**
  Senior Education Officer, Education Scotland (Scotland)

- **Jacqueline Morley**
  Senior Education Officer, General Teaching Council of Scotland (Scotland)

- **Mónika Réti**
  Education Policy Officer, Ministry of Interior (Hungary)

- **Sanna Ruhalahti**
  School of Professional Teacher Education, Tampere University of Applied Sciences (Finland)

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