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Theoretical article

# Green and Digital Pedagogies. A Mapping Exercise on CPD Programmes in Teacher Education

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**Abstract**

The current European policies in teacher education address two key-aspects nowadays: sustainability and digital innovation. Sustainability in education goes beyond environmental content and shapes the values, behaviours, and systems for a just and equitable future. Modern teacher education must go beyond basic ICT use and should equip teachers with digital pedagogical competence. An overview of EU Policy Landscape on the above-mentioned issues enhances that green skills, climate literacy, and environmental awareness need to be developed across all levels of education and that digital education should be strengthen by fostering a high-performing digital education ecosystem and enhancing digital skills and competences. Even dough environmental sustainability and digital transformation are approached separately, they can mutually reinforce each other. Our analysis shows how teacher education can contribute to empowering both eco-conscious and digitally skilled citizens. The integrated practices create powerful opportunities for transformative education, that respond to complex societal challenges (e.g., climate change, digitalization, inclusion), promote active engagement and critical thinking, and prepare students for intercultural and sustainable citizenship. Therefore, we conducted a mapping exercise to perform an audit of continuing education programs promoting lifelong learning opportunities in the green and digital areas. Our findings show that EU-Supported CPD Programmes provide a wide range of structured professional learning opportunities for teachers, especially those focusing on innovation, inclusion, and sustainability. Besides, we focused on Romanian national context and listed the challenges and opportunities regarding green and digital competences.

Keywords:
sustainable pedagogies, digital competences, teacher education, future-oriented practices

## 1. Introduction

The transition to green and digital pedagogies is getting more and more relevant worldwide. It is undeniable that the climate has changed and that the rapid degradation of the environment threatens us all. As European strategic plans enhance, education and training are seen as essential to fostering the knowledge, skills, and values necessary for the green transition. Therefore, teachers play a central role in developing climate literacy and sustainability mindsets, integrating environmental awareness into all subjects and school culture, and in leading by example in promoting eco-responsibility. The implications for teacher education highlight the necessity to include sustainability education, climate justice, and interdisciplinary approaches in teacher education programmes. Thus, teachers must be trained to lead environmental education initiatives, model green practices, and develop eco-agency in learners (European Commission, 2020). At the same time, teachers should be prepared to design and deliver blended, online, and hybrid learning and should be prepared to put emphasis on equity and inclusion, to closing the digital divide and supporting disadvantaged learners. The European Framework for the Digital Competence of Educators (DigCompEdu) provides a general reference frame to support the development of educator-specific digital competences in Europe, and it was developed by The Joint Research Centre (JRC) of The European (European Commission, 2022).

## 2. Theoretical foundation

The Green Deal (2019 – 2024) was the EU's flagship strategy to achieve climate neutrality by 2050 (European Commission. (n.d.); European Commission, 2020). In these terms, the role of education systems is to recognize education as a transformational force in the shift toward sustainability. Nevertheless, this target calls for the development of green skills, climate literacy, and environmental awareness across all levels of education and emphasizes the need to reorient curricula, teacher education, and school practices toward sustainability. Therefore, since 2022, Council Recommendation on

learning for environmental sustainability (European Council, 2022) proposes the integration of sustainability across all education sectors, the support for teacher training on environmental topics, and the promotion of whole-institution approaches (e.g., green campuses, eco-pedagogy). Green Education in Teacher Training targets the core-concepts of sustainability, eco-pedagogy, and climate literacy, integrating climate change and sustainability into teacher training curricula. Sustainability in education goes beyond environmental content and it's about shaping values, behaviours, and systems for a just, equitable, and a future in which we all can live. The most appropriate strategies in teacher training promote a whole-school approach, embed systems thinking, and support cross-curricular links. The Eco-Pedagogy empowers teachers and learners to become agents of change by linking social justice and environmental justice and encouraging critical reflection on unsustainable practices. Climate Literacy equips teachers with the ability to understand the scientific basis of climate change, to recognize its societal, economic, and ethical impacts, and to take informed decisions and take climate-positive action. Therefore, teacher education must build confidence and competence to teach about climate change from at least three perspectives: factually, emotionally, and ethically (Vela Almeida et al., 2023; Zguir, Dubis, and Koç, 2022).

Embedding sustainability requires both structural and curricular shifts. First, it will address Curriculum Design, including mandatory modules or topics on environmental science, climate ethics, or sustainable development goals (SDGs) and offering interdisciplinary projects linking science, geography, arts, and civic education. Thus, the Pedagogical Training will equip teachers with acquisitions that will allow them to facilitate experiential, outdoor, and inquiry-based learning, to incorporate place-based education and real-world case studies, and to address eco-anxiety in learners with hopeful narratives. The Institutional Culture will transform campuses and practices from the ecological perspective and will Encourage teachers' reflection on their own consumption, values, and classroom practices. The Frameworks for Green Competences define sustainability in education through the lens of four competence areas: Embodying sustainability values (responsibility, justice), Embracing complexity in sustainability (systems thinking), Envisioning sustainable futures (creativity, long-term thinking), Acting for sustainability (agency, collaboration) (Bianchi et al., 2022). The European Sustainability Competence Framework regulates in teacher education aspects of curriculum design and assessment rubrics, self-assessment and peer feedback tools, or professional development roadmaps. The UNESCO Education to Sustainable Development 2030 Framework provides a global benchmark for reorienting education systems toward sustainability and emphasizes some key issues: whole-institution approaches, transformative pedagogies, local-global connections, advocacy for inclusion and equity (UNESCO, 2019).

Digital Education Action Plan (2021–2027) is the strategy to strengthen digital education across Europe post-COVID and beyond by two strategic priorities: fostering a high-performing digital education ecosystem and enhancing digital skills and competences for digital transformation (European Commission, 2021). The relevance to teachers consists in emphasizing teacher training as a core priority promoting professional development in digital pedagogy, including aspects regarding digital content creation, use of AI and virtual learning environments, data privacy, ethics, and safety. The Implications for Teacher Education require the integration of digital competence development in initial teacher education and CPD. The comprehensive framework developed by the European Commission (European Commission, 2022) that defines what it means to be digitally competent as an educator combines 22 specific competences with 6 proficiency levels (from Newcomer to Pioneer) Structured in 6 competence areas: Professional engagement; Digital resources; Teaching and learning; Assessment; Empowering learners; Facilitating learners' digital competence. In Teacher Education, the framework acts as a benchmark for curriculum design in teacher education, supports self-assessment and professional development planning, and Encourages reflection on how digital tools can enhance pedagogy and support inclusivity. Ref Modern teacher education must go beyond basic ICT use. It should equip teachers with digital pedagogical competence, that empower them to: design digitally enhanced learning experiences, manage blended or online classrooms effectively, facilitate collaborative and interactive learning using digital tools, assess learning through digital formative and summative tools, address ethics, privacy, and well-being in digital contexts. This shift requires: curriculum alignment with frameworks like DigCompEdu, continuous upskilling opportunities for both pre-service and in-service teachers, a new

mindset of innovation, flexibility, and adaptability. Artificial Intelligence (AI) in Education supports personalized learning, automated assessment, and adaptive feedback. That claims teacher education to prepare future educators with abilities of understanding the potential and the limits of AI and the ethics of AI tools, aiming at addressing students' awareness of AI and its use, critical thinking about algorithms, bias, and data use. Digital Citizenship appears essential for promoting responsible, safe, and informed digital behaviour. Digital citizenship emerges from media literacy, online safety and cyberbullying prevention, awareness of digital rights and data protection, and participation in digital spaces.

As teacher education sits at the intersection of systemic reform and classroom innovation, the alignment with the Green Deal and Digital Agenda requires teacher education systems to: rethink curricula and pedagogies to include sustainability and digital citizenship, to develop new competence frameworks for both pre-service and in-service teachers, to integrate interdisciplinary, experiential, and project-based learning approaches, and to build teacher capacity to engage students in climate action and ecological thinking, to use digital tools to personalize, enhance, and expand learning opportunities, and to ensure equity by addressing the digital divide and empowering all learners, regardless of their background. Ref

Council Recommendations on Teacher Education include:

1. *Council Recommendation on Learning for Environmental Sustainability (2022)* urges member states to:

- Embed sustainability in teacher education;
- Foster whole-institution approaches in schools;
- Provide upskilling opportunities for teachers on climate and environmental education (European Council, 2022).

2. *Council Recommendation on Improving the Provision of Digital Skills in Education and Training (2023)* focuses on boosting digital literacy, including for teachers and trainers and stresses the need for clear standards and national frameworks for digital competence development (European Council, 2024).

In teacher education, these key EU policies converge on three major themes: Competence-Oriented Teacher Development, Systemic Transformation of Teacher Education, Equity and Inclusion. In Competence-Oriented Teacher Development frame, teachers need new competences: sustainability literacy, digital skills, cross-disciplinary thinking on the one hand, and policies stress lifelong learning, reflective practice, and innovation in teacher education, on the other hand. From the Systemic Transformation of Teacher Education point of view, The Green Deal and DEAP both call for system-wide changes: curriculum redesign, institutional change, cross-sector partnerships. Teacher education institutions are expected to become agents of change for sustainable and digital societies. Regarding equity and inclusion, both agendas address social justice: reducing the digital divide, supporting environmental justice, and preparing teachers for inclusive, learner-centred classrooms.

## 3. Research methodology

Considering the embedded approach of green and digital competences in teacher education, we formulated the research question that guided our study: *How are addressed the green and digital pedagogies in CPD*? The first aim of our investigation was to identify the CPD targeting green and digital pedagogies worldwide. The second aim was to list CPD targeting green and digital pedagogies in Romania. Therefore, we performed a mapping exercise to identify the programmes that green and digital aspects in teaching.

## 4. Results

**Table 1**

*Green, digital, green and digital themes identified in training courses provided by the European School Education Platform*

| **Green Themes** | **Digital Themes** | **Green and digital Themes** |
|---|---|---|
| Green future – 3 courses | ICT and technology-integrated learning – 5 courses | ICT and Outdoor Teaching and Learning |
| Sustainability – 7 courses | Blended learning activities - 2 courses | |
| Pedagogical approaches to green skills – 6 courses | Digital tools – 6 courses | |
| Whole school approach – 2 courses | AI – 23 courses | |

Our analysis showed that both at European and Romanian levels sustainability and digital competences are considered individually, separately. The catalogue of professional development courses includes online courses and course series offered by

the European School Education Platform (European Commission[b], n.d.), that provides 5369 courses, starting with the middle of June 2025, in school education. More than 40 courses address ICT, digital, and AI tools in teaching and learning. At least 12 courses address green skills in education. Only one course was close to green and digital pedagogy, but the content analysis revealed just the use of ICT in outdoor activities, as presented in Table 1.

## 5. Discussions

Even dough the some of the key findings of ICILS 2023, international study report on digital skills and information literacy, based on data from 34 countries, including Romania, showed that 59% of teachers have participated in several activities in the last two years aimed at using subject-specific digital resources in teaching and learning (Fraillon (ed.), 2024), the number of CPD programmes in Romania is reduced. The previous study highlights that training tends to focus on technical aspects, often neglecting the pedagogical aspects of ICT integration. Green skills are barely addressed in CPD, even dough elements of ecological education are introduced in mandatory curricular activities in school education. The preference for technology, ICT, digital, or AI tools and education is relevant due to the rapid evolution and growth of the above-mentioned fields. We assume that the reduced number of training programmes dedicated to green pedagogies is a consequence of the novelty of the topic.

The integrated practices green and digital are synergies between sustainability and digital innovation, that can mutually reinforce each other. Teacher education should help future teachers design from this embedded perspective, empowering learners to become both eco-conscious and digitally skilled citizens. The integration of green and digital approaches creates powerful opportunities for transformative education. Some examples include *Digital labs for environmental science* (Virtual simulations of climate systems, biodiversity loss, or renewable energy; Data modelling for environmental impact assessments; Remote experiments or sensors for air/water quality); *Citizen science platforms* (Students contribute to real-world environmental research via apps (e.g. tracking pollution, local flora/fauna); Builds skills in data literacy, collaboration, and environmental responsibility); *Sustainable use of technology* (Teaching about energy-efficient devices, e-waste, and ethical consumption of tech; Encouraging schools to adopt green IT policies (e.g. device lifespan, cloud vs. local storage impact); *Digital storytelling for climate action* (Using multimedia tools (podcasts, videos, blogs) to raise awareness about local environmental issues; Integrates creativity, research, and advocacy). Project-Based Learning Combining Tech and Green Issues stresses the benefits of project-based learning (PBL) as a pedagogical approach that lends itself perfectly to cross-cutting green and digital themes. In teacher education, trainees can learn to design and facilitate projects such as: *Smart School Garden* Projects (Students use digital sensors and IoT (Internet of Things) to monitor soil moisture, light, and plant health; Integrates biology, coding, and sustainable agriculture); *Digital Eco-Audits* (Students audit their school's energy usage or carbon footprint using spreadsheets, infographics, and reports; Results can be shared digitally with stakeholders and spark real action); *Sustainable Urban Design with AR/VR* (Use augmented or virtual reality to reimagine greener cities, parks, or school spaces; Merges environmental science, geography, and digital design); *Green Journalism or Eco-Influencer Campaigns* (Learners create social media content to promote sustainable habits using tools like Canva, TikTok, or blogs; Encourages authentic communication, digital citizenship, and environmental advocacy). Many Erasmus Plus projects already model integrated green and digital approaches (*Green Future for Europe* (KA220-SCH); *EDUGREEN TECH*; *EcoDigital Teachers*). Platforms like *School Education Gateway* and *eTwinning* include collaborative international efforts (Climate Action Day; Digital Clean-Up Day; Earth Observation from Space - ESA & Copernicus resources).

## 6. Conclusions

Teacher educators are the change agents who will have the challenging contribution to design the thinking patterns of their students for our sustainable, comprehensive, and ethical future. Therefore, teacher education, at both levels of initial and continuous preparation, will address the strategies to develop the appropriate mindset of the efficient teacher in the upcoming future: green and digital. Thus, teacher educators will have to be able to model and assess cross-disciplinary thinking that unites technology and sustainability, to prepare teachers to create authentic, future-focused learning experiences, to help trainees reflect on their own ecological and digital footprints, to encourage co-design with learners to solve real-world problems using digital tools.

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