

Editorial

Teacher education is undergoing profound transformation in response to rapidly changing scientific, technological, environmental, and societal demands. Preparing teachers for these changes requires approaches that move beyond disciplinary knowledge and address areas such as digital competence, sustainability, transversal skills, professional identity, internationalization, and meaningful connections between educational institutions and wider society. The acaSTEMy project, funded by the European Commission under its Teacher Academy call, was established in response to these needs, bringing together universities, schools, educational organizations, science centers, and other stakeholders across Europe to strengthen research-based STEM teacher education and professional development. Involving eight countries and 37 organizations over 3 years, the project has developed and piloted flexible learning opportunities, digital learning resources, micro-credentials, mobility activities, job-shadowing experiences, and co-supervision models for pre-service and in-service STEM teachers.

This special issue of *Science Education International* begins with an overview paper by Miia Rannikmäe, the coordinator of the project. This is followed by eight studies that illustrate different dimensions of the acaSTEMy approach to contemporary STEM teacher education. Collectively, this special issue seeks to demonstrate how teacher education can connect research, professional learning, international collaboration, and authentic educational contexts.

The overview paper is followed by “Operationalising Future-Oriented STEM Teacher Education: The acaSTEMy Framework for Science Education” by Jack Holbrook, Cláudia Faria, Luca Szalay, Bulent Cavas, Karlis Greitans, Anne Mari Roost, Regina Soobard, Priit Reiska, and Miia Rannikmäe. The paper presents the conceptual foundation of acaSTEMy and proposes a coherent framework linking integrated STEM education with transversal and transformative competences, sustainability, digital confidence, systems thinking, and career awareness.

The third paper, “Sustainability-Oriented STEM Teacher Education in Transnational Contexts: Design and Evaluation of an Energy Sustainability Module in Estonia, Finland, and Croatia,” by Anne Laius, Anssi Salonen, and Josip Burušić, examines the implementation of an energy sustainability module across three national contexts. Its findings highlight the value of maintaining a shared theoretical foundation while adapting examples, terminology, pacing, and classroom applications to different teacher profiles and local contexts.

The fourth paper, “Developing Pre-Service Teachers’ Transversal STEM Competencies Through Structured Educational Psychology: Evidence from a Module Implementation in

Türkiye,” by Simge Akpullukcu Koç, Bulent Cavas, and Josip Burušić, examines the effectiveness of a 4-week blended educational psychology module developed within the project. Its findings demonstrate significant improvements in pre-service teachers’ transversal STEM competencies, particularly in inclusive instructional design, educational psychology-based decision-making, and collaborative learning, while also highlighting high levels of perceived competence and satisfaction with the module.

Digital transformation is addressed in “Profiling Gaps in STEM Teachers’ Digital Technology Use Related to Their Self-Perceived Capability,” by Justus Kinnunen and colleagues. Drawing on responses from 810 pre-service and in-service STEM teachers across eight European countries, the study identifies four teacher profiles and demonstrates that teachers with higher self-perceived digital competence may also have a more differentiated awareness of unmet technological needs.

The sixth contribution, “The Co-Supervision Process in Pre-Service STEM Teacher Education: Development of a Flexible Model Adaptable to Different European Countries,” by Cláudia Faria and colleagues, explores an international co-supervision model involving teacher educators and pre-service teachers from eight European countries. The study emphasizes the potential of co-supervision to foster critical reflection, professional development, peer learning, and international networking, while also drawing attention to the importance of organizational structures, clearly defined roles, and intercultural communication.

Three further papers focus on job shadowing as a form of experiential and boundary-crossing professional learning. Josip Burušić, Ljerka Jukić Matić, and Mila Bulić, in “Broadening Career Horizons Through Job Shadowing: A Qualitative Thematic Study of Croatian Pre-Service Teachers in Gifted, Inclusive, Upper-Secondary, and Vocational Education Settings,” demonstrate how structured exposure to diverse educational contexts can support professional identity, career awareness, engagement, and reflection on inclusive practices.

Similarly, “Job Shadowing Across Boundaries: Collaborative Learning Between Chemistry Pre- and In-Service Teachers” by Silvija Markic, Laura Naumann, and Melanie Ripsam examines job shadowing within a Community of Practice. The study highlights reciprocal learning between pre-service and in-service teachers and proposes a multi-level perspective connecting individual learning, community interaction, and the wider educational ecosystem.

Finally, Cláudia Faria’s “Potentialities of a local Job Shadowing experience in initial science teachers’ training” investigates job shadowing across a museum, an oceanarium, and a research

center. The findings suggest that such experiences can broaden pre-service teachers' understanding of education, strengthen professional awareness and social commitment, and promote a more interdisciplinary and socially relevant view of teaching.

Taken together, these contributions provide a multidimensional picture of contemporary STEM teacher education. They address not only what teachers need to know but also how teachers can develop professionally through authentic experiences, collaborative networks, digital learning, sustainability-oriented education, and international exchange. Importantly, the studies demonstrate that effective teacher education cannot rely on a single model; rather, it requires flexible approaches that can be adapted to disciplinary traditions, institutional contexts, teacher profiles, and national educational environments.

The significance of this special issue therefore extends beyond the individual studies presented here. It illustrates the potential of transnational collaboration to connect teacher education research with practical innovation and to generate approaches that are both internationally informed and locally adaptable. In this respect, the acaSTEMy experience offers a valuable contribution to ongoing discussions about how STEM teachers can be prepared for increasingly digital, diverse, sustainable,

and rapidly changing educational environments. We hope that the studies in this special issue will stimulate further research, collaboration, and innovation in STEM teacher education and contribute to strengthening the bridge between research, teacher preparation, and classroom practice.

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