



Digital Transformation and Educational Technology Integration in Teacher Education: A Competency-Based Framework for Professional Excellence

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ABSTRACT: Digital transformation in teacher education requires more than the curriculum, pedagogy, assessment, and professional learning around teachers' capacity to teach meaningfully with technology. This chapter examines how educational technology can be integrated into teacher preparation through a competency-based and practice-oriented model. Drawing on research on technological pedagogical content knowledge (TPACK), teacher digital competence (TDC), pre-service teacher preparation, and technology-enabled professional development, the chapter argues that future teachers need integrated competencies: pedagogical design with technology, digital assessment literacy, ethical and inclusive use of digital tools, collaboration in networked learning environments, and reflective professional growth. The discussion highlights the crucial role of teacher educators as role models and gatekeepers, the need to connect campus-based coursework with school-based practice, and the importance of institutional leadership and infrastructure. The chapter proposes a five-pillar framework for digital transformation in teacher education: vision and governance, curriculum integration, pedagogical modelling, authentic practice, and quality assurance. It concludes with implications for teacher education institutions seeking to prepare digitally competent, reflective, and professionally excellent teachers.

1. INTRODUCTION

Digital transformation has become one of the most significant priorities in contemporary education. However, in teacher education, digital transformation should not be reduced to the use of computers, projectors, mobile applications, or learning management systems. Its deeper meaning lies in transforming how future teachers understand learning, design instruction, assess student progress, collaborate professionally, and respond to the ethical challenges of digital society. Teacher education institutions therefore occupy a strategic position: they do not merely train individuals to operate digital tools, but prepare future teachers to make informed pedagogical decisions in technology-rich classrooms.

The need for this transformation is especially urgent because pre-service teachers often reproduce the pedagogical models they experience during their own training. If technology is presented only as an isolated ICT course, student teachers may learn technical procedures without developing the professional judgement needed to integrate digital tools with subject content, pedagogy, assessment, and learner diversity. The TPACK framework explains this challenge clearly by showing that meaningful technology integration requires the interaction of technological knowledge, pedagogical knowledge, and content knowledge rather than the separate acquisition of technical skills (Mishra & Koehler, 2006).

Research on teacher preparation further suggests that successful technology integration depends on both programme-level design and institutional conditions. Tondeur et al. (2012) found that effective preparation of pre-service teachers involves strategies such as teacher educators acting as role models, learning technology by design, scaffolding authentic technology experiences, reflection, collaboration, and continuous feedback. This means that teacher education institutions must move beyond tool demonstration and create learning environments in which future teachers experience, design, practise, and evaluate technology-enhanced pedagogy.

This chapter presents a conceptual discussion of digital transformation and educational technology integration in teacher education. It argues that professional excellence in teaching increasingly depends on teacher digital competence, reflective practice, ethical awareness, and the capacity to design inclusive learning experiences through technology. The chapter proposes a competency-based framework that can guide teacher education institutions in embedding digital transformation across curriculum, pedagogy, practicum, and quality assurance.

2. FROM DIGITAL SKILLS TO TEACHER DIGITAL COMPETENCE

A central challenge in teacher education is the distinction between digital skills and teacher digital competence. Digital skills often refer to the ability to use specific tools, platforms, or applications. Teacher digital competence, however, is broader and more professional. It includes the ability to select, adapt, evaluate, and ethically use digital technologies to support learning objectives, student engagement, assessment, inclusion, and professional collaboration.

Falloon (2020) argues that teacher digital competence should move beyond narrow technical and information-literacy models. His Teacher Digital Competency framework includes not only curriculum-related competencies, but also personal-ethical and personal-professional competencies. This is particularly important because teachers work in complex digital environments where decisions about technology involve issues of privacy, equity, safety, accessibility, intellectual property, and learner autonomy.

Similarly, Pettersson (2018) emphasizes that digital competence should not be understood only as an individual teacher attribute. It is also shaped by policy, infrastructure, leadership, school culture, and organisational support. For teacher education, this means that digital transformation cannot be achieved simply by requiring student teachers to use digital tools. It requires institutional vision, faculty development, school partnerships, and assessment systems that recognise digital competence as a core dimension of professional teacher preparation.

TPACK remains a useful theoretical foundation for this work because it connects technology with pedagogy and subject matter. However, contemporary digital transformation also requires attention to context, ethics, and emerging technologies. The rise of generative artificial intelligence, for example, has expanded the knowledge teachers need in order to evaluate AI-generated content, design meaningful learning tasks, protect academic integrity, and support students' critical use of digital tools (Mishra et al., 2023). Therefore, teacher education should prepare future teachers not only to use existing educational technologies, but also to respond thoughtfully to technological change.

3. THE ROLE OF TEACHER EDUCATORS IN DIGITAL TRANSFORMATION

Teacher educators are central to digital transformation in teacher education. They have a dual responsibility: they must use technology effectively in their own teaching, and they must also prepare pre-service teachers to develop professional digital competence for future classrooms (Instefjord & Munthe, 2017). This dual responsibility makes teacher educators powerful role models. When teacher educators demonstrate purposeful technology use, student teachers can observe how digital tools support inquiry, collaboration, formative assessment, differentiation, and reflective practice.

Tondeur et al. (2019) describe teacher educators as "gatekeepers" in preparing future teachers for technology integration. This idea is important because teacher educators influence not only the content of teacher preparation, but also the culture of professional practice. If they model technology as a tool for student-centred learning, critical thinking, and inclusion, pre-service teachers are more likely to develop positive and pedagogically grounded beliefs about technology. If, however, technology is used only for presentation, administration, or information transmission, pre-service teachers may develop limited views of educational technology. Teacher education programmes should therefore support teacher educators through continuous professional development. Philipsen et al. (2019) show that effective professional development for online and blended learning requires contextualised strategies and attention to the design of teacher learning. Professional development should not be limited to one-off workshops. Instead, it should include collaborative curriculum design, mentoring, peer observation, reflective dialogue, and evidence-based evaluation of technology-enhanced teaching.

4. A FIVE-PILLAR FRAMEWORK FOR TECHNOLOGY INTEGRATION IN TEACHER EDUCATION

To support digital transformation, teacher education institutions may adopt a five-pillar framework: vision and governance, curriculum integration, pedagogical modelling, authentic practice, and quality assurance.

4.1 Vision and Governance

Digital transformation begins with a clear institutional vision. Teacher education institutions should define what kind of digitally competent teacher they aim to prepare. This vision should be aligned with curriculum outcomes, practicum expectations, assessment practices, and faculty development. Without governance and leadership, technology initiatives may remain fragmented, dependent on individual enthusiasm, or limited to short-term projects.

Strategic planning should include infrastructure, digital access, technical support, ethical guidelines, and professional development. Bond et al. (2018) show that even in higher education contexts where digital media are available, technology use may remain limited

or assimilative unless institutions support broader pedagogical change. Therefore, teacher education institutions should treat digital transformation as an organisational process rather than a simple technology procurement issue.

4.2 Curriculum-Embedded Digital Competence

Digital competence should be embedded across the teacher education curriculum rather than confined to a single ICT course. A standalone course may introduce tools, but it cannot fully prepare pre-service teachers to apply technology in subject-specific, learner-centred, and assessment-oriented ways. Curriculum mapping can help institutions identify where digital competence is developed, practised, assessed, and reflected upon.

For example, a language education course may include digital storytelling, multimodal composition, and online peer feedback. A science education course may involve simulations, data logging, virtual laboratories, and inquiry-based digital resources. A mathematics education course may integrate dynamic geometry software, adaptive assessment, and visualisation tools. In each case, technology is not an add-on but part of pedagogical content design.

4.3 Pedagogical Modelling and Design-Based Learning

Pre-service teachers learn effectively when they experience strong models of technology-enhanced pedagogy. Teacher educators should demonstrate how digital tools can support active learning, collaborative inquiry, formative assessment, and differentiated instruction. Modelling should be explicit: teacher educators should explain why a digital tool is used, how it supports learning objectives, what limitations it has, and how it can be adapted for different learners.

Design-based learning is also essential. Rather than only consuming digital resources, pre-service teachers should design lesson plans, digital learning materials, assessment rubrics, online discussions, and inclusive learning activities. Baran et al. (2019) found that teacher education strategies are positively related to pre-service teachers' TPACK development, with reflection and teacher educators as role models being especially important. Therefore, digital transformation requires student teachers to become designers of learning, not merely users of tools.

4.4 Authentic Practice and School-Based Integration

A persistent challenge in teacher education is the gap between campus-based coursework and school-based practice. Pre-service teachers may learn about digital pedagogy in university courses but face limited opportunities to apply it during practicum. To close this gap, teacher education institutions should collaborate with partner schools to create authentic technology integration experiences.

During practicum, student teachers can design and teach technology-supported lessons, collect evidence of student learning, receive feedback from mentors, and reflect on the effectiveness of their choices. Mentor teachers should also be included in digital competence development, because they influence how pre-service teachers interpret classroom realities. Instefjord and Munthe (2017) show that professional digital competence in initial teacher education involves multiple stakeholders, including pre-service teachers, teacher educators, and mentor teachers. Thus, digital transformation should connect institutional coursework with school ecosystems.

4.5 Assessment and Quality Assurance

Digital competence should be assessed through authentic evidence rather than only through self-reported confidence. Assessment may include e-portfolios, lesson plans, microteaching videos, digital resource evaluations, reflective journals, student feedback, and practicum observations. Schmid et al. (2020) developed the TPACK.xs instrument as a shorter measure of pre-service teachers' TPACK and highlighted the importance of reliable assessment tools. While such tools can support programme evaluation, they should be combined with performance-based evidence.

Quality assurance should also examine whether teacher education programmes provide equitable access to digital learning, whether faculty members receive professional development, whether practicum experiences include technology integration, and whether graduates can demonstrate ethical and inclusive use of technology. Digital transformation should be measured not by the number of devices or platforms used, but by the quality of learning design, student engagement, and professional decision-making.

5. ETHICAL, INCLUSIVE, AND EMERGING TECHNOLOGY CONSIDERATIONS

Digital transformation in teacher education must be guided by ethical and inclusive principles. Technology can expand access to learning, but it can also reproduce inequalities if students lack devices, connectivity, language support, accessibility features, or digital confidence. Future teachers should therefore learn to evaluate digital tools for accessibility, cultural relevance, affordability, data privacy, and pedagogical appropriateness.

The emergence of generative AI makes ethical competence even more important. AI tools can support lesson planning, feedback generation, language assistance, and resource creation. However, they may also produce inaccurate information, biased content, superficial learning, or academic integrity concerns. Mishra et al. (2023) argue that generative AI requires reconsideration of teachers' knowledge because such tools are generative, unstable, and socially interactive. Teacher education should therefore include AI literacy: understanding what AI can and cannot do, how to verify outputs, how to design assessments that value human reasoning, and how to maintain teacher and learner agency.

Inclusion should remain at the centre of educational technology integration. Digital tools should be selected and designed to support diverse learners, including students with disabilities, multilingual learners, rural learners, and learners from disadvantaged backgrounds. A digitally competent teacher is not simply a technologically skilled teacher, but a professional who can use technology to make learning more meaningful, accessible, ethical, and equitable.

6. IMPLICATIONS FOR TEACHER EDUCATION INSTITUTIONS

Several implications emerge from this discussion. First, teacher education institutions should conduct a curriculum audit to identify where digital competence is currently addressed and where gaps exist. Second, ICT should be reframed from a technical subject into an integrated professional competence across foundations, methods, assessment, and practicum courses. Third, teacher educators require sustained professional development so that they can model effective digital pedagogy. Fourth, partnerships with schools should include shared expectations for technology-enhanced practicum experiences. Fifth, assessment should combine self-report measures, performance tasks, reflective evidence, and mentor feedback.

Institutions should also create communities of practice where teacher educators, mentor teachers, and pre-service teachers collaboratively design and evaluate technology-enhanced lessons. This collaborative culture can help move technology integration from individual experimentation to institutional transformation. Wohlfart and Wagner's (2023) umbrella review shows that teachers are central to digitalising education and that technology integration and digital literacy development should be understood as complex, interconnected processes. Teacher education must therefore prepare future teachers not only to participate in digital transformation, but to lead it responsibly.

7. CONCLUSION

Digital transformation in teacher education is a professional, pedagogical, ethical, and institutional project. It cannot be achieved through devices alone, nor through isolated ICT training. It requires a coherent vision of teacher digital competence, curriculum-embedded technology integration, teacher educators as role models, authentic school-based practice, and rigorous quality assurance. The proposed five-pillar framework offers a practical direction for teacher education institutions seeking to prepare future teachers for digitally mediated classrooms.

Professional excellence in the digital era depends on teachers' ability to make informed, reflective, inclusive, and ethical decisions about technology. Future teachers must understand not only how to use digital tools, but also why, when, and for whom such tools should be used. By integrating TPACK, teacher digital competence, authentic practice, and ethical awareness, teacher education can move beyond technical training toward transformative professional preparation.

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