

## Teachers' pedagogical digital competence profiles and their predictors

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### Summary

Digital learning environments create new opportunities for teaching and learning, yet they also require teachers to integrate a more complex set of competencies – digital competence, pedagogical reasoning, and socio-emotional awareness. Importantly, teachers' digital competence is not limited to operating tools; it concerns the deliberate, pedagogically justified use of technology to support learners' development, autonomy, and participation (Instefjord & Munthe, 2017; Redecker, 2017). These demands become even more pronounced in classrooms characterised by linguistic, cultural, and socio-economic diversity, where technology use may either support equitable participation or inadvertently intensify disparities.

While digital technologies can broaden learning opportunities and foster learner autonomy, research consistently shows that their effects are not uniformly positive. Outcomes depend strongly on instructional quality and on how well learners' self-regulated learning is supported (Cai & Lombaerts, 2024; Prasse et al., 2024). For example, a student's ability to regulate their learning processes has been found crucial for success in technology-supported environments, with more strategic self-regulators demonstrating higher problem-solving efficiency (Wang et al., 2024). Conversely, learners with weaker SRL may struggle with attention control, motivation regulation, and time management in digital environments (Tammets et al., 2021), which may contribute to widening educational inequalities. OECD reviews emphasise that moderate and purposefully structured technology use can support learning, but variability

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in outcomes remains large and is closely linked to teachers' capacity to design empowering learning activities (OECD, 2024).

Against this backdrop, teachers' pedagogical digital competence (PDC) becomes central. Building on framework-based conceptualisations of teachers' digital competence (Redecker, 2017; Vuorikari et al., 2022), PDC is increasingly understood as an integrated, multidimensional construct that connects technology use with pedagogical goals and learner development (From, 2017; Gudmundsdottir & Hatlevik, 2018). Critically, PDC entails not only technological and pedagogical knowledge, but also awareness of how digital tools may affect different learners and the ability to design learning environments that support learning (Gudmundsdottir & Hatlevik, 2018). Teachers' self-efficacy for using digital technologies in teaching and learning is also essential, as it shapes instructional decision-making and teachers' willingness to design and enact developmentally supportive learning situations (Bandura, 1997; Scherer, Siddiq, & Tondeur, 2019).

Although the structure of teachers' digital competence has been widely studied, often through frameworks such as DigCompEdu and related profile approaches (Lucas et al., 2021; Quast et al., 2023), profile studies have tended to highlight technological-pedagogical dimensions while paying less attention to why and how competence is enacted differently in practice. In particular, two factors remain underexamined in person-centred PDC profiles: teachers' inclusion awareness (i.e., sensitivity to learner diversity and commitment to equitable opportunities) and teachers' self-regulation, which enables reflective, adaptive, and sustainable professional learning. These dimensions may help explain why teachers with similar levels of perceived digital competence can implement technology in ways that lead to markedly different experiences for learners.

To address this gap, the present study identifies profiles of teachers' pedagogical digital competence. It examines how perceived digital competence and self-efficacy for technology-supported teaching combine with inclusion awareness and teachers' self-regulation. Using a person-centred approach, the study moves beyond variable-level associations and captures qualitatively distinct competence configurations.

The study draws on survey data collected during the pilot phase of the international *EffecTive* project. The sample includes pre-service and in-service teachers from three countries (Estonia, Germany, and Finland) representing different professional development stages and training contexts. All measures were administered after the completion of the respective training interventions. Pedagogical digital competence was operationalised with five continuous indicators: perceived digital competence for teaching and learning, perceived digital competence for learner empowerment, self-efficacy for using digital

technologies in teaching and learning, inclusion awareness, and self-regulation in professional learning.

Latent Profile Analysis (LPA) was used to identify distinct PDC profiles. Model selection relied on multiple fit indices and entropy, combined with theoretical interpretability. In addition, multinomial regression analyses examined whether professional background and training-related factors predicted profile membership.

The analysis revealed four qualitatively distinct profiles that differed not only in overall perceived digital competence but, crucially, in the configuration of inclusion awareness and self-regulation relative to technology-related self-efficacy. The findings underscore that PDC does not develop in a linear, uniform manner; instead, competence components may co-develop at different rates, resulting in profiles where strong technological confidence coexists with only moderate inclusion awareness and self-regulation, and vice versa. Regression results further suggested that profile membership is systematically associated with teachers' professional background and training experiences, indicating that inclusion awareness and self-regulation are shaped through professional learning rather than by technical competence alone.

Overall, the study highlights the multidimensional and non-linear nature of pedagogical digital competence and suggests that inclusion awareness and self-regulation are key differentiators for how digital competence is translated into learner-centred and equitable teaching practices. From a practical perspective, the findings support professional development approaches that go beyond technical skill acquisition and explicitly strengthen reflective practice, self-regulation, and inclusion-oriented decision-making when preparing teachers for digitally supported learning environments.

*Keywords:* pedagogical digital competence, inclusion awareness, self-regulation, latent profile analysis, teacher professional learning