

Theses of doctoral (PhD) dissertation

**The Impact of ICT Tools on
Changes in Teachers' Attitudes
in the Counties of the Northern
Grate Plain Region**

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The Purpose and Scope of the Dissertation

The social and economic processes of the twenty-first century are fundamentally shaped by the logic of the information society, in which the creation, interpretation, processing, and application of information have become central. In this context, information is not merely a resource; rather, it constitutes one of the principal organizing principles of economic, social, and cultural functioning (e.g., Castells, 1996). Consequently, educational systems face new expectations, particularly with regard to the development of digital competences, the critical interpretation of information, and the conscious and pedagogically grounded use of information and communication technologies (ICT) (Krumsvik, 2008). Within this context, education is no longer limited to the transmission of knowledge; instead, it involves the creation of complex learning environments that foster students' active participation, problem-solving skills, and the development of adaptive knowledge.

The expansion of digital technologies has fundamentally transformed teaching and learning processes, a

transformation closely linked to the pedagogical and technological evolution of educational tools. The development of educational tools cannot be interpreted as a linear process; rather, it represents a complex trajectory in which the functions, roles, and pedagogical embeddedness of tools are continuously evolving. From traditional visual aids to digital and interactive learning environments, new learning spaces have emerged that enable individualized, adaptive, and networked forms of learning (Petriné Feyér, 2003; Gál, 2020). This transformation has also brought about a shift in pedagogical thinking, with learner-centered approaches and active learning methods gaining increasing prominence.

In this dissertation, the concept of educational tools is interpreted in an extended sense. It encompasses not only physical devices but also all media and environments that support the learning process, including digital platforms, interactive applications, and networked learning spaces (Gál, 2020). Accordingly, the use of educational tools cannot be understood in isolation; rather, it becomes meaningful only in relation to pedagogical objectives and

methods. Various approaches to the classification of educational tools—whether functional, technological, or pedagogical—consistently confirm that the role of tools can only be understood within the broader context of the learning process (Nádasi, 2007; Chrappán, 2020).

In digital environments, the interpretation of learning has also expanded considerably. Alongside formal learning, non-formal and informal learning have assumed increasing importance, particularly with respect to teachers' professional development. Online learning communities, professional networks, digital teaching materials, and open educational resources facilitate continuous, self-directed learning that can be flexibly aligned with teachers' professional needs. This mode of learning not only complements formal training but, in many cases, becomes even more influential, especially in the development of digital competence.

In the present dissertation, digital competence is not reduced to technical skills; rather, it is conceptualized as a complex, multi-layered set of abilities that includes the critical handling of information, digital content creation, online collaboration, and the pedagogical integration of

technology (Redecker et al., 2011; Ferrari, 2013). In this sense, digital competence is not a static state but a continuously evolving, context-dependent construct that is closely related to teachers' learning strategies, attitudes, and professional identities.

The interpretation of ICT adopted in this dissertation likewise extends beyond conventional definitions. ICT is viewed not simply as a collection of technological tools but as a pedagogical system of resources that plays a decisive role in organizing and supporting the learning process. One of the implicit contributions of this research lies in interpreting ICT use not merely as a frequency indicator but as a dimension of pedagogical quality, manifested in the manner, purpose, and context of its application.

Models of technology integration in education—particularly the TPACK framework—highlight that effective use of educational technologies requires the integration of technological, pedagogical, and content knowledge (Mishra & Koehler, 2006). This perspective reinforces the interpretation that digital pedagogy is not merely a question of tool use but a complex

methodological challenge that necessitates the reorganization of teaching and learning processes (Szűts, 2022; Norhagen et al., 2024).

A central element of the dissertation's theoretical framework is the integrated model of digital capital, which interprets the concept of digital capital within a pedagogical context. In this framework, digital capital is understood as a complex resource comprising the dimensions of access, competence, and use, and as a determinant of teachers' digital opportunities and scope for action (Ragnedda, 2018). An important innovation of the dissertation is that this model is subjected to empirical investigation and its internal relationships are systematically explored.

The aim of the research was to examine the complex system of factors shaping teachers' use of digital tools and to identify the relationships among competence, infrastructure, and patterns of use. The study moves beyond descriptive analysis and seeks to uncover the structural and competence-based mechanisms underlying digital pedagogical practice.

The dissertation thus pursues a dual objective: first, to explore teachers' use of digital tools; and second, to interpret this use within an integrated theoretical framework. This approach enables a comprehensive examination of pedagogical effects and contributes to a systemic understanding of digital pedagogy.

The significance of the research lies in its contribution to the theoretical and empirical foundations of digital pedagogy, as well as in the provision of findings that are relevant both to pedagogical practice and to educational policy decision-making.

Applied Methods

The empirical part of the study employed a quantitative research design based on questionnaire surveys conducted at two points in time: in 2019 and in the spring of 2023. The implementation of two waves of data collection was a deliberate methodological decision that made it possible to examine longitudinal changes in teachers' use of digital tools and self-perceived digital competence.

The comparison of the two data collection periods is of particular importance because the second wave took place

after the experiences of the COVID-19 pandemic. This provided an opportunity to explore the extent to which and the ways in which the transition to digital education reshaped pedagogical practice. Methodologically, however, it is important to emphasize that the study was not designed to examine the impact of the pandemic directly, and no specific survey items explicitly addressed this issue. Consequently, conclusions concerning the effects of COVID-19 can only be drawn indirectly from changes in patterns of tool use and in teachers' self-assessed digital competence.

The two survey waves each involved substantial sample sizes. In 2019, 331 teachers completed the questionnaire, while 452 teachers participated in 2023, resulting in a total sample of 783 respondents. This sample size was sufficient to support reliable statistical inferences and comparative analyses across different background variables.

The target population consisted of teachers working in public education institutions in Hajdú-Bihar and Szabolcs-Szatmár-Bereg counties in the North Great Plain region of Hungary. A non-probability sampling strategy was

employed, combining purposive and convenience sampling. The primary aim was not to achieve representativeness but to ensure the inclusion of teachers from a variety of institution types, including primary schools, secondary schools, and other public education institutions.

The composition of the sample was heterogeneous, covering a broad range of age groups, levels of professional experience, and subject specializations. This diversity enabled an examination of how ICT use varies across different groups of teachers and across individual and institutional background characteristics.

The research instrument was a structured questionnaire consisting of several thematically related blocks. The questionnaire was designed so that each block corresponded directly to one of the dimensions of the integrated model of digital capital. Accordingly, it included items measuring digital competence, the frequency and nature of ICT use, institutional infrastructure and access conditions, and teachers' attitudes and motivations.

Most variables were measured using Likert-type scales, enabling quantitative comparison of respondents' attitudes and perceptions. In addition, nominal and ordinal variables were included, particularly for background characteristics and measures of usage frequency. Prior to the main data collection, a pilot study was conducted with a panel of 20 experts to assess the clarity of the questions and refine the instrument. Based on the pilot results, several items were revised and certain response options were modified.

Data analysis involved multiple levels of statistical procedures. Descriptive statistics were used to explore the basic characteristics of the sample and the distributions of the variables. This was followed by factor analysis to identify the underlying structures of ICT use and to group variables into latent dimensions that facilitated a more meaningful interpretation of usage patterns.

To examine relationships among variables, one-way analysis of variance (ANOVA) was employed to identify significant differences across background variables. Where the assumptions of parametric testing were not met, non-parametric procedures—particularly the Mann–

Whitney U test and the Kruskal–Wallis H test—were used to ensure the robustness of the results.

Special attention was devoted to the interpretation of significance levels and to the placement of statistical findings within a pedagogical context. The study was aimed not merely at identifying statistical relationships but also at interpreting their implications for educational practice.

A key methodological characteristic of the research is that the findings were interpreted not in isolation but within the framework of the integrated model of digital capital. This approach made it possible to examine how competence, structural conditions, and usage practices jointly shape pedagogical processes and how their interactions manifest in educational practice.

In this way, the methodological design ensured a close connection between the theoretical and empirical parts of the dissertation and enabled a complex, multidimensional interpretation of digital pedagogy.

Summary of the Findings

The findings clearly demonstrate that teachers' use of digital tools cannot be explained by any single background factor. Rather, it is best understood as a complex, multidimensional system in which competence-based, structural, and usage-related dimensions interact to reinforce or constrain pedagogical practice.

The integrated model of digital capital applied in the analysis (Bartal, 2026; Vincze, 2021) proved to be a particularly effective interpretive framework, as it enabled ICT use to be examined not as a set of isolated variables but as an interconnected system of factors. Within this model, the structural dimension captures institutional infrastructure and technological access; the competence-based dimension reflects teachers' digital preparedness and knowledge; and the usage dimension encompasses the frequency and pedagogical modes of ICT application. Pedagogical effects were interpreted as an outcome dimension emerging from the interaction of these three components.

Hypothesis 1 (H1): Competence-Based Dimension

Hypothesis 1 (H1) proposed that informal learning sources play a decisive role in the development of teachers' digital competence and that learning patterns differ across age groups.

The results confirmed that digital competence develops to a substantial extent through informal learning processes. Self-directed learning, the use of online resources, and knowledge sharing with colleagues proved to be particularly important. At the same time, age-related differences were clearly identifiable: younger teachers typically drew on a wider range of learning channels, whereas older teachers relied more heavily on experiential and practice-based forms of competence development.

Accordingly, H1 was confirmed. The findings indicate that competence-based digital capital is not simply a collection of individual technical skills, but a complex and structured form of capital shaped by the interaction of competencies, learning strategies, methodological knowledge, institutional conditions, and motivational factors.

Hypothesis 2 (H2): Structural Dimension

Hypothesis 2 (H2) assumed that institutional infrastructure and access to ICT tools are significantly related to the frequency of teachers' classroom use of digital technologies.

The results confirmed that teachers working in better-equipped institutions used digital tools more frequently in their teaching practice. However, the analyses also revealed that infrastructure alone does not automatically lead to effective pedagogical integration. Even institutions with similar technological conditions exhibited considerable differences in usage patterns.

Thus, H2 was supported, but the findings demonstrate that infrastructure constitutes a necessary rather than sufficient condition for meaningful digital integration. Its impact depends on the presence of appropriate competence and methodological readiness.

Hypothesis 3 (H3): Usage Dimension

Hypothesis 3 (H3) proposed that the frequency and methodological integration of ICT use differ significantly according to individual background variables—

particularly age and subject specialization—as well as institutional characteristics.

The results showed significant differences across several background variables, although these effects were not uniform across all dimensions examined. Age, institution type, and the year of data collection were especially important factors. The comparison between 2019 and 2023 indicated a clear increase in the frequency of ICT-supported classroom activities.

Accordingly, H3 was supported overall. The findings suggest that ICT use should be interpreted as a differentiated, layered, and selective process of pedagogical integration rather than as a uniform modernization trajectory.

Hypothesis 4 (H4): Competence and Use

Hypothesis 4 (H4) assumed that teachers with higher levels of digital competence are more likely to use ICT tools and internet-based applications in their classroom activities.

The findings confirmed that teachers with stronger digital competence and greater technological self-confidence

indeed used digital tools more frequently. However, this relationship was not automatic. The pedagogical relevance of digital competence depended substantially on methodological preparedness, institutional support, and the extent to which teachers were able to functionally integrate digital technologies into classroom activities. Thus, H4 was confirmed. At the same time, the results underscore that digital competence becomes a meaningful pedagogical resource only when accompanied by supportive structural and methodological conditions.

Hypothesis 5 (H5): Pedagogical Effects

Hypothesis 5 (H5) proposed that higher levels of teachers' digital capital are positively associated with attitudes toward the educational use of ICT and with motivational factors related to pedagogical work.

The results supported this hypothesis. Teachers who viewed ICT more favourably and were more open to the classroom use of students' mobile devices integrated digital tools into their teaching practice significantly more frequently.

At the same time, the findings revealed that teachers' perceptions were not idealized. Respondents simultaneously recognized the motivational, illustrative, and interactive benefits of digital technologies, as well as the additional workload, methodological challenges, and infrastructural limitations associated with their use.

These results also provide a direct answer to Research Question 4 (RQ4), confirming that teachers' digital capital is closely related to their perceptions of the educational role of ICT and to the motivational factors that shape their willingness to adopt technological innovations.

An important additional finding of the study was the distinction between teachers' personal and professional technology use. The data indicate that digital tools are used more confidently and intensively in everyday life than in pedagogical practice. This suggests that technological proficiency does not automatically translate into pedagogical competence.

The comparison of the two data collection waves also showed that the COVID-19 pandemic served as a significant catalyst for change. Between 2019 and 2023, the frequency of ICT use increased, self-assessed digital

competence improved, and satisfaction with institutional infrastructure rose. At the same time, the pandemic accelerated existing processes rather than generating a uniform developmental trajectory, while also exposing structural and methodological shortcomings.

One of the most significant scientific contributions of the dissertation lies in interpreting teachers' digital tool use and attitudes through the dimensions of the integrated model of digital capital. The results demonstrate that teachers' use of digital technologies can only be fully understood when competence, structural conditions, and pedagogical practices are examined together.

This approach enables a systemic interpretation of pedagogical effects and conceptualizes the digital transformation of education not as a linear process of digitalization but as a process of hybridization and differentiation.

Overall, the findings support all five hypotheses, while also demonstrating that their empirical validation cannot be interpreted in simple linear terms. Instead, the analyses reveal a complex system of interrelated factors and mechanisms.

The results confirm that the development of digital pedagogy can only be effective within an integrated framework. Without the coordinated development of teachers' competences, institutional infrastructure, organizational support, and pedagogically meaningful use, the full educational potential of digital technologies cannot be realized. The dissertation provides both empirical evidence and a coherent theoretical framework for this integrated, digital-capital-based interpretation of teachers' ICT use.

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