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# Preschool Teachers and Digital Technologies: Evidence of a U-Shaped Experience Effect

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Research on digital technologies (DT) in early childhood education rarely explores how teachers' attitudes differ by career stage or whether adoption follows non-linear paths. This cross-sectional survey of 535 Czech preschool teachers examined four domains: attitudes, parent engagement, perceived benefits, and tool use. Results revealed clear differences across career stages, including a U-shaped trend: initial enthusiasm among novices, a decline in early mid-career, and renewed—though more selective—uptake among later-career teachers. These findings extend international debates beyond the "digital native–immigrant" divide by showing how career stage shapes DT adoption. They also highlight the need for tailored professional development: structured mentoring for novices, reflective and evidence-based support for transitional teachers, leadership roles for mid-career staff, and concise, context-relevant training for late-career teachers. Although the study was conducted in the Czech Republic, the results are discussed against evidence from Asia, Africa, and Europe, underscoring their global relevance and suggesting directions for cross-national and longitudinal research.

Keywords: preschool education, digital technologies, teacher experience, non-linear adoption, professional development, international comparison

## INTRODUCTION

Digital technologies (DT) are a defining feature of contemporary societies, reshaping communication, problem-solving, and learning (Tran et al., 2024). Education is especially affected: teachers must not only adopt DT but also guide children in using them meaningfully. This is crucial in early childhood education, where preschool teachers offer the first structured encounters with digital tools. Their ability to integrate DT into everyday practice is key to providing developmentally appropriate and balanced learning environments (Bay, 2022). The OECD (2023) stresses that digital tools enrich learning only when educators integrate them thoughtfully, rather than allowing passive exposure.

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Preschoolers grow up surrounded by DT, which brings both opportunities and risks. While DT can enhance motivation and learning, it may also reduce creativity and social interaction if used without pedagogical reflection (Izumi-Taylor et al., 2010; Mertala, 2017). Studies show that the impact of DT depends less on access and more on teachers' beliefs, knowledge, and professional readiness (Hoareau et al., 2021; Chui et al., 2024). Many teachers express interest in using DT yet report low confidence in practice (Peretti et al., 2024). Recent evidence further suggests that even preservice teachers who feel technically competent often show gaps in critical digital literacy, particularly in evaluating bias, credibility, and ethical implications of online information (Chen et al., 2025). Other research notes that some preservice teachers view DT as potentially conflicting with play-based pedagogy or children's well-being (Merjovaara et al., 2024; Dong & Xu, 2020). These findings underline the importance of targeted preparation in initial teacher education (Alelaimat et al., 2020; Casillas et al., 2020).

Access and institutional resources also shape DT use. A Portuguese study found positive attitudes among preschool teachers regardless of age or tenure, yet noted that educators relied on personal devices and that limited resources constrained children's independent DT use (Akyar et al., 2024). Turkish evidence indicates that even with adequate resources and positive attitudes, DT use can remain confined to a few activities (Konca & Erden, 2021). Access alone is therefore insufficient for rich pedagogical integration.

***Review of Literature***

Teachers' attitudes strongly influence DT implementation. Hsu (2011) argued that unless teachers see DT as pedagogically valuable, integration remains superficial. Attitudes are shaped by prior experience (McGrail, 2005), knowledge (Tsitouridou & Vryzas, 2003, 2004), and institutional or technical support (Inan & Lowther, 2010; Howard et al., 2020). Hew & Brush (2007) distinction between first-order barriers (infrastructure) and second-order barriers (beliefs, confidence) remains relevant, and recent studies confirm that even when access improves, second-order barriers persist; Valdez & Mendoza, 2024). The Portuguese and Turkish findings illustrate how both kinds of barriers can coexist (Akyar et al., 2024; Konca & Erden, 2021).

Generational explanations have often framed DT use: "digital natives" are assumed to embrace innovation, while older teachers are portrayed as hesitant (Blackwell et al., 2014; Gjelaj et al., 2020). This view is now seen as oversimplified (Mertala et al., 2024). Attitudes depend on career stage, institutional culture, and pedagogical identity (Mertala, 2017; Hoareau et al., 2021). Research from Turkey links attitudes to both age and education (Bölük Yıldırım & Atasoy, 2023); in South Africa, systemic barriers limit teachers' ability to apply positive views (Ogegbo & Aina, 2020). A Spanish study identified profiles ranging from skeptics to active integrators, showing diverse adoption beyond generational labels (Sosa-Alonso et al., 2025). A Balkan study found that teachers with moderate tenure applied DT more broadly across professional tasks—idea generation, project design, documenting practice, and dissemination—than colleagues with longer experience (Kozoderović et al., 2024). This suggests that adoption may vary non-linearly, aligning with the present study's focus on career-stage effects.

Although research on DT attitudes is extensive, few studies systematically explore variation by teaching experience, especially in preschools. Existing work often assumes linear adoption, leaving open whether professional trajectories may be more complex. Central and Eastern Europe are also underrepresented in debates on DT in early childhood education, despite rapid digital change in recent years.

This study addresses these gaps by analyzing data from 535 preschool teachers in the Czech Republic across five experience groups. It contributes in three ways: (1) examining how experience influences attitudes, including possible non-linear effects; (2) extending debates beyond the "digital natives vs. immigrants" dichotomy to include career-stage dynamics; and (3) providing evidence from Central Europe to inform global research and practice.

## METHOD

The aim of this study is to examine how preschool teachers' attitudes toward digital technologies (DT) are shaped by teaching experience and to determine whether adoption follows a linear trajectory or a more complex path. We draw on Rogers' *Diffusion of Innovations* (2003) and Ertmer's (1999) distinction between first- and second-order barriers as conceptual lenses for understanding teachers' attitudes and practices. These frameworks guide our analysis of whether technology uptake in preschool education reflects predictable, linear stages or more nuanced, career-related dynamics. Rather than testing these theories through strict hypotheses, the study applies them as interpretive tools. Four objectives were formulated:

1. To examine how teachers' attitudes differ across career stages and whether they align with Rogers' adoption patterns or reveal non-linear tendencies.
2. To analyze how teachers approach parent collaboration in children's DT use, from participatory models among novices to autonomy or deference to parental requests among late-career teachers.
3. To investigate how teachers at different career stages assess the cognitive, motivational, communicative, and inclusive benefits of DT, and whether these perceptions confirm or challenge existing models.
4. To identify the types of DT tools used by teachers and to explore how usage patterns vary across career stages, assessing whether they reflect theoretical expectations or alternative pathways.

Together, these objectives explore how far existing models explain adoption in preschool education and whether teaching experience accounts for openness to innovation, resistance, or transitional practices.

This study used a cross-sectional survey design, allowing us to compare preschool teachers' attitudes and practices across career stages at a single point in time. Although a longitudinal approach would enable tracking changes over time, it was not feasible within the scope of this project because of organizational and financial constraints. The aim was to compare teachers at different stages of their careers to determine whether

adoption patterns vary systematically between groups. Future studies should therefore include longitudinal follow-up.

The research sample comprised N = 535 preschool teachers from various regions of the Czech Republic. Participants were divided into four groups according to teaching experience: 1–5 years (n = 210), 6–10 years (n = 85), 11–20 years (n = 34; combining the 11–15 and 16–20 groups due to small subgroup sizes), and 21+ years (n = 206).

We used an open purposive sampling strategy, inviting all in-service preschool teachers in the Czech Republic to take part. Regional OMEP coordinators shared the invitation at professional meetings to ensure broad geographical coverage. Purposive sampling was chosen to secure heterogeneity across career stages, which was essential for answering the main research question about how adoption varies with professional experience. The sample is not nationally representative; rather, the goal was analytical generalization to theoretical frameworks such as Rogers' *Diffusion of Innovations* and Ertmer's first- and second-order barriers.

Unequal subgroup sizes were a limitation. Teachers with shorter and longer experience were more likely to respond, while mid-career teachers were underrepresented. This imbalance may reflect life-stage factors (e.g., the "sandwich generation," balancing family and work). To minimize its impact, we reported results mainly in relative terms (percentages and proportions), used statistical techniques robust to unequal cell sizes, and conducted sensitivity analyses by merging the 11–15 and 16–20 groups into a single mid-career category.

The questionnaire was developed specifically for this study. Its construction involved several steps: a) definition of domains – Based on research objectives and international literature (e.g., Gjelaj et al., 2020; Howard et al., 2020), we identified four domains: (i) attitudes toward digital technologies, (ii) approaches to parental involvement, (iii) perceived benefits, and (iv) actual tool use; b) item formulation – items were partly adapted from existing instruments and expanded to reflect the Czech preschool context; c) expert review (content validity) – three experts in early childhood education and educational technology reviewed the draft questionnaire for clarity, coverage, and relevance; d) Pilot testing (face validity) – A pilot with 30 student teachers working in preschools helped refine item wording; e) finalization – the final instrument combined open-ended, multiple-choice, and single-choice items, enabling both quantitative and qualitative insights. The questionnaire items are not reproduced in full here due to space constraints. However, each item was designed to align closely with the study's four objectives and corresponds directly to the categories reported in the Results section (e.g., attitudes toward DT, approaches to parental involvement, perceived benefits, and tool use). Graphs and tables in the findings illustrate responses to these items, providing transparency regarding the constructs measured.

Because the instrument consisted of heterogeneous items rather than unidimensional scales, we did not calculate conventional internal-consistency coefficients (e.g., Cronbach's alpha). This decision aligns with methodological guidance cautioning against the automatic use of alpha for multidimensional or heterogeneous constructs; alternative strategies or design-stage validity checks are recommended in such cases.

Data were collected in February and March 2025 through an online questionnaire administered via the Survio platform. Participation was voluntary and anonymous, and informed consent was obtained before respondents began the survey. All procedures complied with institutional ethical standards and data protection guidelines.

We used both descriptive and inferential statistics. Descriptive statistics (percentages and proportions) summarized responses across experience groups. Associations between teaching experience and categorical variables were examined with chi-square tests of independence. When expected cell counts were low, we applied Fisher's exact test. For significant results, post-hoc pairwise comparisons with Bonferroni correction controlled for multiple testing. The strength of associations was expressed with contingency coefficients and Cramér's V, classified as weak, moderate, or strong, and accompanied by 95% bootstrap confidence intervals to enhance robustness. To address small subgroup sizes, we ran sensitivity analyses by merging the 11–15 and 16–20 year groups into a single mid-career category (11–20 years), confirming the stability of overall patterns across career stages.

## FINDINGS

The first objective was to examine how preschool teachers' attitudes toward digital technologies (DT) differ by teaching experience.

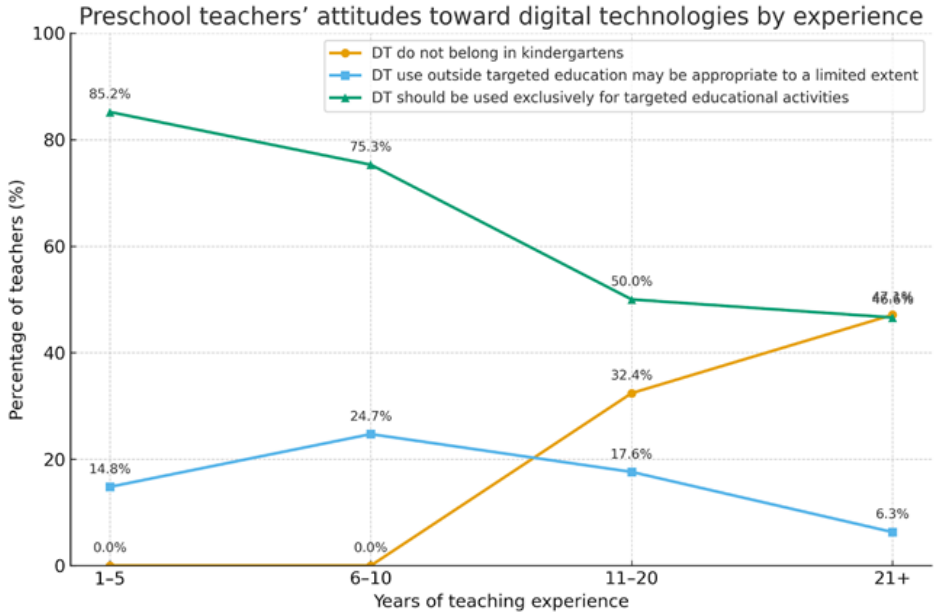


Figure 1
Preschool teachers´attitudes toward digital technologies

A chi-square test of independence confirmed significant differences across career stages ($\chi^2 = 178.34$, df = 6, $p < .001$) with a moderate effect size (Cramér's V = 0.41).

Overall, both linear and non-linear trajectories emerged. Novice teachers (0–10 years) strongly supported the use of DT but preferred to keep it under teacher control, favoring structured educational activities. Teachers with more than 21 years of experience often rejected DT entirely (47%). However, those who accepted them were less restrictive and more open to non-instructional uses.

Mid-career teachers (6–20 years) occupied a transitional position: less enthusiastic than novices but not as dismissive as veterans. When they allowed DT outside targeted instruction, they stressed limiting its scope more than other groups. These results form a clear **U-shaped profile**. Early- and late-career teachers represent two poles—structured support versus frequent rejection—while mid-career teachers favor restricted, carefully controlled use beyond formal lessons.

The second objective examined teachers' approaches to involving parents in DT use. A chi-square test showed significant differences across experience groups ($p = 0.000$) with a weak-to-moderate effect size (Cramér's $V = 0.19$). Three categories varied significantly*: "Do not use or very rarely"* ($p = 0.000$; $V = 0.23$) increased steadily with experience, indicating that late-career teachers were most likely to reject or minimize DT; "*Collaborate with parents"* ($p = 0.000$; $V = 0.24$) declined linearly, reported most by novices and least by late-career teachers; *"Always respect parental requests"* ($p = 0.045$; $V = 0.12$) appeared only among the most experienced teachers.

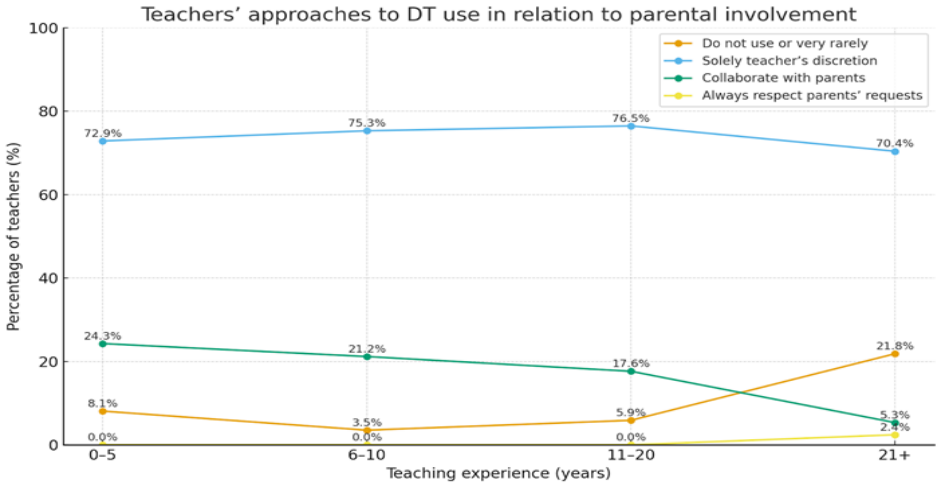


Figure 2
Preschool teachers´ approaches to DT use in relation to parental involvement

By contrast, *"Solely at the teacher's discretion"* did not differ significantly ($p = 0.783$), showing stable professional autonomy across stages. Although a line chart suggested a slight U-shape for two items, this non-linear trend was not statistically significant. The data instead indicate a largely linear progression: collaboration among novices, stable autonomy among mid-career teachers, and increasing rejection or deference to parents among late-career teachers.

The third objective (see Figure 3) focused on teachers' perceptions of DT benefits. Chi-square tests confirmed significant differences across all categories (all p = 0.000). Post-hoc analyses (Fisher's exact test with Bonferroni correction) revealed clear group contrasts.

A non-linear trajectory emerged. Early-career teachers (1–5 years) expressed strong optimism, reflecting initial enthusiasm. This enthusiasm dropped sharply among teachers with 6–10 years of experience, who consistently reported the lowest endorsement of DT benefits and were more likely to state that DT have none.

Teachers with 11–20 years of experience expressed the highest endorsement overall, with almost unanimous agreement across all benefit types. Their scores were significantly higher than those of the 6–10 years group and, in some cases, even higher than those of the 21+ years group. Late-career teachers continued to report high benefits but showed a slight decline compared with the 11–20 years group.

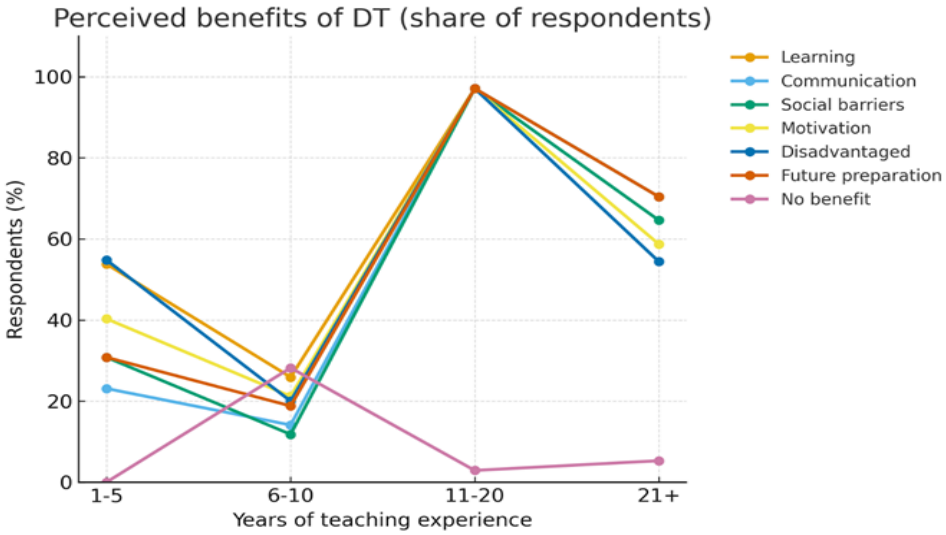


Figure 3
Perceived benefits of DT by preschool teachers

Together, these findings confirm a distinct **U-shaped pattern** with a clear peak: initial enthusiasm, skepticism during early mid-career, strong positivity at 11–20 years, and a modest decline in later years.

The fourth objective analyzed teachers' use of DT (Figure 4). The results showed significant differences across career stages ($\chi^2$ = 511.7, df = 24, p < 0.001) with a moderate effect size (Cramér's V = 0.40). Group differences appeared for nearly all technologies except internet access (p = 0.062). The largest effects (Cramér's V = 0.52–0.71) were observed for modern tools such as interactive whiteboards, robotic devices, electronic pens, and tablets. For traditional technologies (DVD, CD, TV), the effects were smaller but still moderate to strong (Cramér's V = 0.40–0.62).

The results again show a clear **U-shaped pattern**. Early-career teachers (1–5 years) were open to digital innovations and used a broad range of tools, but they had not yet "crossed the threshold" into intensive, comprehensive use. Mid-career teachers (11–20 years) were the most digitally active, using an extensive portfolio of tools—often approaching 100% adoption. Teachers with 6–10 years of experience and those with 21+ years relied far less on modern DT. The 6–10 years group was the least active overall, while late-career teachers maintained a preference for traditional media and used newer tools only minimally.

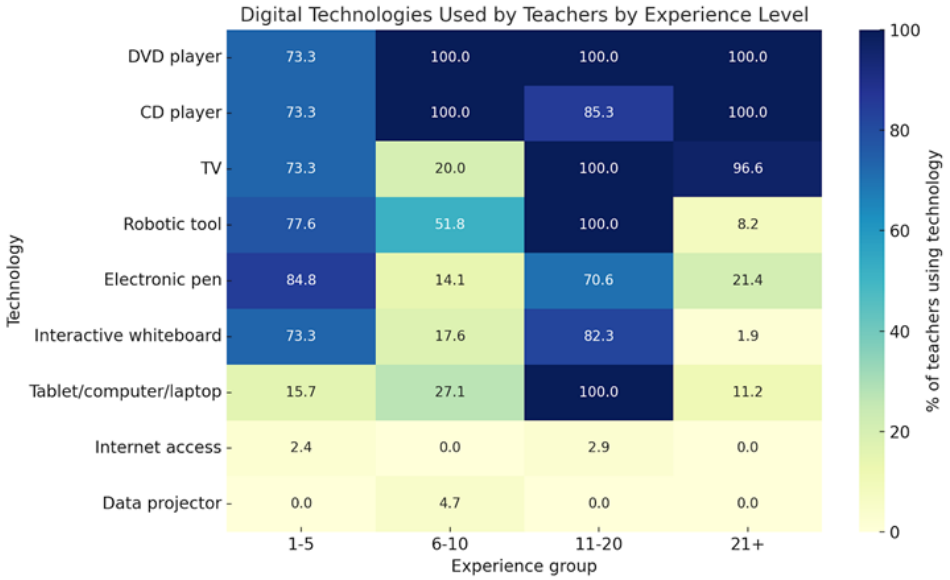


Figure 4
Digital technologies and its use by preschool teachers

## DISCUSSION

The main purpose of this study was to address the research gap identified in the introduction: the lack of systematic knowledge about how teaching experience shapes the adoption of digital technologies (DT) in preschool education. Previous studies often examined teachers' attitudes toward DT in general but rarely considered career stage or the possibility of non-linear trajectories. By analyzing four dimensions—attitudes, parental involvement, perceived benefits, and tool use—our findings go beyond simple description and reveal consistent patterns across stages of experience. The discovery of both linear and non-linear effects, including a U-shaped trajectory, refines existing models of technology adoption such as Rogers' adopter categories and Ertmer's barriers. Adoption in early childhood education does not necessarily follow a single linear path but may reflect more complex professional and generational dynamics.

A key contribution of this study is the identification of a U-shaped relationship between teaching experience and attitudes toward DT. Earlier research often assumed either

steady resistance with increasing experience or a basic divide between "digital natives" and "digital immigrants." Our results show a more nuanced progression: enthusiasm among novices, skepticism in early mid-career, and renewed but selective adoption among later-career teachers. This finding, not previously documented in early childhood education, highlights the need to revise theoretical models by including career-stage dynamics.

Practical implications follow from these findings. Professional development should be tailored to the needs of teachers at each stage rather than applying a uniform approach. Novice teachers (0–5 years) benefit from structured induction, mentoring, and scaffolding to channel their enthusiasm into sustainable practice. Teachers with 6–10 years of experience, who showed the weakest endorsement of DT benefits, require reflective workshops, peer learning opportunities, and evidence-based examples that address skepticism. Mid-career teachers (11–20 years), the most digitally active group, can be supported as leaders through advanced training and collaborative curriculum design. For late-career teachers (21+ years), short, low-threshold workshops focusing on practical, context-relevant tools may encourage incremental adoption without undermining established routines. These recommendations underline the value of differentiated professional development to sustain digital transformation in preschool education.

Several limitations must be acknowledged. The cross-sectional design captures attitudes and practices at a single point in time, limiting conclusions about causality or developmental change. Future research should use longitudinal designs to determine whether the U-shaped effect remains stable over time. The sample was not nationally representative, and voluntary participation may have attracted teachers more interested in DT. Unequal subgroup sizes, particularly the underrepresentation of mid-career teachers, may also have affected precision. Although sensitivity analyses were performed, these limitations should be considered when interpreting the results and highlight the need for representative, longitudinal, and mixed-method studies.

Placing our findings in an international perspective shows that they are not unique to the Czech Republic. Research from Asia reports generally positive attitudes, but with different emphases: in China, training often focuses on technical rather than pedagogical aspects (Dong, 2018; Luo et al., 2021; Yang & Hong, 2022); in Saudi Arabia, pre-service teachers are technically prepared but less confident pedagogically (Alghamdi et al., 2022). In Turkey, attitudes are shaped by age and education (Bölük Yıldırım & Atasoy, 2023), while studies in Indonesia and Palestine highlight issues of attention, age appropriateness, and perceived usefulness (Sutiyono et al., 2022; Ahmad & Zabadi, 2022). Evidence from the Global South adds contrasts: in South Africa, systemic barriers limit practice despite positive views (Ogegbo & Aina, 2020), and in Chile, children's frequent computer use contrasts with teachers' low ICT competence (Hinostroza et al., 2013). Studies from Jordan and Kosovo note tensions between teachers and parents (Ihmeideh & Alkhawaldeh, 2017; Gjelaj et al., 2020). In Europe, Spanish data show diverse teacher profiles from skeptics to active integrators (Sosa-Alonso et al., 2025). Other recent work adds nuance: Portuguese research shows that positive attitudes can coexist with resource limits that restrict children's independent

DT use (Akyar et al., 2024); Turkish data suggest that adequate access may still produce a narrow range of classroom uses (Konca & Erden, 2021). Findings from pre-service cohorts reveal concerns about conflicts between DT and play-based pedagogy (Merjovaara et al., 2024; Dong & Xu, 2020), indicating that career-stage effects may begin in initial preparation. Regional evidence from the Balkans suggests that moderate tenure may be linked to broader DT application across professional tasks (Brankovic et al., 2024), consistent with the mid-career peak observed here.

Together, this international evidence shows that the Czech findings form part of a wider pattern. Career stage, cultural expectations, and systemic conditions jointly shape how teachers engage with DT. While the Czech context has its own institutional and cultural features, the U-shaped trajectory we found may also emerge in systems where access and infrastructure are secure. Our study does not claim universal generalizability but contributes to a broader dialogue about how professional development should address career-stage differences—a policy implication that extends beyond national borders.

In summary, this study enhances understanding of how career stage influences preschool teachers' engagement with DT. By documenting both linear and non-linear patterns, including the novel U-shaped effect, it offers theoretical and practical insights and sets a foundation for further research on the global dynamics of digital adoption in early childhood education.

## CONCLUSION AND SUGGESTIONS

This study makes a clear contribution to international research on technology adoption in early childhood education by identifying a U-shaped relationship between teaching experience and digital engagement. Earlier frameworks often emphasized either generational divides ("digital natives" vs. "digital immigrants"; Prensky, 2001) or a steady increase in resistance with experience (Rogers, 2003; Ertmer, 1999). Our findings show a more complex trajectory: enthusiasm at entry, skepticism in early mid-career, and renewed—though selective—adoption among later-career teachers. By foregrounding career-stage dynamics, this study refines existing models and demonstrates that teachers' use of digital tools cannot be explained by age or generation alone.

The results also highlight the importance of differentiated professional development. Novice teachers need structured induction, mentoring, and support to turn enthusiasm into sustainable practice. Teachers in transition (6–10 years) benefit from reflective workshops, peer learning, and evidence-based demonstrations that counter skepticism. Mid-career teachers, the most digitally active group, can be empowered as leaders through advanced training and opportunities to co-design curricula. For late-career teachers, short and accessible workshops focusing on practical, context-relevant tools may foster incremental adoption while respecting established pedagogical routines. These concrete pathways offer guidance for policymakers seeking to sustain digital transformation in preschool settings.

Several limitations should temper interpretation. The sample was unevenly distributed across career stages, which may have influenced group comparisons. Reliance on self-

reports introduces possible response bias, and the cross-sectional design prevents conclusions about causality or long-term change. These issues underline the need for studies with representative samples, longitudinal designs, and mixed methods.

Although conducted in the Czech Republic, this research contributes to global debates on digital transformation in early childhood education. By aligning our findings with evidence from Asia, Africa, Latin America, and Europe, we show that career-stage dynamics are not confined to one country but reflect broader processes visible where access and infrastructure are in place. The U-shaped pattern offers a useful lens for cross-national analysis and practical insight for policymakers and researchers worldwide.

Future work should pursue longitudinal studies to examine whether the U-shaped trajectory remains stable or shifts across cohorts. Qualitative research could explore the reasons behind transitional phases, such as skepticism among early mid-career teachers. Cross-country comparisons are also needed to assess the generalizability of the U-shaped model and to explore how cultural, institutional, and policy contexts influence teachers' engagement with digital technologies.

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