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The Use of Educational Technologies in Personalized Learning of Primary School Students

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Abstract

This study evaluated the effectiveness of using educational technologies for personalized learning among younger schoolchildren in Ukraine, using a parallel convergent mixed-methods design. The research was carried out in three cities: Kyiv, Lviv, and Odessa, involving 150 students in grades 1 to 4. Qualitative data were collected from teachers (n = 30) and parents (n = 35). Quantitative analysis of pre- and post-tests in mathematics revealed that students in the experimental group achieved significantly greater knowledge gains (p < .001; d = 1.61). Motivational outcomes indicated a medium-to-large positive effect (η^2 = 0.42), showing increased engagement and confidence in the learning process. The findings have practical implications for educational policy and contribute to the understanding of the role of EdTech tools in personalizing learning for students. The conclusions recommend expanding access to educational technologies through government and local initiatives to enhance digital infrastructure in primary schools; creating systematic training programs for teachers to effectively use personalized learning platforms; and establishing ongoing monitoring of students' digital interactions.

Keywords:

Personalized Learning, Primary Education, Learning Outcomes, Digital Inequality

Introduction

Despite increasing research on educational technologies in Ukraine's primary schools, the field lacks a focused study on how digital tools support truly personalized learning paths for individual students in grades 1–4. While many programs have been used in frontline regions, surveys indicate teacher readiness and infrastructure challenges, and there is still little empirical evidence on how these technologies adapt content and pacing to meet individual needs, learning styles, or socio-emotional conditions across different regional settings. Addressing these gaps would be crucial in determining whether and how educational technologies can evolve from generic distance learning to provide genuinely personalized learning pathways for primary-age students in Ukraine. The rapidly changing space of Ukrainian primary schools requires that the new learning model not only update content and teaching methods, but also use modern educational technologies.

The latter are primarily aimed at meeting each student's individual needs (Scippo et al., 2025). The integration of digital tools: adaptive platforms, tablets, educational applications (Seesaw, ClassDojo, or Google Classroom) allows teachers to form individual and adaptive learning routes, provide students with real-time feedback, and create tasks according to the level of mastery of the material. Such approaches are especially important for children aged 6–10 (Putri et al., 2025). At the same time, previous studies have yielded contradictory results, highlighting the heterogeneity of personalized learning effects and their dependence on teacher competencies. Some authors have argued that adaptive digital platforms can improve learning outcomes only if teachers have sufficient digital and pedagogical literacy (Putri et al., 2025). However, other researchers have recognized that algorithmic personalization often simplifies learning trajectories and provides uniform support that fails to account for socio-emotional factors or cultural context (Betts et al., 2021). In Ukrainian conditions, these contradictions are also shaped by unequal access to digital infrastructure and varying levels of teacher readiness across regions (Termenzhy, 2024). Therefore, against this background, there is an urgent need for a comprehensive study of the role of educational technologies in the development of personalized learning in Ukrainian realities. Despite the availability of international research on the impact of technologies on the individualization of the educational process, the Ukrainian experience remains poorly studied.

This study aims to assess the effectiveness of implementing educational technologies in personalized learning for younger schoolchildren in Ukraine. The study has a two-component structure: quantitative to measure the impact of specific digital tools on student learning outcomes, and qualitative to analyze the experiences, expectations, and challenges faced by teachers, students, and their parents.

The research questions include:

1. What impact do educational technologies have on the academic outcomes of primary school students?
2. To what extent does personalized learning using digital tools boost student motivation and engagement?
3. How do participants in the educational process assess the effectiveness of using digital platforms to personalize the learning experience?
4. What experiences do students develop through working with educational technologies, and how do these experiences influence their learning?

This study is essential given the current challenges and opportunities facing Ukrainian education. It will not only provide empirical evidence of the effectiveness of specific technologies but also help to formulate practical recommendations for teachers, school administrators, and curriculum developers. In addition, the results can help shape national educational policies and contribute to the global discourse on the use of technology in personalized learning for primary school children.

Literature Review and Theoretical Framework

Personalized learning: conceptual approaches and significance for primary education

Personalized learning (PL) is considered one of the leading trends in modern education. Its goal is to create a learning environment that considers each student's individual needs, interests, abilities, and learning pace. Some scholars have pointed out that personalized learning is an essential student-centred process with a flexible approach to content, time, method, and place of learning (Maksymchuk et al., 2019a; Maksymchuk et al., 2019b). Other critics have emphasised that the actual implementation of the personalized learning approach may lead to the adaptation of materials without a clear rethinking of pedagogical interaction. According to Putri et al. (2025), learning is essential for younger students due to uneven cognitive development, varying levels of preparation upon entering school, and variability in learning styles.

The PL approach is based on a few of the classical educational theories, in particular Lev Vygotsky's concept of the Zone of Proximal Development. According to Vygotsky, learning is effective when it is aimed at the potential development that a student can achieve with the support of an adult or a more competent peer (Pressley & Roehrig, 2014). Another essential foundation is the theory of "learning to mastery" developed by B. Bloom (Betts et al., 2021). As shown in the study by Betts et al. (2021), this theory involves the gradual advancement of students towards complete mastery of knowledge, taking into account individual paces. This concept serves as an essential foundation for many modern digital platforms that use tests and diagnostic tools to determine a student's developmental needs (Shanthamalar et al., 2024). However, as shown by Zhong (2022), although these theories are valuable guidelines, they were developed in the context of traditional schools, and their direct integration into digital educational environments may not account for new challenges.

Educational technologies as a means of personalizing learning

The use of technology in primary school acts as an

essential catalyst for a personalized approach. Among the most common tools are adaptive educational platforms, in particular DreamBox and i-Ready. These platforms are analysed in detail in the Clark-Wilson (2016) study. In addition, learning management systems (Google Classroom, Microsoft Teams), mobile assessment applications (Seesaw, Kahoot), and local resources (Vseosvita, Na Urok) are also widespread (Rusli et al., 2023). According to Kurnaedi (2025) and Walkington and Bernacki (2020), adaptive platforms use artificial intelligence algorithms to collect data about students and automatically adjust the complexity of tasks. Other researchers have emphasized that such systems focus only on the cognitive aspect of learning (Zuhri et al., 2024). This leads to the neglect of students' social and emotional development, which is extremely important during the 6–10 age range. The popular platform Google Classroom in Ukraine provides teachers with flexibility in managing learning. However, the effectiveness of such platforms largely depends on digital literacy, access to technology, and administrators' support (Kosenko et al., 2024; Mazur et al., 2025). Moreover, Andrusiak et al. (2022) emphasized the importance of an appropriate level of digital competence among participants in the educational process.

Personalized learning in a global and Ukrainian context: existing research

At the international level, technology-supported personalized learning has been the subject of extensive empirical research. For instance, a study by the RAND Corporation covered more than 60 schools in the United States and found a positive correlation between the use of technologies and improved performance in mathematics (Pane et al., 2015). The other authors also noted that the effect was heterogeneous and depended on school capacity, teacher training, and the organization of the learning process (Rahayu et al., 2025). They demonstrated the critical role of personalization in primary school. Then Ariesta (2025) noted that when students learn at their own pace and level, the results are much better. An effective model of personalized learning in mathematics education is presented by Termenzhy (2024), which features student-centered lab work tailored to diverse sensory modalities. Other studies have shown that personalization has a greater impact on students with low starting scores and in classes with fewer students (Bang et al., 2022). This calls into question the universality of the approach, especially in countries with heavy teacher workloads (Yusuf, 2025).

In the current Ukrainian scientific space, there are few systematic studies of personalized learning in primary school. Some works emphasize the importance of using Google Classroom (Andrusiak et al., 2022; Kosenko et al., 2024). In addition, Ukrainian platforms are actively used to create tests, conduct online lessons, and provide teaching materials (Lokhvytska et al., 2025). The other works focus on general issues in the digitalization of education, blended learning methods, or the development of digital competences (Berezovska et al., 2025; Mytsyk et al., 2024).

The literature review identified several significant gaps. Specifically, there are few mixed-methods studies. Many researchers primarily rely on empirical testing or descriptive approaches. As a result, mixed-methods research remains underutilized in this field. Additionally, the way participants in the educational process perceive change has been largely overlooked. There is also a clear lack of emphasis on the emotional and social aspects of learning. Theories of personalization are often reduced to technological algorithms, while social support and emotional comfort are just as vital for younger students. This study aims to address these gaps.

Theoretical framework

Given the identified gaps, it is advisable to use a combined theoretical framework that combines quantitative and qualitative indicators. The quantitative component is based on indicators of academic performance (assessment results, progress dynamics, frequency of tool use). This allows for an objective assessment of the impact of educational technologies on personalization. In contrast, the qualitative component is based on self-determination theory. This theory assumes that motivation is formed through the satisfaction of three basic needs: autonomy, competence, and relatedness.

This study is based on Self-Determination Theory (SDT), developed by Ryan and Deci (2000). According to this theory, an individual's motivation and engagement are determined by the satisfaction of three basic psychological needs: autonomy, competence, and relatedness. In the context of modern personalized digital learning, these constructs provide a theoretical framework for understanding how educational technologies can enhance or, conversely, limit intrinsic motivation. In this study, Self-Determination Theory serves as a general theoretical framework and an analytical tool for interpreting qualitative data.

Method

Research design

The study used a mixed-methods, parallel-convergent design, integrating quantitative and qualitative data to provide a comprehensive understanding of the impact of educational technology on personalized learning. This means that quantitative and qualitative data were collected simultaneously but analysed

separately. These data were then integrated during the interpretation of the results. This approach enabled the collection of statistically sound results and essential insights into the use of educational technologies in personalized learning for primary school pupils.

The quantitative part of the study aimed to assess students' academic achievement resulting from the use of an adaptive educational platform (in mathematics), while the qualitative part focused on the experiences, perceptions, and attitudes of teachers, parents, and students regarding the use of educational technologies in a personalized environment. The integration of such data enabled comparisons between quantitative changes (test scores) and qualitative topics (motivation or ease of use).

Participants

The study was conducted in three cities in Ukraine: Kyiv, Lviv, and Odesa, which have a developed educational infrastructure, a high level of digital accessibility, and experience implementing EdTech solutions. A total of four primary school classes (grades 1–4, ages 6–10) were selected. The quantitative component involved 150 students, who were divided into an experimental group (using the educational platform) and a control group (studying according to the traditional programme). The division was formed at the class level to avoid mixing methods within the same educational community. The qualitative component also involved 35 primary school teachers and 30 parents selected from the same schools. Six to eight focus groups with students (four to six children per group) were also conducted to record children's impressions of learning with technology. All participants took part voluntarily, with written consent (for children – with parental consent).

Materials

Quantitative instruments

The main instrument for collecting quantitative data was adaptive educational platforms (DreamBox Learning and the Ukrainian platform Smart Kids). These platforms use individualized learning trajectories based on each student's current level of knowledge. To measure learning progress, pre- and post-testing in mathematics was conducted. Hence, students in the experimental group underwent personalized digital mathematics training using the DreamBox Learning and Smart Kids platforms for 8–12 weeks. Classes were held three times a week for 30–40 minutes and were integrated into the regular curriculum. At the same time, each lesson included adaptive exercises in arithmetic operations, logical thinking, and problem solving that were automatically adjusted to the student's level.

Pre- and post-testing

The tests covered the main cognitive components typical of primary mathematics education: logical thinking (recognizing patterns, classifying objects, reasoning); computational skills (arithmetic operations within the class curriculum, working with numbers and solving problems); analytical thinking (interpreting problems, devising solution strategies, performing multi-step actions); and spatial reasoning (orientation on a plane, working with geometric shapes, symmetry). The test tasks were tailored to suit the age and cognitive development of children aged 6–10. Additionally, compliance with the State Standard for Primary Education was verified. The pre- and post-tests comprised 25 multiple-choice and short-answer tasks across four cognitive domains: (1) arithmetic speed, (2) logical thinking, (3) analytical thinking, and (4) spatial reasoning. The content validity of the tests was confirmed by an expert panel of three elementary school methodologists. Reliability was acceptable (Cronbach's α = 0.82 for the pre-test and 0.85 for the post-test).

Qualitative tools

To determine the role of technology-enabled personalized learning, a set of qualitative tools was developed to capture perspectives from teachers, students, and parents. Interviews and surveys were used to gather the data.

Procedure

Quantitative part

The experimental group worked with selected platforms (at least three lessons per week). At the same time, the control group studied using traditional methods without digital platforms. Before the experiment, both groups took an introductory test (pre-test), and after its completion, a final test (post-test) on the same material. Duration of the experiment: 8–12 weeks.

Qualitative part

After the experiment, the following were conducted: interviews with teachers who taught in the experimental classes, focus groups with students (gathering impressions of learning through the platform), and surveys of parents (ascertaining the impact of technology on home learning and child motivation). All interviews were conducted in person or online, depending on the schools' logistical capabilities.

Data analysis

Quantitative analysis: Statistical software (SPSS) was

used to process the data. The main methods included conducting a t-test for independent samples to compare mean scores between the experimental and control groups. The effect size (Cohen's d) was also calculated to assess the practical significance of the changes. Additionally, a sensitivity check was performed to account for possible differences at the pretest stage and the effects of nested class structure. In addition to independent t-tests and Cohen's d, an analysis of covariance (ANCOVA) was performed to control for pretest differences between groups. The results confirmed the stability of the main effects ($p < .001$), indicating that the improvements in posttest performance in the experimental group were not due to baseline differences.

Qualitative analysis: Qualitative data were analyzed through the lens of self-determination theory, focusing on the core dimensions of autonomy, competence, and connectedness. During thematic analysis, initial open codes were generated inductively, and then grouped deductively into SDT categories.

Specifically, expressions indicating autonomy included references to learner choice, independence, and self-directed learning ("I like that I can choose which task to start with"); competence codes encompassed statements about mastery, self-efficacy, and perceived success ("I can see my progress after each level"). Connectedness involved mentions of teacher or peer support ("We help each other on the app" or "The teacher gives me stars when I do well").

Coding was completed independently by two researchers and cross-checked for consistency (inter-rater consistency $\kappa = .87$). These categories were then used to interpret the data within the SDT framework.

Ethical considerations

The study was conducted in compliance with basic modern ethical standards, Ukrainian legislation, and the recommendations of the Ministry of Education and Science of Ukraine. The main principles applied in the study included obtaining informed consent (all parents signed a consent form for their child's participation in the survey) and confidentiality (personal data of participants is encrypted and stored separately from the results). The study provided for voluntary participation; in particular, participants had the right to refuse at any stage without consequences. The principle of anonymity was also observed: the article does not mention participants' names or school names.

Results and Discussion

Quantitative analysis

To measure the effectiveness of personalized digital learning, a standardized pre- and posttest in mathematics was administered across several key cognitive domains.

As Table 1 shows, students who studied with educational technologies demonstrated a significantly higher increase in scores than those in the control group. The increase in the experimental group is not only statistically significant ($p < 0.00$), but also has a large effect size on the Cohen scale ($d = 1.61$). This indicates a high practical significance of the results. The tests were also structured by cognitive domains (arithmetic skills, logical thinking, analytical thinking, and spatial representations), which allowed assessment of which components showed the most significant changes (See Table 2). Although the table shows the mean values before and after the experiment for clarity, statistical comparisons were made between the experimental and control groups using the t-test for independent samples applied to the growth indicators (differences between the posttest and the pretest). This approach enabled avoiding misinterpreting the table as a within-group analysis.

These data indicate that all skills experienced positive dynamics, but the most significant increase was in logical thinking and basic computational operations. In particular, in the experimental group, all four skills improved, with an increase of 3.8 to 4.9 points. The most significant progress was observed in arithmetic

Table 1

Mean scores in mathematics before and after the experiment

Group	Before test (*M* ± *SD*)	After test (*M* ± *SD*)	Increment	p-value	Cohen's d
Experimental	58.4 ± 12.1	76.2 ± 10.3	+17.8	< 0.00	1.61
Control	57.9 ± 11.4	64.5 ± 12.8	+6.6	< 0.01	0.55

Note: between-group comparisons were conducted on gain scores using an independent-samples t-test

Table 2

Gain in cognitive domains: experimental vs control group

Cognitive Domain	Before Test (Exp)	After Test (Exp)	Gain (Exp)	Before Test (Ctrl)	After Test (Ctrl)	Gain (Ctrl)	Gain Difference (Exp – Ctrl)
Arithmetic Skills	14.2	19.1	+4.9	13.9	16.1	+2.2	+2.7
Logical Thinking	13.1	17.8	+4.7	13.0	15.2	+2.2	+2.5
Analytical Thinking	15.3	19.7	+4.4	15.1	17.2	+2.1	+2.3
Spatial Thinking	15.8	19.6	+3.8	15.7	17.4	+1.7	+2.1

skills (+4.9). This was due to daily exercises and adaptive levels of complexity. In addition, the effect was also noticeable in the development of logic (+4.7), since the programs had many tasks for identifying patterns, sorting, and decision-making. The control group also showed some improvement, however, much less: an increase of only +1.7 to +2.2 points in each domain. The smallest increase was observed in spatial thinking. The lack of visual digital materials in classical education can explain this.

The motivational component was assessed using a short scale completed by students before and after the experiment, employing a visual-motivational scoring system from 0 to 10 points based on criteria such as interest, satisfaction, independence, and self-confidence).

Table 4 shows improvements in all motivational parameters within the experimental group compared with the control group. The most notable increase was in the "independent initiative" category, where the average score rose from 4.7 to 7.6 points (Δ = +2.9), suggesting the development of internal motivation and responsibility among students using educational technologies. In the control group, the corresponding increase was only +0.7 points, resulting in a significant intergroup difference of +2.3 points ($p < 0.001$). Additionally, there was a statistically significant rise in interest in learning (Δ = +1.7; $p < 0.01$) and satisfaction with the educational process (Δ = +1.6; $p < 0.01$) among students using adaptive platforms. An increase in confidence in personal success (from 5.8 to 7.9) further indicates the positive influence of a personalized approach on the emotional and volitional aspects of younger students. Conversely, the control group experienced modest increases across all criteria (from +0.4 to +0.7 points), reflecting typical gradual development under traditional learning conditions without extra stimulating tools. Therefore, digital tools that grant students autonomy and provide ongoing feedback appear to enhance internal motivation.

To determine whether external variables, such as gender, school type, and teachers' level of digital training, influence digital learning effectiveness, additional analyses were conducted.

As shown in this table, the student's gender did not have a statistically significant effect on score increases ($p > 0.05$): the average increase was +18.2 for girls and +17.3 for boys. This suggests gender neutrality in the effect. The type of school had a moderate impact: in private schools, the increase was +19.7 points, slightly higher than the +16.6 points observed in public schools ($p < 0.05$). The most notable effect was related to the variable "teacher competence in EdTech." Classes with teachers exhibiting high digital literacy levels saw an average increase of 20.2 points, compared to 14.5 points in classes with low or medium digital literacy levels ($p < 0.01$). This highlights the critical importance of pedagogical readiness for integrating digital resources. The effect size for school type was medium (Cohen's $d = 0.48$), whereas for teacher digital competence, it was large (Cohen's $d = 0.86$), indicating that teacher readiness has a more substantial impact than school type.

Qualitative analysis

Three primary qualitative methods were used in the study: semi-structured interviews with teachers, open-ended surveys for parents, and focus groups with students. This multi-perspective approach enabled the study of the use of educational technologies in personalized learning for primary school pupils from different angles — professional (teachers), family (parents), and student. The results were analyzed using thematic analysis, which identified five dominant themes.

Table 3

Dynamics of the level of motivation: experimental vs control group

Motivation criterion	Experimental (before → after)	Control (before → after)	Δ between-group	p-value
Interest in learning	6.1 → 8.4	6.0 → 6.7	+1.7	< 0.01
Satisfaction with the process	5.9 → 8.1	6.1 → 6.5	+1.6	< 0.01
Independent initiative	4.7 → 7.6	4.6 → 5.3	+2.3	< 0.00
Belief in one's own success	5.8 → 7.9	5.7 → 6.3	+1.6	< 0.01

Table 4

Increase in results in subgroups of the experimental group

Variable	Category	Gain (M)	p-value
Student Gender	Boys	+17.3	n.s.
	Girls	+18.2	
Type of School	Private	+19.7	< 0.05
	Public	+16.6	
Teacher	High EdTech Competency	+20.2	< 0.01
	Average/Low	+14.5	

Table 5

Main thematic blocks and key quotes

Thematic block	Key ideas	Typical quotes
1. Individualization of learning	- Ability to adapt tasks to the student's level	"I can give each student a task that matches their level." (Teacher 3)
2. Motivation and engagement	- Pace and content differentiation	"It's like a game, but I'm learning!" (Grade 2 student)
3. Independence and control over learning	- Gamification and positive emotionality	"I decide what to do first and what to leave for later." (Grade 3 student)
4. Technical barriers and inequality	- High interest in digital format	"Some children don't have a device or proper Wi-Fi." (Teacher 4 from a rural school)
5. Role transformation	- Students plan their own learning	"I'm not just teaching anymore—I'm guiding individual trajectories." (Teacher 10)

Topic 1. Individualization of learning

As shown in the table, the first important block was the individualization of the learning process. In particular, most of the teachers surveyed noted that educational technologies create favorable conditions for a targeted approach to each student. The integration of platforms allows varying the difficulty of tasks, the pace of work, and the type of educational activity according to the individual needs of children. A teacher with 14 years of experience pointed out that "Previously, I could only divide the class into groups conditionally. Now I can literally see who needs to repeat, who needs additional work, and who is ready to move on. And all this without reducing the motivation of others." This is confirmed by parents' feedback on changes in their children's independent learning activities. The mother of a second-grade student reported that her daughter began using the math platform and noticed it became easier for her to solve problems. Thus, technology not only allows for variation in teaching materials but also helps students develop confidence in their own abilities.

Topic 2. Improved motivation

The next topic that was clearly identified in all three categories of respondents is a significant increase in motivation to learn, in particular, thanks to the game elements, interface, and system of points and awards built into the platforms: "We even have a phrase in our class: When will the platform be available? The children eagerly await these moments. And it's not just a game, because they think and analyze", said a teacher from Kyiv.

In addition, student focus groups showed genuine enthusiasm for the opportunity to learn in a digital format. The children positively evaluated the fact that they could 'play and learn at the same time,' as well as try to do the task again in case of a mistake: "I like that if it doesn't work out, you can click and try again. I want to try again myself," said a third-grade student. Therefore, these results indicated that digital tools activate students' internal motivation, which is key at the primary school age.

Topic 3. Independence and control over the learning process

Parents often pointed out that children began to organize their own learning, plan time for completing tasks, and independently evaluate results: 'My daughter opens the app herself, does the exercises, and even analyses why she failed. This was impossible before without an adult (the father of a first-grade student). Teachers also pointed out that technology promotes the development of self-regulation and responsibility skills. In particular, some teachers acknowledged that digital learning offers students a degree of freedom. This is especially important in the context of developing the key competence of 'lifelong learning'.

Topic 4. Access issues, digital inequality, and technical difficulties

Despite generally positive feedback, respondents did not overlook the issues. In particular, teachers and parents from areas with unstable internet or limited technical resources noted barriers to fully using the platforms. A teacher from a rural school in the Lviv region noted that some children in her class can't work at home because they lack proper devices or Wi-Fi. Additionally, some parents reported difficulties with new programs, particularly when their digital skills were limited. A mother of a second-grade student said she sometimes cannot understand how the program works and struggles to figure it out. Therefore, it is crucial to consider the social context when rolling out digital solutions and to avoid widening educational inequality.

Topic 5. Transformation of the role of teachers and families

The final summary topic concerns the transformation of teachers' roles. In particular, the use of educational technologies enables not only changes in teaching format but also in pedagogical roles. Teachers are no longer the sole source of knowledge but instead become facilitators, mentors, and coordinators of individual educational paths: "We don't just explain

the material. We now analyze statistics, adapt tasks, support weaker students, and challenge stronger ones. It's more like an instructor model" (Grade 4 teacher). At the same time, parents pointed out that digital platforms have made them more active participants in the educational process. Thus, this interaction among teachers, students, and families has shaped a new ecosystem of learning.

Therefore, this study showed that educational technologies have great potential for implementing personalized learning in primary school. Digital platforms contribute to better adaptation of content to the individual needs of students, increased motivation and the development of independence. Additionally, significant challenges related to technical support and digital competence have been identified and require attention at the level of educational policy. The integration of technology is changing the traditional roles of participants in the educational process, stimulating deeper cooperation between schools and families.

Discussion

The study results demonstrated the impact of educational technologies on primary school students' academic performance. Specifically, the data showed an increase in performance in the experimental group that used the DreamBox and Smart Kids platforms. The average score improvement for this group was +17.8 points (from 58.4 to 76.2). In contrast, the control group's average increase was only +6.6 points. The effect size (Cohen's d = 1.61) indicated strong practical significance for personalized digital learning. These findings align with many international studies, including meta-analyses of educational interventions utilizing EdTech tools (Aslan & Shiong, 2023; Barua et al., 2022; Chaipidech et al., 2022; Dhananjaya et al., 2024; Farida et al., 2025). The results in cognitive domains were especially notable, with the most significant gains observed in arithmetic (+4.9) and logical thinking (+4.7). Similar patterns have been identified by other researchers working with different digital platforms (Halkiopoulos & Gkintoni, 2024; Kerimbayev et al., 2023). These authors emphasised that personalisation of learning, which promotes autonomy, has a positive effect on internal motivation (Hashim et al., 2022; Ingkavara et al., 2022; Kim et al., 2022; Sabarun et al., 2024). Other studies also demonstrate various changes in the system of engaging a personalized approach (Major et al., 2021; Nurseitova et al., 2024; Patil et al., 2024; Foster). Other studies also indicate that the effective implementation of technology in education depends not on the availability of the tools themselves, but on teachers' willingness and ability to adapt them to teaching (Grygus et al., 2019; Ruiz-Rojas et al., 2023; Safitri et al., 2021). Therefore, a comparison of the quantitative results obtained with international studies shows that modern educational technologies are highly effective in improving academic achievement, especially in the domains of logic and arithmetic (Ruiz-Rojas et al., 2023; Shevchenko et al., 2024).

This study also used qualitative data analysis from semi-structured interviews with teachers, open questionnaires for parents and focus groups with students. This approach enabled the recording of perceptions of digital learning by all key participants in the educational process. Accordingly, it was highlighted that individualization plays a significant role in the digital approach (Tsekhmister et al., 2022; Tsekhmister et al., 2023). The teachers who participated in the study unanimously emphasized that digital platforms significantly expand their opportunities for individualization. This is also consistent with the findings of other researchers, such as Alam et al. (2023), Behas et al. (2019), Safitri et al. (2021), Schmid et al. (2023), Sitovskyi et al. (2019), and Zheng et al. (2022).

The results showed that educational technologies have significant transformative potential for personalized learning in primary school. These technologies enable greater motivation among learners and foster independence and responsibility. In addition, they influence the formation of new forms of interaction between students, teachers, and families. However, the study also identified barriers related to digital infrastructure and unequal access that require targeted support. Effective integration of EdTech tools into primary schools requires not only technical infrastructure, but also teacher training, parent information and support for a digitally inclusive environment. Thus, the novelty of this study lies in revealing that qualitative changes in education are only possible through conscious partnership between all participants.

Limitations

The main limitations of the study relate to the sample size and the relatively short duration of the experiment. For example, the sample size (n = 150) and the cluster structure, limited to three cities (Kyiv, Lviv, Odesa), reduced the generalizability of the results to all of Ukraine. Despite using a stratified sample and including both public and private schools, regional differences in digital infrastructure and teacher readiness levels could influence the data collected. Additionally, a major drawback is the length of the intervention. Specifically, the study lasted only one academic semester, which may not be enough to observe the long-term effects of personalized digital learning. On the other hand, while the use of a mixed or convergent design allows combining quantitative and qualitative elements of the analysis, it also has disadvantages. Particularly, reliance on data obtained from teachers and students could have caused a certain subjectivity of assessments. Despite these

limitations, the study's results provided valuable insights into the role of educational technologies in primary education.

Prospects for further research include conducting longitudinal or multicenter randomized experiments. These studies will allow us to check the stability of the identified effects and analyze the mechanisms of motivation formation. Thus, future multicenter randomized trials will help determine the long-term impact of EdTech integration on learning outcomes. In addition, future work should focus on identifying mediating factors: digital literacy and classroom climate.

Conclusions

The proposed study confirmed the high effectiveness of educational technologies in implementing personalized learning in primary school. Students in the experimental group actively used the DreamBox and Smart Kids educational platforms. Accordingly, specific recommendations can be made. It is important for teachers to continue actively using digital innovations, but this requires creating conditions for improved and systematic training, especially considering various aspects of digital didactics, assessment, and the development of individual learning trajectories. It is crucial for managers and policymakers to support investments in upgrading school infrastructure. In particular, developing programs for teachers' professional development in EdTech and personalized learning is recommended. Additionally, mechanisms should be used to monitor the effectiveness of digital solutions at local and national levels. Researchers are encouraged to conduct long-term studies. Limitations of the study include the sample size and the relatively short duration of the experiment. Promising areas for further research include analyzing the long-term effects of personalized digital learning, its impact on academic achievement, motivation, and social skills. It is also important to further explore the use of educational technologies in rural schools, especially in environments where there are significant challenges limitations.

References

Alam, A. (2023). The Secret Sauce of Student Success: Cracking the Code by Navigating the Path to Personalized Learning with Educational Data Mining. In *2023 2nd International Conference on Smart Technologies and Systems for Next Generation Computing (ICSTSN)*(pp. 1–8). IEEE. https://doi.org/10.1109/icstsn57873.2023.10151558

Andrusiak, I., Kolesnyk, O., Slyvka, M., & Kolesnyk, A. (2022). Covid-19 and war emergency remote teaching shifts in Ukraine: Challenges faced and lessons learned. In *15th annual international conference of education, research and innovation*(pp. 4499–4506). IATED. https://doi.org/10.21125/iceri.2022.1084

Ariesta, F. W. (2025). Optimizing Elementary Student Learning Outcomes through Differentiated Instruction Based on Learning Styles. *Jurnal Ilmiah Sekolah Dasar*, *9*(2), 356–364. https://doi.org/10.23887/jisd.v9i2.94754

Aslan, A., & Shiong, P. K. (2023). Learning in the Digital Age Full of Hedonistic Cultural Values Among Elementary School Students. *Bulletin of Pedagogical Research*, *3*(2), 94. https://doi.org/10.51278/bpr.v3i2.515

Bang, H. J., Li, L., & Flynn, K. (2022). Efficacy of an Adaptive Game-Based Math Learning App to Support Personalized Learning and Improve Early Elementary School Students' Learning. *Early Childhood Education Journal*, *51*, 717–732. https://doi.org/10.1007/s10643-022-01332-3

Barua, P. D., Vicnesh, J., Gururajan, R., Oh, S. L., Palmer, E., Azizan, M. M., Kadri, N. A., & Acharya, U. R. (2022). Artificial Intelligence Enabled Personalised Assistive Tools to Enhance Education of Children with Neurodevelopmental Disorders – A Review. *International Journal of Environmental Research and Public Health*, *19*(3), 1192. https://doi.org/10.3390/ijerph19031192

Berezovska, L., Saraieva, I., Britskan, T., Ushnevych, S., & Tytun, O. (2025). The use of educational technologies for ensuring continuity of preschool and primary education. *Eduweb*, *19*(2), 167–183. https://doi.org/10.46502/issn.1856-7576/2025.19.02.12

Betts, A., Thai, K.-P., & Gunderia, S. (2021). Personalized Mastery Learning Ecosystems: Using Bloom's Four Objects of Change to Drive Learning in Adaptive Instructional Systems. In *Adaptive Instructional Systems. Design and Evaluation*(pp. 29–52). Springer International Publishing. https://doi.org/10.1007/978-3-030-77857-6_3

Clark-Wilson, A. (2016). Transforming Mathematics Teaching with Digital Technologies: A Community of Practice Perspective. In *Handbook on Digital Learning for K-12 Schools*(pp. 45–57). Springer International Publishing. https://doi.org/10.1007/978-3-319-33808-8_4

Chaipidech, P., Srisawasdi, N., Kajornmanee, T., & Chaipah, K. (2022). A personalized learning system-supported professional training model for teachers' TPACK development. *Computers and Education: Artificial Intelligence*, *3*, 100064. https://doi.org/10.1016/j.caeai.2022.100064

Dhananjaya, G. M., Goudar, R. H., Kulkarni, A., Rathod, V. N., & Hukkeri, G. S. (2024). A Digital Recommendation System for Personalized Learning to Enhance Online Education: A Review. *IEEE Access*, *12*, 34019–34041. https://doi.org/10.1109/access.2024.3369901

Farida, Prabowo, H. A., Anton, & Rizki, H. T. (2025). Technology Acceptance Model in the Application of Online Learning During COVID-19 Pandemic: Case Study in a Remote Area of Indonesia. *E-Learning Innovations Journal*, *3*(1), 4–28. https://doi.org/10.57125/elij.2025.03.25.01

Foster, M. E. (2023). Evaluating the Impact of Supplemental Computer-Assisted Math Instruction in Elementary School: A Conceptual Replication. *Journal of Research on Educational Effectiveness*, *17*(1), 1–25. https://doi.org/10.1080/19345747.2023.2174919

Grygus, I., Nagorna, O., Nogas, A., & Zukow, W. (2019). Anthropological providing educational services to children with special educational needs. *Journal of Human Sport and Exercise, 14*(4proc), 852–866. https://doi.org/10.14198/jhse.2019.14.Proc4.48

Halkiopoulos, C., & Gkintoni, E. (2024). Leveraging AI in E-Learning: Personalized Learning and Adaptive Assessment through Cognitive Neuropsychology—A Systematic Analysis. *Electronics*, *13*(18), 3762. https://doi.org/10.3390/electronics13183762

Hashim, S., Omar, M. K., Ab Jalil, H., & Mohd Sharef, N. (2022). Trends on Technologies and Artificial Intelligence in Education for Personalized Learning: Systematic Literature Review. *International Journal of Academic Research in Progressive Education and Development*, *11*(1). https://doi.org/10.6007/ijarped/v11-i1/12230

Ingkavara, T., Panjaburee, P., Srisawasdi, N., & Sajjapanroj, S. (2022). The use of a personalized learning approach to implementing self-regulated online learning. *Computers and Education: Artificial Intelligence*, *3*, 100086. https://doi.org/10.1016/j.caeai.2022.100086

Kerimbayev, N., Umirzakova, Z., Shadiev, R., & Jotsov, V. (2023). A student-centered approach using modern technologies in distance learning: a systematic review of the literature. *Smart Learning Environments*, *10*(1). https://doi.org/10.1186/s40561-023-00280-8

Kim, J., Lee, H., & Cho, Y. H. (2022). Learning design to support student-AI collaboration: perspectives of leading teachers for AI in education. *Education and Information Technologies*, *27*, 6069–6104. https://doi.org/10.1007/s10639-021-10831-6

Kosenko, V., Startsev, V., Babenko, O., Nikiforov, I., & Kalachova, V. (2024). Challenges and prospects for the development of online education in Ukraine. *Conhecimento & Diversidade*, *16*(43), 192–209. https://doi.org/10.18316/rcd.v16i43.11813

Kurnaedi, D. (2025). The Role of Computers in Collaborative E-Learning: Implications for the Future of Digital Education. *bit-Tech*, *7*(3), 956–964. https://doi.org/10.32877/bt.v7i3.2277

Lokhvytska, L., Martovytska, N., Kolomiiets, O., & Sheleg, T. (2025). E-learning in Developing Interaction with the Environment as Soft Skills in 6-Year-Old Children (on the Example of Preschool Educational Institutions in Ukraine and France). In *E-Learning and Enhancing Soft Skills*(pp. 157–176). Springer Nature Switzerland. https://doi.org/10.1007/978-3-031-82243-8_9

Maksymchuk, B., Sitovskyi, A., Kuzmenko, V., Nosko, Y., Korytko, Z., Bahinska, O., & Maksymchuk, I. (2019a). Differentiated approach to physical education of adolescents with different speeds of biological development. *Journal of Physical Education and Sport, 19*(3), 1532–1543. https://doi.org/10.7752/jpes.2019.s4192

Maksymchuk, B., Behas, L., Babii, I., Tsymbal-Slatvinska, S., Golub, N., Golub, V., & Maksymchuk, I. (2019b). The influence of tempo-rhythmic organization of speech during gaming and theatrical activities on correction of stammering in children. *Journal of Physical Education and Sport, 19*(4), 1333–1340. https://doi.org/10.7752/jpes.2019.s4193

Major, L., Francis, G. A., & Tsapali, M. (2021). The effectiveness of technology-supported personalised learning in low- and middle-income countries: A meta-analysis. *British Journal of Educational Technology*, *52*(5), 1935–1964. https://doi.org/10.1111/bjet.13116

Mazur, H., Bolhov, V., Akhnovska, I., Dluhopolskyi, O., & Kozlovskyi, S. (2025). The impact of educational development on the countries' competitiveness in the knowledge economy. *Naukovyi Visnyk Natsionalnoho Hirnychoho Universytetu*, (1), 140–146. https://doi.org/10.33271/nvngu/2025-1/140

Mytsyk, H., Popova, A., & Bohdanova, M. (2024). The Use of Gamification in the System of Social and Psychological Adaptation of Forcibly Displaced Teenagers from Ukraine: Reflections of the German Experience. *Journal of Education for Students Placed at Risk (JESPAR)*, 1–27. https://doi.org/10.1080/10824669.2024.2309359

Nurseitova, Z., Abayeva, G., Shubayeva, G., Karayeva, T., & Rakhimova, A. (2024). Organization of correctional work for children with dyslexia at primary school. *Scientific Herald of Uzhhorod University Series Physics*, (55), 383–391. https://doi.org/10.54919/physics/55.2024.38la3

Pane, J. F., Steiner, E. D., Baird, M. D., & Hamilton, L. S. (2015). Continued progress: Promising evidence on personalized learning. RAND Corporation. https://www.rand.org/pubs/research_reports/RR1365.html

Patil, A. A., Joshi, H., Shinde, P., Jadhav, J., & Pise, G. (2024). Adaptive Tutoring Systems: Crafting Personalized Learning Experiences. In *2024 2nd International Conference on Advances in Computation, Communication and Information Technology (ICAICCIT)*(pp. 261–266). IEEE. https://doi.org/10.1109/icaiccit64383.2024.10912102

Pressley, M., & Roehrig, A. (2014). Lev S. Vygotsky on Education: A Cultural-Historical, Interpersonal, and Individual Approach to Development. In *Educational Psychology*(pp. 221–242). Routledge. https://doi.org/10.4324/9781315734255-17

Putri, W., Ardianti, I., & Wirandani, W. (2025). Implementation of Technology-Based Learning Strategies through Digital Storytelling Applications of Elementary School Students. *Aphorisme: Journal of Arabic Language, Literature, and Education*, *6*(1), 49–64. https://doi.org/10.37680/aphorisme.v6i1.6871

Rahayu, N., Kawuryan, S. P., & Buaga, G. F. (2025). Differentiated Project Based Learning Model: An Effective Strategy in Ecoliteracy Education for Elementary School Students. *Jurnal Penelitian Pendidikan IPA*, *11*(3), 178–186. https://doi.org/10.29303/jppipa.v11i3.10389

Ruiz-Rojas, L. I., Acosta-Vargas, P., De-Moreta-Llovet, J., & Gonzalez-Rodriguez, M. (2023). Empowering Education with Generative Artificial Intelligence Tools: Approach with an Instructional Design Matrix. *Sustainability*, *15*(15), 11524. https://doi.org/10.3390/su151511524

Rusli, R., Hashim, F., Mohd Akhir, N., & Nasrudin, N. (2023). Learning management system (lms) preference among malaysian educators: A comparison between google classroom and microsoft teams. *Asian People Journal (APJ)*, *6*(2), 212–228. https://doi.org/10.37231/apj.2023.6.2.527

Ryan, R. M., & Deci, E. L. (2000). *Self-Determination Theory and the Facilitation of Intrinsic Motivation, Social Development, and Well-Being. American Psychologist, 55*(1), 68–78. https://selfdeterminationtheory.org/SDT/documents/2000_RyanDeci_SDT.pdf

Sabarun, Widiastuty, H., Ajahari, Asmawati, & Azhari Azman, M. N. (2024). The relationship between Instrumental and Integrative Motivation on the Students' Writing Ability. *Multidisciplinary Science Journal*, (|Accepted Articles), 2024166. https://doi.org/10.31893/multiscience.2024166

Safitri, D., Lestari, I., Maksum, A., Ibrahim, N., Marini, A., Zahari, M., & Iskandar, R. (2021). Web-Based Animation Video for Student Environmental Education at Elementary Schools. *International Journal of Interactive Mobile Technologies (iJIM)*, *15*(11), 66. https://doi.org/10.3991/ijim.v15i11.22023

Schmid, R., Pauli, C., & Petko, D. (2023). Examining the use of digital technology in schools with a school-wide approach to personalized learning. *Educational technology research and development*. https://doi.org/10.1007/s11423-022-10167-z

Scippo, S., Madiai, S., & Cuomo, S. (2025). Digital Tessellation for Geometry Learning in Primary School: A Quasi-Experimental Study. *Journal of Information Technology Education: Research*, *24*, 009. https://doi.org/10.28945/5473

Shanthamalar, J., Sheelam, D., Bodla, S. R., Gowri Manohari, V., & Nancy Noella, R. S. (2024). Bloom's Taxonomy Based Question Analysis for Personalized Learning. In *IFIP Advances in Information and Communication Technology*(pp. 296–311). Springer Nature Switzerland. https://doi.org/10.1007/978-3-031-69986-3_23

Shevchenko, Y., Dubiaha, S., Saienko, Y., Huz, V., & Svyrydenko, H. (2024). Exploring dysgraphia in elementary school students: assessment and tailored intervention strategies from a psycholinguistic perspective. *Multidisciplinary Science Journal*, *6*, 2024ss0714. https://doi.org/10.31893/multiscience.2024ss0714

Termenzhy, D. (2024) Implementation of person-centered approach in pre-service mathematicians' training by using VARK model of learning. *Collection of Scientific Papers with the Proceedings of the 2nd International Scientific and Practical Conference «Scientific Research: Modern Innovations and Future Perspectives»* (November 25-27, 2024. Montreal, Canada). European Open Science Space. 235-242.

Tsekhmister, Y., Stetsenko, N., Volyk, O., Gumennykova, T., & Sharov, O. (2023). Forecast of educational trends in the role of "soft skills" for the professional development of future specialists in the conditions of distance learning: The challenges of our time. *Journal of Higher Education Theory and Practice, 23*(10). https://doi.org/10.33423/jhetp.v23i10.6195

Tsekhmister, Y., Yakovenko, O., Miziuk, V., Sliusar, A., & Pochynkova, M. (2022). The effect of online education on the teachers' working time efficiency. *Journal of Curriculum and Teaching, 11*(6), 44–54. https://doi.org/10.5430/jct.v11n6p44

Walkington, C., & Bernacki, M. L. (2020). Appraising research on personalized learning: Definitions, theoretical alignment, advancements, and future directions. *Journal of Research on Technology in Education*, *52*(3), 235–252. https://doi.org/10.1080/15391523.2020.1747757

Yusuf, F. A. (2025). Trends, opportunities, and challenges of artificial intelligence in elementary education - A systematic literature review. *Journal of Integrated Elementary Education*, *5*(1), 109–127. https://doi.org/10.21580/jieed.v5i1.25594

Zheng, L., Long, M., Zhong, L., & Gyasi, J. F. (2022). The effectiveness of technology-facilitated personalized learning on learning achievements and learning perceptions: a meta-analysis. *Education and Information Technologies*. https://doi.org/10.1007/s10639-022-11092-7

Zhong, L. (2022). A systematic review of personalized learning in higher education: learning content structure, learning materials sequence, and learning readiness support. *Interactive Learning Environments*, *31*(10), 1–21. https://doi.org/10.1080/10494820.2022.2061006

Zuhri, R. S., Wilujeng, I., Haryanto, H., & Ibda, H. (2024). Information communication technologies education in elementary school: a systematic literature review. *Journal of Education and Learning (EduLearn)*, *18*(3), 1070–1082. https://doi.org/10.11591/edulearn.v18i3.21435

Appendix 1. Motivational scale for elementary school students

The goal is to determine the subjective level of motivation of younger schoolchildren when using educational technologies.

No. Question	No. Question	+	+/-	-
1 I am interested in studying with this program.				
2 I am satisfied with the way we are studying now.				
3 I want to study even more independently.				
4 I believe that I have achieved good results.				

Appendix 2. Semi-structured interview for teachers

Aim: To explore the experience of integrating EdTech into personalized learning.
General instructions: The interview lasts 20–30 minutes. It is conducted individually (online/offline). It is recorded with the respondent's permission.

Key questions:

1. How do you use educational technologies in your work with younger students?
2. What features or advantages of digital platforms have you noticed for personalized learning?
3. Have student outcomes changed since the introduction of technologies? If so, how?
4. What challenges have you faced?
5. How do parents react to the use of technologies in education?
6. Do you plan to continue using these platforms?
7. What recommendations could you give to other teachers?

Appendix 3. Parent Questionnaire (Semi-Open Format)

Purpose: To identify parental attitudes towards EdTech, changes in child's motivation and behaviour.

Part 1. Demographic information:

Child's age:
Grade:
Parents' education:
School type
Your level of digital literacy:

Part 2. Open-ended questions:

How has your child's interest in learning changed since the introduction of the educational platform?
Did your child need help with digital tasks? If so, what kind?
What do you like most about digital learning?
What do you dislike or worry about?
Is it worth continuing to use educational platforms in the future?
What are your tips or wishes for teachers and schools?

Appendix 4. Focus group scenario for students

Purpose: To explore children's emotions, impressions, and difficulties while learning with technology.
Participants: 4–6 students from 1st grade
Duration: 25–30 min
Form: Informal conversation with visual and game elements
Moderator: Psychologist or teacher (with adherence to ethical principles)
Key questions:
What do you like most about the program/platform you work with?
What do you find most interesting about learning with a tablet or computer?
What was complex or unclear?
What would you like to change or improve?
Would you like to study like this at home?
How do you feel during such lessons - joyful, calm, worried?
Methodological notes: To conduct these focus groups, emoticon cards were used for emotions. Children could draw their favorite elements of the lesson. All responses were recorded in audio recordings and notes.