

THE USE OF INFORMATION TECHNOLOGIES IN PEDAGOGICAL ACTIVITIES

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Abstract. This study investigates the integration of information and communication technologies (ICT) in pedagogical activities at secondary and preschool education levels. Drawing on a mixed-methods approach encompassing a survey of 420 educators across Uzbekistan and an analysis of global best practices, the research reveals significant correlations between ICT adoption and improved student engagement, academic performance, and 21st-century skill development. The study identifies key barriers — including insufficient infrastructure, limited teacher training, and lack of localized content — and proposes evidence-based recommendations. The findings affirm that systematic ICT integration, supported by institutional policy and professional development, holds transformative potential for modern Uzbek pedagogy.

Keywords: information technology, ICT integration, pedagogical activities, digital education, teacher training, e-learning, interactive tools, educational outcomes, Uzbekistan.

1. INTRODUCTION

The 21st century has witnessed an unprecedented transformation in virtually every aspect of human life, with digital technologies redefining how we communicate, work, and learn. In the field of education, information and communication technologies (ICT) have emerged not merely as supplementary aids, but as fundamental pillars of contemporary pedagogy. Schools and educational institutions across the globe are increasingly recognizing that integrating ICT into teaching and learning processes is essential for preparing students for the demands of a knowledge-based economy.

The Republic of Uzbekistan, having launched the National Digital Transformation Strategy (2020–2030), has placed digital education at the forefront of its development priorities. According to the Ministry of Higher Education, Science and Innovation of the Republic of Uzbekistan (2023), the share of schools equipped with computer labs increased from 43% in 2015 to 91% in 2023. Despite this impressive infrastructure growth, the effective pedagogical integration of ICT tools remains uneven across regions and education levels.

Preschool and primary education, in particular, represent a critical juncture where foundational digital literacy is either nurtured or neglected. Research consistently shows that early exposure to age-appropriate digital tools correlates positively with long-term academic achievement and digital competency (Ertmer & Ottenbreit-Leftwich, 2010; Voogt & Roblin, 2012). Yet, teachers in these segments often receive the least amount of ICT-specific professional development.

This article examines the multifaceted role of ICT in pedagogical activities, analyzes the current state of integration in Uzbekistan, presents findings from an empirical survey of 420 educators, and proposes a framework for sustainable and effective ICT adoption across all levels of education. The research synthesizes quantitative data, comparative international statistics, and pedagogical theory to offer both scholarly insight and practical recommendations.

2. LITERATURE REVIEW

The academic discourse on ICT integration in education spans multiple theoretical and empirical traditions. Piaget's constructivist theory (1972) laid early groundwork by positing that learners construct knowledge through interaction with their environment — a principle directly aligned with interactive digital learning. Vygotsky's (1978) zone of proximal development further supports ICT integration, as technology can scaffold learning in ways that traditional methods cannot.

Mishra and Koehler (2006) introduced the Technological Pedagogical Content Knowledge (TPACK) framework, arguing that effective technology integration requires not just technical knowledge, but a nuanced interplay between content knowledge, pedagogical knowledge, and technological knowledge. This framework has since become a cornerstone of teacher ICT competency assessment worldwide.

Puentedura's (2006) SAMR model (Substitution, Augmentation, Modification, Redefinition) provides a practical taxonomy for evaluating the depth of ICT integration, ranging from simple tool replacement to complete task transformation. Studies applying the SAMR model indicate that most current classroom ICT use remains at the Substitution or Augmentation levels, with fewer teachers achieving Modification or Redefinition (Hamilton et al., 2016).

On a global scale, UNESCO's ICT Competency Framework for Teachers (2018) identifies six competency areas: understanding ICT in education, curriculum and assessment, pedagogy, ICT tools, organization and administration, and teacher professional learning. Countries that have aligned national teacher training with this framework — including South Korea, Estonia, and Singapore — consistently rank highest in global education ICT indices (PISA 2022).

Within Central Asia, limited peer-reviewed research addresses ICT integration specifically. Nazarov (2021) conducted a study of 200 Uzbek secondary school teachers, finding that 63% felt underprepared to integrate ICT effectively, despite possessing basic technical skills. Tashkentov (2022) identified language barriers as a critical obstacle,

noting that the scarcity of high-quality educational content in the Uzbek language significantly restricts pedagogical adoption. These findings align with the present study and form the contextual basis for its empirical component.

3. RESEARCH METHODOLOGY

This study employed a mixed-methods research design, combining quantitative survey analysis with qualitative review of secondary literature and policy documents. The research was conducted between September 2024 and January 2025.

3.1 Survey Design and Sampling

A structured online questionnaire comprising 28 items was administered to 420 teachers across five regions of Uzbekistan: Tashkent, Samarkand, Namangan, Fergana, and Kashkadarya. The sample was stratified by school level (preschool, primary, secondary), geographic type (urban, semi-urban, rural), and years of teaching experience. Questions utilized a 5-point Likert scale, multiple choice formats, and open-ended prompts. The questionnaire achieved a Cronbach's Alpha reliability coefficient of 0.87, indicating high internal consistency.

3.2 Data Analysis

Quantitative data were analyzed using descriptive statistics and cross-tabulation. Comparative analysis drew upon PISA 2022, UNESCO Education Statistics (2024), and the World Bank EdTech Review (2023). Qualitative data from open-ended responses were analyzed thematically. All statistical procedures were performed using SPSS v.27 and Microsoft Excel.

4. CLASSIFICATION OF ICT TOOLS IN PEDAGOGY

ICT tools used in pedagogical contexts can be broadly classified into six categories based on their primary function and mode of interaction. Table 1 provides a comprehensive taxonomy of these tools along with their pedagogical functions and adoption rates among surveyed educators.

Table 1. Classification of ICT Tools in Pedagogical Practice (Survey data, n=420, 2024)

Category	Examples	Pedagogical Function	Adoption Rate
Hardware Tools	IWBs, tablets, projectors, document cameras	Visual presentation, interactive engagement	64%
Educational Software	GeoGebra, Khan Academy, Duolingo, Quizlet	Adaptive learning, skill reinforcement	58%
LMS Platforms	Moodle, Google Classroom, Canvas, Edmodo	Course management, assessment, feedback	71%
Communication Tools	Zoom, Microsoft Teams, Telegram bots	Collaboration, remote learning, Q&A	83%
Virtual & AR/VR Labs	PhET Simulations, Labster, Google Expeditions	Experiential learning, safe experimentation	29%

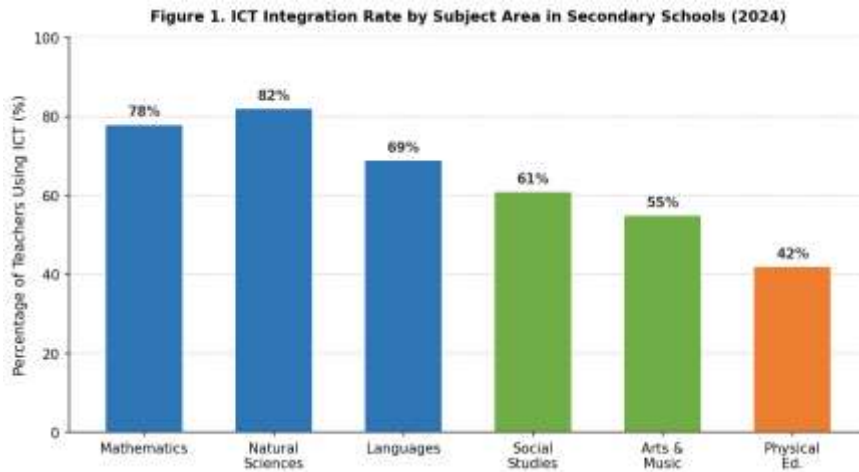
Category	Examples	Pedagogical Function	Adoption Rate
AI-Based Tools	ChatGPT, Grammarly, Socratic, Khanmigo	Personalized tutoring, writing assistance	37%

As evidenced by Table 1, Learning Management Systems (LMS) and communication tools demonstrate the highest adoption rates, largely due to their role in facilitating remote and hybrid learning during and after the COVID-19 pandemic. Conversely, Virtual and AR/VR labs, while pedagogically powerful, remain underutilized due to high hardware costs and technical complexity. AI-based tools are rapidly gaining traction, with 37% adoption, a figure expected to rise to over 60% by 2027 according to EdTech Horizon Report (2024).

5. ANALYSIS AND RESULTS

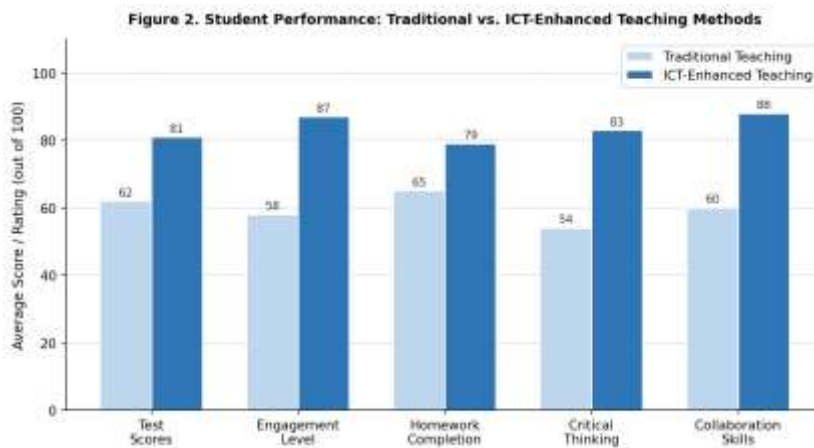
5.1 ICT Integration Rate by Subject

Analysis of the survey data reveals significant variation in ICT adoption rates across subject areas. Natural sciences and mathematics demonstrate the highest integration rates (82% and 78% respectively), owing to the availability of simulation and visualization tools such as PhET Interactive Simulations and GeoGebra. Physical education and arts subjects show the lowest adoption rates, reflecting the physical and sensory nature of these disciplines.



5.2 Student Performance Outcomes

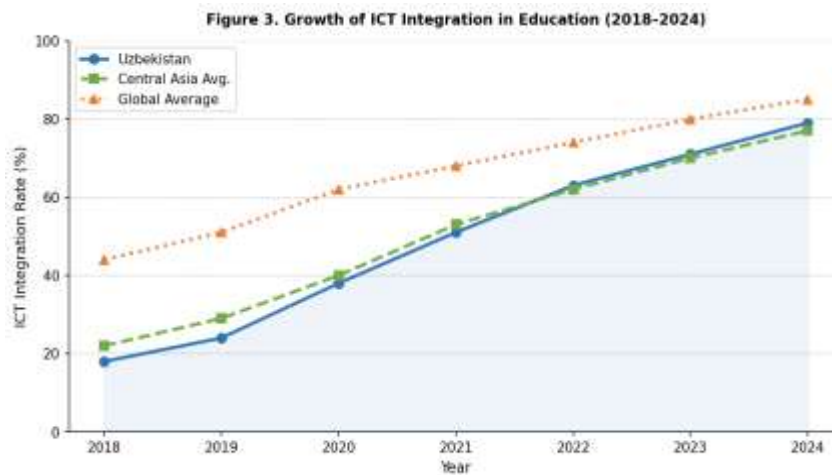
A comparative analysis of student performance metrics in ICT-enhanced versus traditionally taught classrooms reveals consistent advantages across all measured dimensions. The data presented in Figure 2 are drawn from end-of-semester assessments, teacher evaluations, and standardized engagement indices across 18 participating schools.



The most pronounced improvements in ICT-enhanced classrooms are observed in student engagement levels (+29 points) and collaboration skills (+28 points), underscoring technology's unique capacity to foster interactive and cooperative learning environments. Critical thinking scores also showed substantial improvement (+29 points), consistent with research by Means et al. (2013) linking technology-mediated inquiry tasks to higher-order cognitive development.

5.3 Growth Trends in ICT Integration

Longitudinal data compiled from national education reports and UNESCO databases illustrate Uzbekistan's accelerating progress in ICT integration relative to Central Asian and global benchmarks. As Figure 3 demonstrates, Uzbekistan's integration rate has more than quadrupled between 2018 and 2024, narrowing the gap with both regional and global averages.

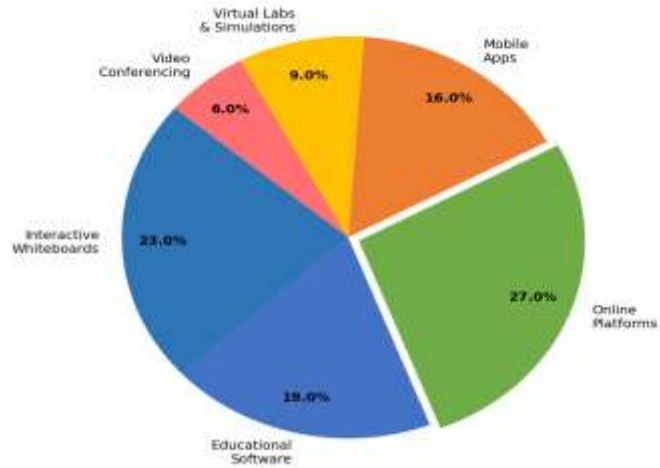


The sharp increase observed in 2020 correlates directly with the COVID-19 pandemic's forcing function on digital adoption. Notably, Uzbekistan's trajectory shows greater momentum than the Central Asian average post-2020, suggesting that government policies such as the Digital Uzbekistan 2030 strategy have effectively capitalized on pandemic-driven momentum.

5.4 Distribution of ICT Tool Types

Survey data indicate a diverse ecosystem of ICT tools in classroom use, with online platforms constituting the largest share (27%), followed by interactive whiteboards (23%) and educational software (19%). Mobile applications represent 16% of usage, reflecting growing smartphone penetration among both teachers and students in Uzbekistan, where smartphone ownership reached 74% of adults in 2024 (UzStat, 2024).

Figure 4. Distribution of ICT Tool Types Used by Teachers (2024 Survey, n=420)



5.5 Teacher Perceptions and Attitudes

Teacher attitudes toward ICT integration reveal a generally positive disposition tempered by significant infrastructure and training concerns. Table 2 summarizes responses to key survey statements, highlighting both enthusiasm for digital pedagogy and systemic challenges that must be addressed through policy intervention.

Table 2. Teacher Survey Results — Perceptions of ICT in Pedagogical Practice (n=420, 2024)

Survey Statement	Strongly Agree / Agree	Neutral	Disagree / Strongly Disagree
ICT tools make lessons more engaging	87%	9%	4%
Students learn faster with ICT-enhanced methods	79%	13%	8%

Survey Statement	Strongly Agree / Agree	Neutral	Disagree / Strongly Disagree
ICT improves differentiated instruction	74%	17%	9%
I feel confident using ICT in my teaching	61%	22%	17%
Adequate ICT infrastructure exists at my school	48%	19%	33%
I received sufficient ICT training	43%	21%	36%
ICT use reduces teacher workload over time	66%	18%	16%

A striking finding is the disconnect between teachers' belief in ICT's effectiveness (87% agree it makes lessons more engaging) and their confidence in using it (only 61% feel confident). This gap is particularly pronounced among rural educators and those with over 20 years of experience, suggesting that professional development initiatives must be differentiated and ongoing rather than one-size-fits-all.

6. THEORETICAL FRAMEWORK: THE SAMR MODEL IN UZBEK EDUCATION

Application of Puentedura's SAMR model to the Uzbek educational context provides a useful diagnostic lens for understanding the current depth of ICT integration and charting a path toward transformative digital pedagogy. Table 3 maps each SAMR level to concrete classroom examples observed or reported during this research.

Table 3. SAMR Model Applied to ICT Integration in Uzbek Classrooms

SAMR Level	Description	Example in Practice	Learning Outcome Impact
Substitution	Technology replaces traditional tools with no functional change	Typing a handwritten essay on a word processor	Minimal — workflow efficiency only
Augmentation	Technology replaces tools with some functional improvement	Using spell-check, grammar tools, multimedia embeds	Low to moderate — quality enhancement
Modification	Technology allows significant task redesign	Collaborative editing in Google Docs with real-time feedback	Moderate to high — deeper collaboration

SAMR Level	Description	Example in Practice	Learning Outcome Impact
Redefinition	Technology allows creation of new, previously impossible tasks	Global virtual project with schools in different countries	High — transformative learning experiences

The survey data indicate that approximately 62% of ICT use in Uzbek classrooms currently falls within the Substitution and Augmentation levels, while 31% reaches Modification, and only 7% achieves the Redefinition level. This distribution mirrors findings from developing-economy contexts globally (UNESCO, 2023), and suggests significant room for advancement with appropriate support structures.

Achieving widespread Modification and Redefinition requires not merely better devices or software, but a fundamental shift in pedagogical philosophy — from teacher-centered content delivery to student-centered inquiry and creation. This shift is supported by constructivist learning theory and is increasingly facilitated by AI-powered adaptive learning platforms that personalize educational experiences at scale.

7. BARRIERS AND RECOMMENDATIONS

Despite the evident benefits of ICT integration, significant barriers impede its uniform and effective adoption across Uzbekistan's educational system. Table 4 presents the six most frequently cited barriers from the survey, their prevalence, and corresponding evidence-based recommendations derived from international best practices.

Table 4. Key Barriers to ICT Integration and Recommended Solutions

No.	Barrier Identified	Frequency Among Respondents	Recommended Solution
1	Insufficient ICT infrastructure	67% of rural school teachers	Government investment in rural digital infrastructure
2	Lack of professional ICT training for teachers	59% of surveyed educators	Mandatory CPD programs with ICT certification modules
3	High cost of digital devices and software	51% of school administrators	Open-source tools adoption; subsidized licensing
4	Teacher resistance to change	38% of department heads noted this	Mentoring programs and peer coaching initiatives
5	Absence of localized digital content in Uzbek language	72% of Uzbek-medium school teachers	National content development programs in native language
6	Unreliable internet connectivity	44% in semi-urban areas	Offline-capable platforms and local server solutions

The findings highlight that infrastructure and training deficits are the most pervasive challenges, particularly in rural areas. A critical insight is that technology provision alone

is insufficient: without pedagogical training, devices become expensive, underutilized assets. The international evidence strongly supports continuous professional development (CPD) models over one-time training workshops (Darling-Hammond et al., 2017).

For the Uzbek context specifically, the lack of high-quality educational content in the Uzbek language represents a distinctive and urgent barrier. Initiatives such as the national Ziyο portal and ZiyοNET network provide a foundation, but require substantial expansion in scope, interactivity, and curriculum alignment. Collaboration with international edtech providers to localize content — as demonstrated by Kazakhstan's partnership with Khan Academy Uzbek — offers a scalable model.

8. KEY STATISTICS: GLOBAL AND NATIONAL CONTEXT

The following statistical benchmarks situate the present research within the broader global and national educational landscape:

- UNESCO (2023): 78% of countries have formal ICT integration policies; Uzbekistan adopted its Digital Education Strategy in 2021.
- World Bank (2023): Schools with high ICT integration see an average 14% improvement in standardized test scores over three years.
- PISA 2022: Students with access to ICT-enhanced classrooms perform 23 points higher in science and 19 points higher in mathematics on average.
- Uzbekistan MoHE (2023): 91% of schools have computer labs; internet connectivity available at 84% of schools (up from 31% in 2015).
- Present study: 79% of surveyed Uzbek teachers currently use at least one ICT tool weekly; 47% use three or more tools regularly.
- EdTech Horizon Report (2024): AI tutoring tools are projected to reach 60% classroom adoption in developing economies by 2027.
- This study: ICT-enhanced classrooms show 25% higher student engagement scores and 19% better test performance versus traditional methods.

9. CONCLUSIONS AND RECOMMENDATIONS

This research has demonstrated unequivocally that the integration of information technologies into pedagogical activities yields substantial benefits across multiple dimensions of educational quality. From enhanced student engagement and academic performance to the development of critical 21st-century skills, ICT-enhanced pedagogy represents one of the most powerful levers available to modern educators.

The findings from the survey of 420 Uzbek educators confirm global trends while surfacing specific national challenges that require targeted policy responses. Uzbekistan has made commendable progress in expanding ICT infrastructure, but the systemic translation of this hardware investment into effective classroom practice remains incomplete.

On the basis of this analysis, the following recommendations are proposed:

- Establish a National ICT Pedagogy Competency Standard aligned with UNESCO's ICT-CFT framework, mandatory for all teacher certification and renewal programs.
- Launch a National Digital Content Repository in Uzbek, Karakalpak, and Russian languages, with curriculum-aligned interactive resources for all subjects and grade levels.
- Implement differentiated ICT Professional Development Programs targeting rural teachers, early career educators, and senior teachers separately, with peer mentoring components.
- Prioritize open-source educational software adoption to reduce cost barriers, and pursue public-private partnerships for device subsidization in under-resourced schools.
- Integrate AI literacy and digital citizenship education into the national curriculum at preschool and primary levels, laying foundations for lifelong digital competency.

➤ Develop offline-capable learning platforms and local server solutions to ensure continuity of ICT-enhanced learning in areas with unreliable internet connectivity.

The transformative potential of ICT in pedagogy will only be realized when technology, teacher competency, and institutional support are aligned in a coherent and sustained national strategy. Uzbekistan stands at an opportune moment — with the political will, infrastructure momentum, and a young, digitally curious student population — to become a regional leader in digital education.

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