Journal of Social Research Dynamics (JSRD), Volume 1 Issue 1 (2025)
ISSN: 2978-4352

Effect of Innovative Technology Integration in Primary School on Student's Learning

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Abstract

This paper discusses the effect on student learning through use of technology in primary school environments; early education matters because it involves creative learning that needs engaging teaching. The study administered a questionnaire with multiple-choice questions as well as detailed open-ended questions via Microsoft Forms to all teachers who had at least one- or two-years' experience (open-access link), after obtaining their consent prior to participation, and analyzed using thematic and descriptive methods showing how innovative technology is linked to better student learning outcomes when they play AI-based games, 3D print objects, and attend interactive workshops.

Keywords: Innovative Technology Integration; Primary School; Student Learning; AI-based Games; 3D Printing

Introduction

The 21st century is a time of innovation and technological advances that have been global in nature and impact on all citizens around the world (Yılmaz, 2021) and as technology continues to evolve, it is constantly updated and adapted to be a part of modern educational curricula and used on a daily basis by today's students. Today, collaborative methods are the norm; however, some educators have also found new ways for skill development, creativity, and academic performance (Yildiz & Celik, 2020), such as technology has made it possible to learn mathematics more interactively (Asare et al., 2024). Hence, technology should be incorporated into educational systems, particularly in mathematics instruction and knowledge delivery systems (Bakar et al., 2020). Likewise, different learning tools assist learners in their language acquisition process, with research indicating that technological practices can improve multiple dimensions of language learning such as motivation to study English and expand vocabulary beyond what traditional teaching methods are able to accomplish due to time constraints (De Souza et al., 2021). This article will focus on innovative interactive technology and how it contributes to enhancing students' skills, creativity, and academic performance.

Background

In this digital era, integrating technology innovations in educational settings is both beneficial and necessary for creating an innovative educational environment that meets the various needs of students (Abulibdeh et al., 2024) while preparing them for a modern job market with new technologies (Khan & Khan, 2020). With innovation seeping into every corner of society, it has become essential to succeed in academia (Van Petegem et al., 2021), and as shown in the first wave

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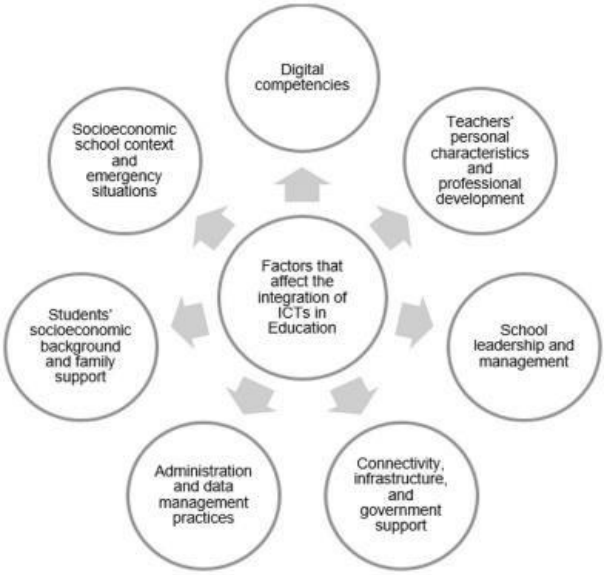
of COVID-19, the swift implementation of digital tools in education sparked some crucial concerns about how schools would continue to digitalize (Timotheou et al., 2023). The integration of technology in teaching allows students not only to learn using technological tools but also to be prepared to engage with a more digitized society. Now, Information and Communication Technology (ICT) is essential in education as it enhances engagement in the classroom and helps retain knowledge for students, enabling them to understand even the most challenging educational topics in innovative ways (Aslam et al., 2021). Additionally, ICT integration plays a key role in widening individual opportunities while also improving the efficiency of educational processes as well as quality of the learning experience with greater learner satisfaction and attainment of specific goals such as gaining new skills, better academic performance or career advancement (Akram et al., 2021).

Figure 1
Factors highlighting the impact of ICTs on education



There are several factors that influence the incorporation of ICT in educational process, mainly including digital competencies, school administration, and governance (see Figure 1; Timotheou et al., 2023). The centrality of innovative technology in educational system is underscored by several factors such as digital competencies among others (see Figure 1; Timotheou et al., 2023) which can enhance student engagement and foster collaborative learning (Mohebi, 2021). Online courses exist today and technology has ushered in a host of benefits for the education industry (Yildiz, 2022). Therefore, implementing ICT in education can completely change students' learning styles by engaging them in innovative and interactive technological approaches (Suleima, 2020).

Technology plays a critical role for educators in facilitating language learning. In every language class, various forms of innovation are routinely utilized (Carstens et al., 2021). Such innovations have been employed to enrich the language learning experience, allowing instructors to modify

classroom activities and thereby enhance the overall process of language acquisition (Yildiz, 2021).

Digital technology is being marketed for its potential to stimulate creativity among students by offering new tools and environments that inspire creative thinking and imaginative learning (Bereczki 2019). As technology continues to evolve, more digital components are finding their way into the classroom (Carstens et al. 2021), but the influence of technology on education can be both positive and negative (Ismail et al., 2020); therefore, this article explores the effect of innovative ICT on student learning outcomes, with emphasis on methods that directly impact students' academic performance.

Research Questions

How does innovative technology integration affect student learning outcomes in primary schools of Pakistan?

How does technology integration impact student engagement, motivation, and academic achievement?

Literature Review

With the rapid growth of online learning, they argue for a new form of education that meets the demands of online learners with more dynamic and interactive online infrastructure to reduce dropout rates. They suggest that an enhanced online learning environment with real-time communication can provide a welcoming space for students with varied learning preferences, offering them a unique educational experience that is both accessible and flexible beyond what traditional physical classrooms can offer. Results highlight the importance of digital platforms for transforming the education system into a participatory, engaging, and successful one in an increasingly connected world (Shinde et al., 2024).

Another study on how technology influences global disruptions during COVID-19 pandemic through remote teaching and learning (2021) focused on challenges faced by teachers in Pakistan showed that even though Pakistani teachers primarily used applications such as Zoom and WhatsApp for online classes, lack of electricity, intermittent internet connectivity, and parental resistance to online education are still issues, and many Pakistani students do not have technology in rural areas due to a large digital divide between urban and rural parts. Administrations need to ensure that they prioritize digital literacy and inclusive teaching practices so that no student is left behind in this rapidly changing environment (Rehman et al., 2021).

Recent research (2022) described how Pakistani educators are using information and communication technologies (ICT) at different levels, suggesting that while many educators have a positive attitude toward ICT integration, they encounter significant barriers such as infrastructure deficiencies, low internet access, and lack of training. They noted the importance of improving policies to address these barriers to better enable teachers to advance their technological skills in order to amplify ICT use in learning. The researchers also pointed out how important it is for teachers' perceptions of technology play a part in implementing technology in classroom activities (Akram et al., 2022).

An understanding of barriers to incorporating modern technologies into primary schools will help develop strategies for using technology effectively to improve educational experiences in Pakistani elementary school students. This paper explores the use of technology-enhanced games boards such as interactive whiteboards, specifically looking at primary factorization principles and how a game-based learning strategy can be used to address the common problem of low motivation and

achievement in mathematics among elementary students. In an experiment comparing the use of a technology-enhanced board game with traditional review exercises, they found that the game increased student engagement and significantly contributed to improved performance in prime factorization. Researchers also noted, the recommended strategy not only enhanced the learning of students and their achievement in prime factorization but also in hands to their desire to learn and perspective (Yen-Ting Ling and Ching Te Cheng, 2022).

Furthermore, another study explored how technology-based learning environments affect English as a foreign language fluency among Pakistani students. They stated that "information and communication technologies offered the opportunity to transform the education system," noting that advanced technologies combined with innovative teaching methods can substantially enhance students' learning experiences. The integration of ICT in classroom settings has been shown to improve student performance, particularly in language learning. Moreover, by comparing the results of pre-test and post-test, an experimental group using technology and a control group employing conventional methods, it was clear that the experimental group scored much higher (Ali, Alaa, & Shahnaz, 2024).

Methodology

This article employed a mixed-methods research grounded in constructivist theory to examine the incorporation of technology in primary schooling system. By combining quantitative and qualitative methods, the research captured both statistical trends and rich narrative insights, thereby enhancing validity through data triangulation (Dawadi, Shrestha, & Giri, 2021). Thirty primary school teachers (26 females and 4 males) with minimum teaching experience of two years and prior exposure to classroom technology were purposefully selected, with only those teaching Grade 2 or above included to maintain consistency and control extraneous variables (Strijker, Bosworth, & Bouter, 2020). Data were collected via an online questionnaire disseminated through email and social media, comprising sections on demographic information, teaching and IT experience, perceived technology benefits, and encountered challenges; while closed-ended items yielded quantitative data, five open-ended questions provided qualitative insights, and participants had two weeks to complete the survey after giving informed consent via Google Forms. Quantitative analysis identified emerging trends, and thematic analysis of the qualitative responses revealed meaningful patterns, with the tool was shown to be reliable, with a Cronbach's alpha score of 0.85 and its validity supported by expert review and a pilot study with five participants. Ethical protocols were rigorously maintained by obtaining informed consent and ensuring confidentiality and anonymity, thereby safeguarding participants' professional standing. Despite these strengths, the study's findings are limited by the small, context-specific sample and reliance on self-reported data, suggesting that future research should involve a larger and more diverse sample to further validate and extend these results.

Results and Data Analysis

Participants and Demographic Overview

Thirty participants, all over 18 years of age, completed the survey. The demographic profile indicates that most respondents are early-career educators, with only 3 respondents (10%) aged 35 or older. Reflecting common trends in education, 26 respondents (87.7%) were female, while 4 respondents (13.3%) were male. Regarding teaching experience, 4 respondents had two year, and the remaining 26 had more than two years of experience.

Perceptions of Incorporation of Technology

When evaluating the present level of incorporated technologies in selective institutions, respondents reported a high degree of satisfaction. With an average rating of 6.36 on the scale provided, 93% of participants expressed positive sentiments. This indicates a strong belief that innovative digital tools are transforming classrooms into dynamic, engaging, and student-centered environments, thereby enhancing both student engagement and learning outcomes.

Use of Technology in the Classroom Practices

Research participants were asked about the advantages of incorporating advanced technology in early classroom settings. Key insights include:

- Over 90% (combining "agree" and "strongly agree" responses) confirmed that the use of innovative technology is crucial for enriching instructional practices.
- Many educators emphasized that digital resources such as video lectures and interactive simulations play a vital role in clarifying complex scientific and mathematical concepts for young learners.
- While the survey did not delve deeply into specific technologies, the overall feedback strongly supports the notion that interactive and creative digital tools are beneficial for early student learning.

Challenges and Limitations

The survey employed seven Likert-scale statements to identify potential challenges associated with integrating innovative technology in classrooms. The summarized responses are as follows:

General Use of Technology

16 respondents (53.3%) agreed and 12 respondents 40% strongly agreed that technology is effectively implemented in their classrooms.

Impact on Student Interest

12 respondents (40%) agreed and 16 respondents (53.3%) strongly agreed that digital tools boost students' interest in studying.

Utilization of Digital Lectures and Tools

18 respondents (60%) agreed and 9 respondents (30%) strongly agreed that digital lectures and tools are consistently used to support learning.

Enhancement of Learning Outcomes

12 respondents (40%) agreed and 14 respondents (46.7%) strongly agreed that digital tools contribute to improved learning outcomes.

Relevance of Traditional Methods

9 respondents (30%) agreed and another 9 respondents (30%) strongly agreed that traditional teaching methods are becoming less effective in today's digital era.

Engagement through Innovative Technology

12 respondents (40%) agreed and 14 respondents (46.7%) strongly agreed that interactive tools such as games, video lectures, and 3D lessons enhance learning outcomes.

Comparative Effectiveness of Digital Resources
9 respondents (30%) agreed and 16 respondents (53.3%) strongly agreed that digital resources like video lectures, audiobooks, and digital workshops offer superior learning experiences compared to traditional methods.

Overall, between 70% to 90% of respondents expressed positive views (either "agree" or "strongly agree") on most of the statements, with only a small fraction (5–10%) disagreeing and only 1% to 3% were strongly disagree. These findings suggest a broad consensus that innovative technology can considerably enhance students' involvement, motivation, and academic achievement when appropriately implemented.

Institutional Support and Digital Infrastructure
The survey also investigated external factors influencing technology integration:

Internet Connectivity
Out of 30 respondents, 28 (93.3%) confirmed they had reliable internet access at home, enabling them to utilize digital lectures and other online resources effectively.

Administrative and Management Support
Although 24 out of 30 respondents, (80%) noted that their school management provided adequate training and support, whereas 6 respondents (20%) expressed concerns regarding the overall receptiveness of their administration to innovative technology.

Professional Development
The results highlight the need for continuous training and growth for professionals that not only covers technical skills but also integrates pedagogical strategies. Without such support, even the most sophisticated technologies may fall short of their educational potential.

Frequency Distribution of Likert Scale Responses
Analysis of the Likert-scale data shows that most teachers (ranging from 40% to 60%) are in strong favor of integrating technology in their classrooms. Approximately 30–50% of the respondents agreed with the benefits of digital tools, reflecting a predominantly positive stance, albeit with a few reservations. Only a minimal percentage (around 5–10%) disagreed, and strong opposition was nearly non-existent (0–5%). This pattern reinforces the overall acceptance and enthusiasm for digital innovations among educators in early childhood and primary education settings.

Evaluation of Investigative Questions of the Research
The study was driven by two main questions of inquiry:
How does innovative technology integration affect student learning outcomes in primary schools of Pakistan?
The results indicate that digital tools such as video lectures, 3D models, and interactive simulations significantly enhance student engagement and comprehension. Educators reported that these tools demystify complex subjects like science and mathematics, leading to improved learning outcomes and increased student motivation.

How does technology integration impact student engagement, motivation, and academic achievement?

The data reveal that using digital technologies is linked to positive outcomes in key educational metrics. Classrooms that have adopted digital tools see Greater involvement and improved critical thinking skills, and enhanced problem-solving skills among students. Furthermore, the shifting from a teacher-led approach to student-directed learning, facilitated by digital platforms, empowers students to take greater ownership of their educational journey.

Thematic Analysis

Thematic analysis of the qualitative responses from primary school teachers (Class 2 and above) identified a number of patterns regarding how technology is integrated into classroom activities. The most frequently mentioned benefit was improved interactivity: digital tools such as smart boards, educational games, and simple simulations were credited with making lessons more interactive and participatory; for example, one teacher reported that *"when we use the interactive games or videos, students are much more involved and they are excited to answer questions and explore ideas themselves."* This change from passive listening to active engagement was seen as especially helpful in keeping younger learners engaged.

A second theme was the differentiation in teaching that technology enabled as learning apps provided a way for teachers to assign tasks at different levels of difficulty: *"Some of my students need more time or extra practice, and apps let them work at their own pace while others move ahead,"* one of the teachers said. This made it easier for teachers to manage mixed-ability classrooms and support all students without holding some back.

Virtual learning platforms, even when used in basic forms, were also recognized as helpful adjuncts to instruction: teachers mentioned using classroom apps or a school portal to share homework, lesson recaps, or additional practice materials. *"It's good for review at home if they didn't quite get something during class,"* one teacher said. Yet many also highlighted the desire for more guidance and hands-on training on how to use these tools effectively: *"We're doing our best, but we still need proper training so that we can make better use of the technology,"* another respondent stated.

Cooperation was another theme that came up; technology was seen as enabling cooperation among students from sharing slideshows in class to group project apps assigned for homework. One teacher put it this way: When students work on a common assignment, particularly when digital, they are more inclined to speak with each other, exchange ideas, and accept responsibility for their respective roles.

Some teachers also expressed concerns about screen time, emphasizing that while technology is an important tool, it should not be allowed to supplant hands-on or physical learning experiences. *"It's fine to use tablets for some lessons but kids also need to write by hand, do crafts, and a lot of things that are not on-screen."*

The last one was assessment; technology allowed teachers to instantly check for understanding through digital quizzes and apps*: "Apps like Quizizz or basic online polls help me see who gets it right away and I can adjust the lesson"* explained by a teacher. But some also noted that care needs to be taken when using digital assessments, to ensure fairness and accuracy. To sum up, primary school teachers value technology as an aid to engagement, differentiation, and collaboration but recognize the importance of ongoing training and balance to make sure technology supplements rather than supplants key classroom practices.

Discussion

The findings from this analysis indicate that early adoption of technology by teachers is valued because it makes teaching more engaging for students, and it allows customization of lessons; however, they also point to the need for robust institutional support, training, and equitable access to resources and equipment.

As evidenced by the data, digital tools have a significant positive impact on student engagement and learning outcomes, with teachers reporting that video lectures, 3D models, and interactive simulations are most effective in helping students understand complex concepts in science and mathematics; however, inconsistent administrative support, insufficient ongoing professional development, and inadequate infrastructure indicate that while technology can transform education, its impact is contingent upon institutional backing and teacher training.

Schools can support improved technology use by providing professional development opportunities for teachers to become more comfortable and proficient with emerging technologies, addressing accessibility issues so that all students reap benefits of technological advances within the school environment, and dedicating funds toward teacher training in effective technology use that will maximize instructional practices and student performance.

These findings are of relevance to our study on the use of creative technology within instruction in elementary school and learning of students. Candia-Rodriguez and other game developers demonstrate that new technologies can dramatically impact learning and student motivation, for example, board games that incorporate mobile and sensor technologies. Additionally, the findings reveal how technology can foster student intellect by encouraging active learning process and autonomy; meanwhile, the data suggest that teacher's lack of experience in technology plays as an obstacle, which is resulted in convenient tool to use in their classroom.

Limitations

There are several limitations of this study that need to be considered for the interpretation of the results. The participants were few and teachers of the same context, a fact that may reduce the possibility of their results being applied to other regions, schools or educational settings. As a result, the views presented may not reflect the range of early childhood education settings. Furthermore, self-reported use of technology and attitude may be subject to response bias, as individuals may have inadvertently exaggerated or underreported their use of technology or attitudes because of social desirability, and memory-based issues, respectively. These variables might influence the results. Further studies would benefit from including larger and more diverse samples and applying multiple sources of data (e.g. classroom observations, as well as feedback from students and parents) in order to obtain in-depth and more representative perceptions of technology.

Conclusion

The findings of this study indicate that Pakistani early childhood and primary teachers have positive views about the potential advantages of leveraging of technology integration. But the challenges of equitable access, full teacher training, and strong administrative support are all things that need to be worked out in order for the program to work successfully and be sustainable. This is valuable guidance for policy makers and education leaders in how to design technology- supported learning environments that meet the changing needs of the students in the digital age.

Recommendations

To use technology at the early childhood education (ECE) level is to be supported, in-service teachers must also be provided with substantive and continuous professional development. Targeted and topic-specific training sessions can prepare teachers to feel more confident, as well as more competent, not only in employing digital tools for instructional purposes, but also for differentiation and assessment via technology. Mentorship programs that pair tech-savvy teachers with those who are less experienced can foster a supportive, collaborative learning environment.

In addition, further research is needed to understand the long-term impact of technology integration on student learning, especially in relation to how teachers are trained to close the digital divide. It's also important to examine how technology affects students with special needs and those who are learning English as a second language.

The involvement of school leaders and policymakers plays a critical role in creating a culture of innovation. For technology adoption to be successful, schools must also provide strong institutional support which includes reliable internet access, up-to-date devices, interactive tools, and initiatives like device loan programs to ensure equitable access for all students.

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