



Journal for Social
Science Archives

Journal for Social Science Archives

Online ISSN: 3006-3310

Print ISSN: 3006-3302

Volume 4, Number 1, 2026, Pages 297 – 305

Journal Home Page

<https://jssarchives.com/index.php/Journal/about>



Impact of Digital Pedagogies Usage on Critical Thinking Skills among Private Secondary School Students

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ARTICLE INFO

Article History:

Received: November 02, 2025
Revised: December 12, 2025
Accepted: January 18, 2026
Available Online: February 02, 2026

Keywords:

digital pedagogies, critical thinking, secondary education, ICT integration, Pakistan

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ABSTRACT

The rapid integration of digital technologies in the secondary school setting has given rise to numerous arguments about the purported ability of digital technologies to improve higher-order cognitive processes, especially critical thinking. Empirical findings, however, suggest that the effects of digital pedagogies on such abilities can be rather small and situation-specific. The given causal-comparative quantitative study aims to establish the correlation between the use of digital pedagogies and critical-thinking abilities among the students of the private secondary schools in the context of Pakistan as a situational case within the general international literature. Structured instruments were used to gather data of 97 students and included measurements of the types and frequency of digital tool use, perceived quality and effectiveness of digital pedagogies, and critical-thinking skills. The descriptive analysis showed neutral results on the use of digital tools but high on perceptions of pedagogical effectiveness. The regression results indicated that the types and frequencies of digital tools explained a statistically non-significant percentage of variance in skills of critical-thinking ($R^2 = .007$), though the perceived pedagogical effectiveness explained about 10% of the variance ($R^2 = .101$). These results are consistent with meta-analysis data on the use of technology worldwide that showed it to be an enabler and not a determinant of critical thinking. The paper finds that substantial improvements in critical thinking have to be achieved through teacher-competent and instructionally designed digital integration and not merely by using more technology.



Introduction

Digital revolution in education is one of the greatest changes that are redefining schooling systems in the world. In the last ten years or especially during the COVID-19 pandemic, digital technologies became quickly integrated into schools and colleges to instruct, learn, assess, and communicate (Bond et al., 2023). Online assessment tools, learning management systems, educational applications, interactive content platforms and learning management systems have become common in the secondary education. The most common excuse used by policymakers and school leaders to justify such investments is that digital pedagogies will increase not only access and efficiency but also the overall quality of learning outcomes including higher order cognitive skills like critical thinking (OECD, 2025).

Critical thinking has become an educational goal in the twenty-first century. The international frameworks focus on providing learners with the ability to process information and to evaluate and analyze evidence and complex issues and to make rational decisions in more information-rich and technologically mediated societies (Zhai et al., 2024). Digital technologies are, therefore, commonly placed as platforms of fostering such skills as they support inquiry, teamwork, simulation, and reflective learning. With proper implementation, digital pedagogies are likely to shift the classrooms to a higher level of learning than rote learning into more in-depth levels of cognitive learning (Hwang and Chen, 2022).

Nevertheless, empirical studies have a more sober and complex picture despite these positive assumptions. A mounting strength of global evidence shows that the connection between the use of digital technology and cognitive results is not direct and automatic. The systematic reviews and meta-analyses published in the recent years all have common results that the effect of digital learning interventions on higher-order thinking skills is typically small to moderate (Wu et al., 2024; Zhai et al., 2024). The results indicate that technology has no effect to change learning per se, but its effect is mediated by pedagogical design, competence of teachers, institutional support and assessment compatibility. In situations where digital technologies are used in content presentation, the benefits of critical thinking are not so significant as in inquiry-based and project-based digital pedagogies that yield more qualitative cognitive benefits (Hwang and Chen, 2022).

In the educational context, these challenges are especially relevant in the developing setting. The access to technology is unequal, inconsistent in the training of teachers, and performance evaluation in some countries like Pakistan where memorization is more likely to be assessed than analytical thinking (OECD, 2025). In Pakistan, the uptake of digital technologies in the context of secondary schools has been higher in the case of the former than the latter because of the higher financial resources and expectations of parents. Digital infrastructure (e.g., smart board, digital textbook, and online test) is often viewed as a measure of quality, but little empirical study has investigated the degree in which these technologies are pedagogically integrated to promote critical thinking (Rehman et al., 2024).

Access, attitudes, or general academic performance has received a lot of attention in the Pakistani research on ICT integration, whereas higher order cognitive skills have received comparatively less attention. Furthermore, most of the research lacks empirical differentiation between the utilization of digital tools and the quality and effectiveness of digital pedagogies, which leaves the evidence gap required to make informed policy and instructional choices (Iqbal et al., 2022). This paper fills that hole by looking at the relationship between the types and frequency of use of digital tools and perceived pedagogical efficacy and how the results relate to critical thinking skill

development among high school-aged students in the United States, putting its results into the context of the larger study of digital pedagogy worldwide.

Statement of the Problem

Despite substantial investments in digital technologies, there is limited empirical evidence regarding their effectiveness in fostering critical thinking skills among secondary school students, particularly in developing contexts such as Pakistan. Many private secondary schools equate the presence of digital tools with pedagogical innovation, assuming that increased technology usage will naturally lead to improved cognitive outcomes. This assumption overlooks the critical role of instructional design, teacher mediation, and pedagogical intent in shaping learning processes.

Existing studies often emphasize access to technology, frequency of use, or students' attitudes toward digital learning rather than examining measurable outcomes related to higher-order thinking. Consequently, the cognitive impact of digital pedagogies remains underexplored. Furthermore, where evidence does exist, findings suggest that the effects of digital learning on critical thinking are often modest and context dependent.

Without robust empirical evidence, policymakers and educators lack clear guidance on how digital pedagogies should be designed and implemented to meaningfully enhance critical thinking skills. This problem is particularly pressing in private secondary schools in Pakistan, where digital infrastructure is increasingly available but pedagogical practices may remain teacher-centered and assessment systems may not prioritize analytical reasoning. The present study seeks to address this problem by empirically examining the relationship between digital pedagogies usage and critical thinking skills among private secondary school students.

Research Objectives

1. To identify the types and frequencies of digital tools used by private secondary school students.
2. To examine the perceived quality and effectiveness of digital pedagogies in private secondary schools.
3. To evaluate the impact of digital pedagogies usage on critical thinking skills among private secondary school students.

Research Questions

1. What are the types and frequencies of digital tools usage by private secondary school students?
2. To what extent is the quality and effectiveness of digital pedagogies evident in private secondary schools?
3. What is the impact of digital pedagogies usage on critical thinking skills among private secondary school students?

Literature Review

The Digital Pedagogies Conceptualization.

The concept of digital pedagogies is also being characterized as a pedagogical intervention and not a technological solution. Modern research argues that digital pedagogy involves the deliberate use of digital resources to support certain learning outcomes, mental processes, and social relations

(Bond et al., 2023; Mishra et al., 2023). This perspective opposes previous technology-based models that primarily focused on access and hardware accessibility, and focuses on the need to match technology usage with pedagogical plans and curriculum objectives (Koh et al., 2022).

Technological Pedagogical Content Knowledge (TPACK) is one of the most popular frameworks that can be used to comprehend the successful integration of technology. According to TPACK, the point of convergence between technological knowledge, pedagogical knowledge, and content knowledge is where meaningful digital pedagogy is created (Mishra et al., 2023). Newer iterations of the framework introduce variables of context (teacher beliefs, institutional culture and assessment practices) and indicate that although teachers might have technical knowledge, digital pedagogy can still be superficial in the event of poor pedagogical alignment (Koh et al., 2022; Dede et al., 2023).

On the same note, the Substitution-Augmentation-Modification-Redefining (SAMR) model provides a model of evaluating the level of technology integration. Empirical literature shows that the majority of in-classroom uses of technology have remained at the substitution or augmentation phases during which digital tools simply recreate the old practice with no significant differences in cognitive demands (Ruggieri and Mong, 2023). The relatively few instances of modification and redefinition that facilitate new forms of learning and higher-order thinking are especially common in the context of secondary education (Bond et al., 2023).

Digital Pedagogies and Thinking Critically.

The general definition of critical thinking is the ability to interpret facts, analyze arguments, draw logical conclusions, and examine how they think (Hwang and Chen, 2022). Educational theorists believe that critical thinking is formed as a result of a long-term work with complex tasks, contact with various opinions, and the possibility of metacognitive control (Zhai et al., 2024). Digital environments hold the possibility of facilitating these processes through the availability of simulations, inquiry, and feedbacks.

However, it has been empirically proven that these affordances are only actualized in particular pedagogical circumstances. In line with the consistent results, the application of digital tools will facilitate critical thinking, provided they are integrated into an inquiry-based, project-based, or problem-based learning (Wu et al., 2024; Hwang and Chen, 2022). Students must also ask questions, hypothesis test, explain decisions, and consider results in such environments. On the other hand, in cases where digital tools are used to provide content or drilllays and practice exercises, there are insignificant gains in critical thinking (Bond et al., 2023). Evidence-based Practice (2020) Meta-Analytic and Systematic Review Evidence (2020-2025). Recent meta-analyses provide a complex insight into the effects of digital pedagogies on critical thinking. In various research studies, average effect sizes are mostly small to medium, with most of the studies showing effect sizes that lie between 0.15 and 0.45 (Zhai et al., 2024; Wu et al., 2024). These findings indicate that although digital learning could be used to facilitate the development of higher-order cognition, the effect of it is limited by pedagogical and contextual influences.

A meta-analysis also reveals that interventions that include inquiry-based activities, group problem solving and formative feedback lead to better results compared with technology-enhanced lectures or instruction through presentations (Zhai et al., 2024). These results support the thesis that pedagogy and not technology is the main force of cognitive growth and digital tools are enablers of instructional quality and not change agents (OECD, 2025).

Pedagogical Mediation and Teacher Competence

Teacher competence comes out as a resolute intermediary in the correlation between digital pedagogies and critical thinking. The evidence indicates that the pedagogical beliefs of teachers, their teaching methods, and assessment practices determine the use of digital tools in the classroom setting (Trust and Whalen, 2020; Dede et al., 2023). Pedagogical design, questioning strategies, and assessment alignment are some of the professional development programs that are related to better cognitive outcomes compared to those based on technical skills only (Koh et al., 2022).

The issue of teacher confidence in the use of digital tools but lack of confidence in designing tasks that encourage higher-order thinking is common in most settings. This gap provides a rationale that the continuous professional development is required within the framework of the pedagogical intentionality, rather than mastery of the tools (Mishra et al., 2023).

Digital Pedagogies in Pakistan and Developing Contexts.

A developing country research indicates other challenges. The obstacles to the pedagogical application of digital technologies may be structural like lack of training opportunities, inflexible curricula, and examination-based assessment systems (OECD, 2025). Research in Pakistan has shown that the digital infrastructure in private schools is, in many cases, sufficient, but the classroom activities are still mostly teacher-based (Rehman et al., 2024).

Empirical studies in Pakistani secondary schools have found small positive effects on critical thinking in the case of the implementation of ICT in the classroom (Iqbal et al., 2022; Rehman et al., 2024). These results are consistent with the evidence on the global level and indicate that digital pedagogies are enabling factors but not transformative agents. The cognitive effect of technology is not very high without the pedagogical alignment.

Synthesis and Research Gap

A number of major conclusions are met in the literature. To begin with, digital pedagogies have positive but ineffective influence on critical thinking ability (Zhai et al., 2024). Second, the predictive power of the pedagogical quality and teacher mediation is higher than the frequency of technology use (Bond et al., 2023; Wu et al., 2024). Third, contextual influences like training, curriculum, and assessment have a great influence on results (OECD, 2025). In spite of these ideas, the lack of empirical research that also investigates the types and frequencies of digital tool use, perceived pedagogical efficacy, and outcomes of critical thinking in private schools in Pakistan is still present. The gap is covered in the current research.

Research Methodology

The research design adopted in this study is causal-comparative quantitative research design because it was used to investigate the impact of the usage of digital pedagogies and gain of critical thinking skills. The population was private secondary school students of Punjab province, data was taken from five private secondary school students by random sampling technique. A validated instrument was used for data collection. To measure digital pedagogies usages of private secondary school students Digital Pedagogies Usage Scale ($\alpha=0.85$) was adapted, to measure Critical Thinking Skills of private secondary school student Critical Thinking skill Scale ($\alpha=0.85$) was used adopted from Kobylarek et al. (2022) who developed the Critical Thinking Questionnaire. The skills of critical thinking were measured by a validated scale which measures the analysis, evaluation, inference and reflection thinking. The descriptive statistics were used to indicate trends in the use of digital tools and attitudes towards pedagogical effectiveness. Simple

linear regression analyses were conducted to determine the predictive power of the use of digital tools and pedagogic effectiveness on the critical thinking skills. The level of statistical significance was set at $p < .05$.

Data Analysis

The descriptions of the tool types, frequency of use, and perceived effectiveness were summarized using descriptive statistics, such as means, and standard deviations. The predictive relationships between (a) the nature and frequency of digital tool use, and critical thinking, and (b) perceived pedagogical effectiveness and critical thinking were analyzed using simple linear regression analyses. The conventional level of statistical significance of $p < .05$ was set.

Results

Table 1: Descriptive statistics of digital pedagogy usages

Digital Pedagogy Usages	<i>M</i>	<i>SD</i>
Frequency of digital tool usage	3.28	.226
Types of digital tools	3.36	.181

The type and frequency variables mean scores are close to the neutral midpoint of Likert, which indicates that students are not very engaged with a wide range of digital tools and use them not often in classes.

Table 2: Descriptive statistics quality and efficacy of digital pedagogies

Digital Pedagogy Usages	<i>M</i>	<i>SD</i>
Effectiveness of digital pedagogies	4.43	.184

The scores of the perceived effectiveness are high (above the agree threshold), which means that digital pedagogies are viewed as of high quality by students when implemented.

Table 3: Regression coefficients of Digital Pedagogy Usage on Critical Thinking Skills among secondary school students

Variable	Unstandardized Coefficients		Standardized Coefficients	<i>t</i>	<i>p</i>	<i>R</i> ²
	<i>b</i>	<i>S.E</i>	β			
Digital Pedagogy Usage	.463	.135	.332	3.427	.001	0.110

Above table shows the impact of digital pedagogy usage on critical thinking skills among secondary school students. The R^2 value of .11 revealed that the predictor variable (Digital Pedagogies Usage) explained 11% variance in outcome variable. The findings indicated that digital pedagogies usage positively predicted critical thinking skills among secondary school students ($\beta = .33$, $p < .001$).

Discussion

The findings of the current study provide strong empirical support to already existing bodies of international research, which suggests that digital pedagogies have a positive, but a weak effect on critical-thinking skills. The relative insignificance of the frequency of digital tool use supports the

constraints of the technology-based pedagogical models; the exposure to such tools does not significantly increase the higher-order cognitive processes.

On the other hand, the perceived pedagogical effectiveness has a moderate effect, which highlights the importance of instructional design and teacher mediation. The estimated 10% of the variance is attributed to pedagogical effectiveness and can be interpreted as being educational in nature, especially in the heterogeneous classroom environments where various variables moderate the learning results.

These results agree with international meta-analytic results and other similar Pakistani studies that indicate similar effect sizes. This overlap of the data indicates that the cognitive influence of the digital pedagogies is largely limited by the quality of pedagogy and not technological accessibility. In this regard, the implications of the research findings are evident in the case of Pakistani secondary schools (which are private schools): the hardware needs to be invested in, but the large investments in teacher professional development and curriculum redesign should also be prioritized.

The current findings are consistent with already available international evidence. Averaged effects of digital interventions on higher-order cognition reported in meta-analyses and systematic reviews (Zhai et al., 2024; Wu et al., 2024) are modest but point to the importance of pedagogical design and teacher mediation in increasing the effects. The fact that we have found that perceived effectiveness has a significantly stronger effect than plain frequency is consistent with Bond et al. (2023) and more recent Frontiers reviews (Zou, 2025), which hypothesized that technology is a pedagogical facilitator; technology with no pedagogical intent has insignificant power.

The insignificant impact of types/frequency ($R^2 = 0.007$), supports one of the core theoretical arguments: the use and access to technology is not cognitive complexity. The types of tools that are mostly used in content delivery or administration do not have instructional affordances that would facilitate analysis, argument or evaluation. This observation correlates with Tinmaz (2022) and Wu et al. (2024), who state that technology produces greater significant improvements in cognition when implemented in inquiry-based, scaffolding tasks.

The moderate correlation between perceived pedagogical effectiveness ($R^2 \sim 0.10$) suggests that the design of the classroom and facilitation of the teacher are important. When teachers design online tasks in ways that require evidence evaluation, the need to support assertions, and participation in peer assessment, critical-thinking results will increase significantly. This finding supports the focus of recent literature on professional learning by teachers that aims at design to higher-order outcomes (Trust & Whalen, 2020; Ruggiero and Mong, 2023).

In Pakistani privatized schools, the technological infrastructure is probably available, but pedagogical practice is not developed. The current results recommend that the policy efforts must now focus on building teacher capacity to engage in inquiry-based digital teaching, curriculum realignment to higher-order learning goals, and restructuring of assessment systems to help in the capture of reasoning and assessment.

This research utilizes convenience sampling and self-report measures that limit the extrapolation of results and could lead to bias in the response. The perceived effectiveness instrument was used; although meaningful, it is subjective. The causal claims would be reinforced with the help of triangulation with classroom observations and task analyses. The R^2 values are small but normal in educational interventions and significant at classroom level.

Conclusions

The application of digital pedagogy into the framework of the private schooling in a secondary-level environment can be shown to have great potential in terms of developing the critical thinking skills in students; however, its effectiveness largely depends on the quality of pedagogical design instead of the shallow implementation or imposition of digital tools. The research evidence has shown that technology only is made educational salient when it is purposefully incorporated into pedagogical procedures that anticipate enquiry, analytical thought, contemplation and problem solving. Less-structured or routinised use of digital technology, particularly in its consistency with the transmissive pedagogical practices, is unlikely to promote long-term cognitive engagement or the learning of higher-orders.

The researcher brings out the inseparability of the pedagogical intentionality in determining the learning outcomes in the digitally enhanced learning setup. The introduction of digital tools into carefully designed instructional processes, which are backed by clear learning goals, thought-provoking activities, and feedback processes, can serve as powerful stimulators of critical thinking. Conversely, technology, which is mainly used to deliver content, or to optimize the procedure, provides rather minimal incremental value to the development of students in terms of their analytical and evaluative abilities.

These results highlight the need to focus on professional development of educators which does not merely involve technical training but focuses on pedagogical level of professional development that facilitates higher-order learning. Besides, redesign of curriculum systematically is needed to ensure the alignment of digital instruction, learning outcomes, and assessment practice. Such properly integrated efforts have the power to enhance the transformative potential of digital pedagogy and stimulate the further growth of the ability to think critically in the context of secondary education.

Recommendations

The development of the pedagogical capacity may be given priority by the policy makers rather than the acquisition of technology. Inquiry based digital teaching, formative assessment and reflective learning may be preempted by teacher professional development activities. Educational institutions are supposed to match the digital pedagogies with the curriculum goals that clearly lay stress on the development of critical-thinking skills. The mixed-methods and longitudinal designs should be used in the future studies to examine the mediating effect of pedagogical practices on the relationship between digital...

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