International Journal of Pedagogy and Teacher Education

Journal Homepage: jurnal.uns.ac.id/ijpte

From Access to Instructional Design: Indonesian Senior High School Students' Digital Pedagogy Experiences, Barriers, and Improvement Priorities

Septi Purfitasari*, Masrukhi, Titi Prihatin, Sungkowo Edy Mulyono

Doctoral Program in Educational Management, Graduate School, Universitas Negeri Semarang, Semarang, Indonesia

ARTICLE INFO

Article History

Received: March 27, 2026

1st Revision: April 01, 2026

Accepted: April 23, 2026

Available Online: April 30, 2026

Keywords:

Digital Pedagogy; Student Experience; Mobile Learning; Digital Learning Barriers; Instructional Design

***Corresponding Author**

Email address:

septipurfitasari@students.unnes.ac.id

ABSTRACT

School-based digital pedagogy has expanded rapidly, yet prior research has often examined it through access, platforms, or adoption rather than through an integrated account of students' experiences, barriers, instructional support, and improvement priorities. This study investigated digital pedagogy among 403 students in Grades 10, 11, and 12 at a public senior high school in Central Java, Indonesia, selected through random sampling from a population of 1,173 students. A cross-sectional descriptive survey was conducted within a convergent mixed-methods design using a questionnaire that combined closed-ended and open-ended items; the closed-ended instrument showed acceptable internal consistency (Cronbach's alpha = 0.82). Quantitative data were analysed using descriptive statistics, multi-response analysis, ranking analysis, and composite scores, while qualitative responses were analysed through open, axial, and selective coding. The findings showed that students had strong baseline access, with smartphone use reaching 99.3% and personal device ownership 98.5%, but participation remained predominantly mobile-based and was constrained by unstable connectivity, limited quota, workload pressure, and technical problems. Digital pedagogy was mainly organised around videos, assignments, presentations, and quizzes, whereas discussion-based and simulation-rich activities were much less common. Students generally experienced digital pedagogy as functional but not yet strongly transformative across implementation exposure, perceived benefit, obstacle, and instructional support. Open-ended responses identified access to materials and relearning as the most helpful experience, while connectivity and access problems emerged as the most disruptive barriers. The study concludes that improving school digital pedagogy requires not only stronger infrastructure but also clearer instructional design to convert access into meaningful and equitable learning experiences.

How to cite: Purfitasari, S., Masrukhi, Prihatin, T., & Mulyono, S.E. (2026). From Access to Instructional Design: Indonesian Senior High School Students' Digital Pedagogy Experiences, Barriers, and Improvement Priorities. *International Journal of Pedagogy and Teacher Education, 10*(1), 13-32. https://doi.org/10.20961/ijpte.v10i1.116892

1. INTRODUCTION

Digital pedagogy refers to a pedagogically driven approach in which digital technologies are intentionally integrated into the design, delivery, assessment, communication, and feedback processes of teaching and learning, rather than being valued for their presence alone (OECD, 2021; Shaikh, 2023). This approach operates across online, blended, and technology-supported face-to-face settings (Bình & Sơn, 2025; Chmyr et al., 2024). It includes activities such as multimedia delivery, assignment management, assessment, collaboration, reflection, and feedback, all of which require alignment between digital affordances and instructional purposes to become meaningful for students (Devlin et al., 2024; Chen & Chan, 2024). Its effectiveness depends less on technology adoption itself than on how far digital tools support engagement, knowledge construction, learner autonomy, collaboration, and feedback within clearly structured learning environments (OECD, 2021; Chong, 2025). Well-designed digital pedagogy can enhance flexibility, self-directed learning, engagement, and academic performance, although these benefits remain highly dependent on context and implementation quality (Tsekhmister, 2022; Baynit et al., 2025). Weak infrastructure, unequal access, limited teacher readiness, and tool-first implementation may instead produce distraction, overload, and inequitable learning experiences (Butler, 2024; Prosen & Ličen, 2025). Digital pedagogy should therefore be understood not as technology adoption in isolation, but as an intentional pedagogical practice embedded in meaningful, inclusive, and well-supported learning design (Masripah et al., 2025; A'yun et al., 2024).

p-ISSN: 2597-7792 / e-ISSN: 2549-8525

DOI: https://doi.org/10.20961/ijpte.v10i1.116892

Digital learning has become increasingly widespread across school systems, yet the expansion of digital tools and platforms has not ensured consistent implementation quality or equitable student experience across contexts (Mallillin et al., 2020; Masripah et al., 2025). Visible technology use often masks substantial variation in infrastructure, pedagogical quality, and institutional readiness, resulting in uneven learning conditions for students (Gikundi et al., 2023; Duwal, 2023). Access alone is an insufficient indicator of meaningful participation, because students may possess devices while still facing unstable internet, limited data access, weak platform functionality, or unsupportive study environments (Daclan, 2025; Adhikari, 2023). At the instructional level, digital learning frequently remains focused on distributing materials, assigning tasks, and administering quizzes rather than promoting deeper interaction, collaboration, or formative support (Mallillin et al., 2020; Seleke, 2024). This pattern suggests that digital pedagogy is still often implemented as a transactional delivery system rather than as an active and student-centred learning environment (OECD, 2021; Omarsaib, 2024). Students' experiences are therefore shaped not by technology availability alone, but by the interaction of connectivity, platform affordances, teacher digital-pedagogical competence, and instructional design quality (Bentri & Hidayati, 2023; A'yun et al., 2024). A student-centred perspective is therefore needed to understand how access conditions, classroom practices, barriers, and teaching design converge to shape participation and learning experience in practice (Masripah et al., 2025; Butler, 2024).

Schools need stronger evidence to improve digital pedagogy beyond the simple provision of devices, platforms, or institutional access points (Masripah et al., 2025; Daclan, 2025). Technology access remains essential, but device ownership alone does not guarantee equitable or effective participation when students still face unstable connectivity, limited data, weak infrastructure, or insufficiently integrated learning environments (Gikundi et al., 2023; Duwal, 2023). These barriers matter because they can reduce participation, weaken engagement, constrain feedback and interaction, and compromise learning outcomes in continuing digital and blended schooling contexts (Sinyinza, 2025). Improving digital pedagogy therefore depends not only on technical provision, but also on teacher capacity, instructional planning, and the design of accessible, scaffolded, and meaningful learning experiences (Bentri & Hidayati, 2023; Simelane-Mnisi & Mokgala-Fleischmann, 2022). Student perspectives are especially important because they reveal how digital pedagogy operates in practice, including hidden barriers and urgently needed forms of support that are often missed by usage-based indicators (Fan, 2024; Devlin et al., 2024). Understanding students' reported barriers and improvement priorities can help schools move from assumption-based technology adoption toward more responsive interventions that address both infrastructural inequality and weaknesses in instructional design (Sugiyanto et al., 2024; Sharma, 2025). Evidence-based improvement is therefore needed not only to strengthen access and technical reliability, but also to guide pedagogical redesign, teacher support, and more equitable learning conditions (Mustafa, 2025; Masripah et al., 2025).

This study examines digital pedagogy through an integrated, student-centred framework that links students' digital access profiles with the forms of digital learning, platforms, and instructional functions they experience in school (Gikundi et al., 2023; Loh & Chib, 2021). It moves beyond narrow measures of device ownership or platform adoption by analysing digital pedagogy as a lived classroom experience shaped by access conditions, pedagogical practices, and instructional design quality (OECD, 2021; Jia et al., 2024). The study identifies frequently reported barriers, recurring implementation problems, and students' open-ended accounts of helpful experiences, disruptive barriers, and improvement priorities, which are often missed in purely quantitative evaluations (Daclan, 2025; Duwal, 2023; Fan, 2024; Sugiyanto et al., 2024). Its main contribution lies in an integrated analytical framework that connects access, classroom practice, student experience, implementation frictions, and student-generated recommendations to provide a more comprehensive learner-perspective account of digital pedagogy in school contexts (Masripah et al., 2025; Tsekhmister, 2022). This approach also combines closed-ended profiling with systematic coding of student voice and helps clarify that the challenges of digital pedagogy are shaped not only by connectivity, but also by workload, instructional clarity, feedback, and broader pedagogical design (Devlin et al., 2024; Fan, 2024; Bentri & Hidayati, 2023; Butler, 2024).

2. MATERIAL AND METHOD

Research Design

This study employed a cross-sectional survey design within a convergent mixed methods framework to examine students' experiences of digital pedagogy implementation (Jiang et al., 2023). A cross-sectional survey

p-ISSN: 2597-7792 / e-ISSN: 2549-8525
DOI: https://doi.org/10.20961/ijpte.v10i1.116892

was considered appropriate because the study aimed to capture students' perceptions, learning experiences, and reported challenges at a single point in time within the natural context of school-based digitally supported learning (Jiang et al., 2023; Elvsaas et al., 2024). The design was primarily descriptive, as it sought to portray the overall pattern of students' access, participation, perceived benefits, obstacles, and views on instructional quality rather than to test causal relationships. A convergent mixed methods approach was selected because students' experiences with digital pedagogy cannot be understood adequately through numerical trends alone. Quantitative data were needed to describe the prevalence and distribution of major patterns, such as device access, frequency of digital learning activities, perceived benefits, and reported barriers. Qualitative data were needed to explain how students interpreted those experiences, which aspects of digital pedagogy they found most helpful or disruptive, and what kinds of improvement they considered most urgent. Integration of both forms of evidence therefore enabled a broader and deeper understanding of digital pedagogy implementation from the students' perspective (Livermon et al., 2025; Elvsaas et al., 2024).

Quantitative and qualitative data were collected during the same phase through a single questionnaire containing both closed-ended and open-ended items. Both datasets were analyzed separately according to their respective analytical procedures. Quantitative analysis was used to identify general response patterns and descriptive tendencies, whereas qualitative analysis was used to uncover meanings, recurring concerns, and improvement expectations expressed in students' own words. Final interpretation was carried out by comparing and connecting the two sets of findings, so that qualitative evidence could clarify, enrich, and contextualize the quantitative results (Barche et al., 2022; Elvsaas et al., 2024). Figure 1 presents the overall research workflow, beginning with the identification of the research focus and key indicators of digital pedagogy, followed by instrument development, sample selection, data collection, separate quantitative and qualitative analyses, and final integration of findings for comprehensive interpretation.

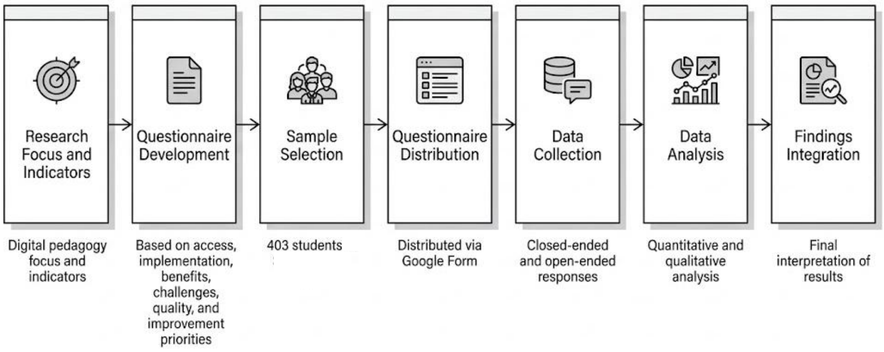

Figure 1. Workflow of the study

Participants

Participants were drawn from the total student population of a public senior high school in Central Java, Indonesia, comprising 1,173 students across Grades 10, 11, and 12. A sample of 403 students was selected using simple random sampling from the school enrolment list. Each enrolled student had an equal chance of being selected, and no stratification by grade or other characteristics was applied. Students were treated as the primary unit of analysis because the study aimed to capture individual perceptions, experiences, and reported challenges related to the implementation of digital pedagogy in school learning. All enrolled students were considered eligible to participate, and no additional inclusion or exclusion criteria were applied. Selected students were then invited to complete the questionnaire distributed through Google Forms during the data collection period. The final sample included students from Grades 10, 11, and 12 and was used to provide a broad description of learners' digital access, learning practices, perceived benefits, encountered obstacles, and views on the quality of digital pedagogy implementation.

Instruments and Measurement

The study instrument consisted of a student questionnaire developed to examine students' experiences with the implementation of digital pedagogy in school learning. The questionnaire was constructed based on the main dimensions investigated in this study, namely digital access, digital pedagogy implementation, opportunities and benefits, challenges, quality of implementation, and improvement priorities. These

p-ISSN: 2597-7792 / e-ISSN: 2549-8525
DOI: https://doi.org/10.20961/ijpte.v10i1.116892

dimensions were translated into relevant indicators and item formats to ensure alignment between the study focus and the data collected. The instrument combined closed-ended and open-ended items to capture both structured response patterns and students' own explanations of their learning experiences. Multiple-choice and category-scale items were used to document students' access to devices, internet conditions, study locations, and learning time. Checklist and frequency-scale items were used to identify digital learning activities, platforms used, learning modes, and the frequency of digital component use. Likert-scale items were included to examine students' perceptions of usefulness, motivation, learning support, and instructional quality. Ranking items were used to identify students' priority areas for improvement, while short open-ended responses were included to provide opportunities for students to describe helpful experiences, disruptive obstacles, and suggestions for improvement in their own words (Barche et al., 2022; Livermon et al., 2025).

The closed-ended section of the questionnaire was designed to support quantitative analysis through descriptive and composite-scoring procedures, whereas the open-ended section was intended to generate qualitative insights into students' views and experiences. Internal consistency reliability was assessed for the closed-ended section of the questionnaire as a whole, yielding a Cronbach's alpha coefficient of 0.82, which indicated acceptable reliability for the purposes of this study. The qualitative items were not included in the reliability analysis because they were intended for thematic interpretation rather than scale-based measurement. Thus, the reliability evidence reported in this study refers specifically to the internal consistency of the closed-ended instrument. The general blueprint of the instrument is presented in Table 1.

Table 1. General blueprint of the instrument

Dimension	Main indicators	Item format	Data type
Access and device	Device ownership, internet quality, quota, study location, learning time, basic digital ability	Multiple choice, category scale	Quantitative
Digital pedagogy implementation	Digital activities, platforms used, learning mode, frequency of digital component use	Checklist, multiple choice, frequency scale	Quantitative
Opportunities and benefits	Perceived usefulness, motivation, digital literacy, collaboration, learning support	Likert scale, ranking, short open response	Quantitative and qualitative
Challenges	Types of obstacles and level of disturbance	Checklist, scale, short open response	Quantitative and qualitative
Quality of implementation	Clarity of instruction, material organization, media suitability, interaction, feedback, fairness	Likert scale, checklist	Quantitative
Improvement priorities	Main areas for improvement and students' key suggestions	Ranking, checklist, short open response	Quantitative and qualitative

Data Collection

Data were collected through a questionnaire administered via Google Forms to students in Grades 10, 11, and 12 at a public senior high school in Central Java, Indonesia. Each respondent completed the questionnaire once during the data collection period. Use of an online form enabled efficient distribution of the instrument across grade levels and ensured that responses were recorded in a standardized format. Standardized administration was important for maintaining consistency in response collection and minimizing variation that might arise from differences in data collection procedures. The questionnaire was designed to gather quantitative and qualitative data simultaneously through a single instrument. Quantitative data were obtained from multiple-choice items, checklists, frequency scales, Likert-scale items, and ranking items, which captured students' digital access, learning practices, perceived benefits, experienced challenges, and views on instructional quality (Jiang et al., 2023; Elvsaas et al., 2024). Qualitative data were obtained from short narrative responses that allowed students to describe positive learning experiences, explain the most disturbing obstacles they encountered, and express their suggestions for improving digital pedagogy implementation (Barche et al., 2022; Elvsaas et al., 2024). Collection of both forms of data within the same survey supported the convergent mixed methods design of the study by providing breadth from structured responses and depth from students'

p-ISSN: 2597-7792 / e-ISSN: 2549-8525
DOI: https://doi.org/10.20961/ijpte.v10i1.116892

own accounts. Confidentiality was maintained throughout the process by protecting respondents' identities during data handling, analysis, and reporting.

Data Analysis

Data analysis was conducted on two types of evidence, namely quantitative and qualitative data, in accordance with the convergent mixed methods design of the study. Quantitative analysis was applied to the closed-ended items to describe the general patterns of students' experiences with digital pedagogy implementation. The procedures included frequency and percentage analysis, category distribution, multi-response analysis, ranking analysis, and composite descriptive statistics. These analyses were used to summarize students' digital access, learning practices, perceived benefits, experienced challenges, and perceptions of instructional quality (Jiang et al., 2023; Elvsaas et al., 2024). Four composite scores were constructed from groups of related closed-ended items to represent the major dimensions of students' experiences, namely implementation exposure, perceived benefit, obstacle, and instructional support. These composite scores were used to provide a more integrated description of students' responses across key aspects of digital pedagogy rather than relying only on single-item results. Descriptive statistics derived from these composites were interpreted to identify dominant tendencies in the implementation of digital pedagogy from the students' perspective (Barche et al., 2022; Elvsaas et al., 2024).

Qualitative analysis was conducted on the open-ended responses related to positive learning experiences, the most disturbing challenges, and students' main suggestions for improvement. The analysis followed three stages of coding. Open coding was used to identify initial meaning units and recurring ideas in students' responses. Axial coding was then applied to connect related codes into broader categories based on conceptual similarity. Selective coding was used in the final stage to synthesize these categories into broader thematic clusters that represented the main patterns in students' experiences and improvement priorities (Jiang et al., 2023). To examine the relationship between reported barriers and suggested areas for improvement, the percentage distributions of barrier domains and improvement-priority domains derived from the coded open-ended responses were compared. Integration of the quantitative and qualitative findings was carried out at the interpretation stage. Quantitative results were used to identify the dominant patterns and distribution of students' responses, whereas qualitative findings were used to explain, enrich, and contextualize those patterns through students' own accounts. This integrative process enabled the study to generate a more comprehensive understanding of digital pedagogy implementation by combining the breadth of survey trends with the depth of thematic interpretation (Jiang et al., 2023; Elvsaas et al., 2024).

3. RESULTS

Students' digital access profile

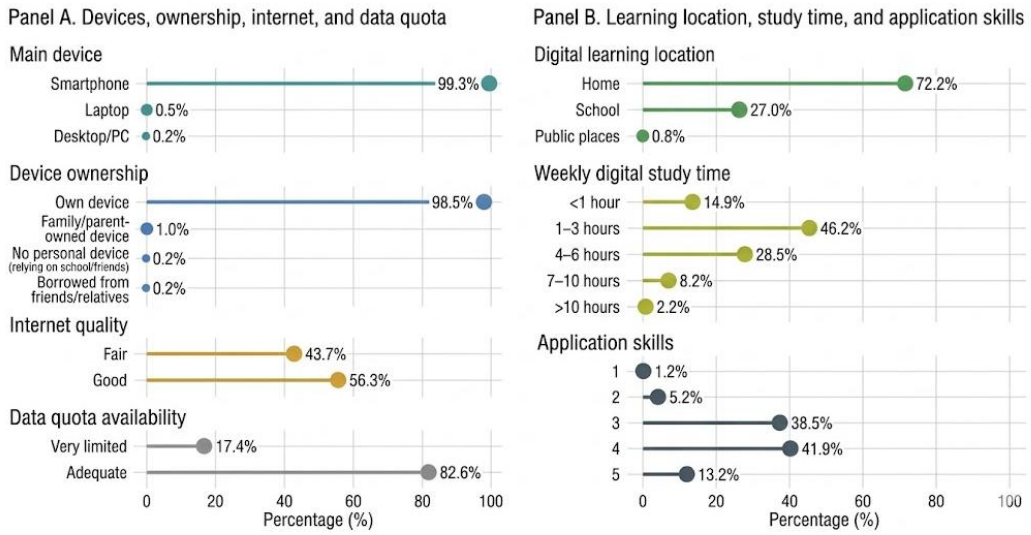

Figure 2. Digital access characteristics of students

p-ISSN: 2597-7792 / e-ISSN: 2549-8525
DOI: https://doi.org/10.20961/ijpte.v10i1.116892

Students in this sample had strong baseline access to digital learning, but that access was overwhelmingly mobile-based. Smartphone was the dominant primary device (99.3%), personal device ownership was very high (98.5%), and the use of laptops (0.5%) and desktop PCs (0.2%) was negligible. Internet quality was mostly reported as good or adequate, although 17.4% of students still reported very limited data quota. As shown in Figure 2, these findings indicate that digital access was broadly available, but participation remained strongly dependent on handheld devices and was still affected by data limitations. Digital learning also occurred mainly at home (72.2%), while weekly engagement was concentrated in the 1–3 hour and 4–6 hour categories. Students' self-rated application skills were mostly moderate to high, especially at levels 3 and 4. Overall, Figure 2 shows a profile characterised by high device access, predominantly home-based participation, moderate weekly engagement, and generally adequate self-reported application skills. This pattern suggests that participation conditions remained uneven despite broad access, an issue that has also been noted in research on digital learning inequality (Masripah et al., 2025).

Landscape of digital pedagogy practices

Digital pedagogy in this sample was primarily organised around content access, task completion, and routine assessment, rather than around highly interactive or practice-based learning. Watching instructional videos was the most common activity (95.0%), followed by completing digital assignments (82.6%), student presentations (79.7%), and digital projects (79.7%), while accessing digital learning materials (73.7%) and using quizzes or forms (70.5%) were also widespread. By contrast, more dialogic and immersive activities were far less common, with online discussion reported by only 25.3% of students and simulation or virtual lab activities by just 4.5%. This distribution suggests that digital pedagogy was already embedded in classroom routines, but mainly in forms that supported delivery, assignment management, and monitoring rather than deeper collaborative knowledge construction, a pattern also reported in studies showing that many digital implementations reproduce teacher-centred workflows in digital form (Mallillin et al., 2020; Seleke, 2024). As reflected in Figure 3, the dominant practice model was therefore closer to a materials–tasks–quizzes configuration than to a strongly interactive or inquiry-driven pedagogy, which is consistent with critical evidence that digital tools often remain pedagogically shallow unless redesign and facilitation are intentionally strengthened (Butler, 2024; Omarsaib, 2024).

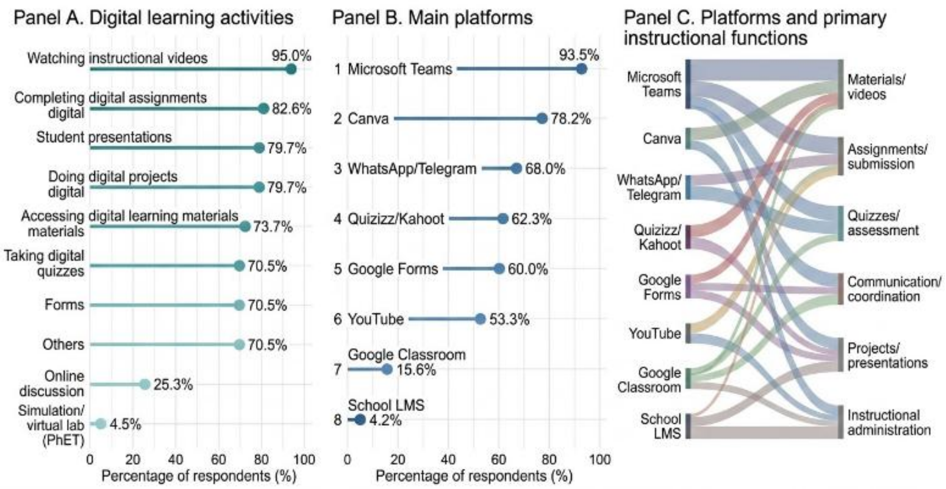

Figure 3. Activity patterns and platform functions in digital pedagogy

The platform landscape reinforces this interpretation by showing that students mainly engaged with tools suited to logistics, communication, and low-friction assessment. Microsoft Teams was the most widely used platform (93.5%), followed by Canva (78.2%), WhatsApp or Telegram (68.0%), Quizizz or Kahoot (62.3%), and

p-ISSN: 2597-7792 / e-ISSN: 2549-8525
DOI: https://doi.org/10.20961/ijpte.v10i1.116892

Google Forms (60.0%), indicating a combination of learning management, communication, creative production, and quick assessment tools. The platform–function mapping further shows that these technologies were used predominantly for distributing materials and videos, collecting assignments, conducting quizzes, and maintaining communication or coordination, rather than for sustained discussion or simulation-rich learning. This pattern is pedagogically understandable because widely available platforms such as Teams, WhatsApp, and low-bandwidth quiz tools are relatively easy to implement in mobile-first and time-constrained learning contexts, and their pragmatic adoption has been widely observed in the literature on school-based digital learning (Lavidas et al., 2020; Daclan, 2025). Taken together, the configuration shown in Figure 3 suggests that digital pedagogy in this context was not absent or inactive, but rather pragmatically operational, with platform choices and activity structures shaped by usability, accessibility, and routine instructional demands more than by ambitions for dialogic, simulation-based, or deeply collaborative pedagogy (Bello, 2023; Sharma, 2025).

Core student experience dimensions across groups

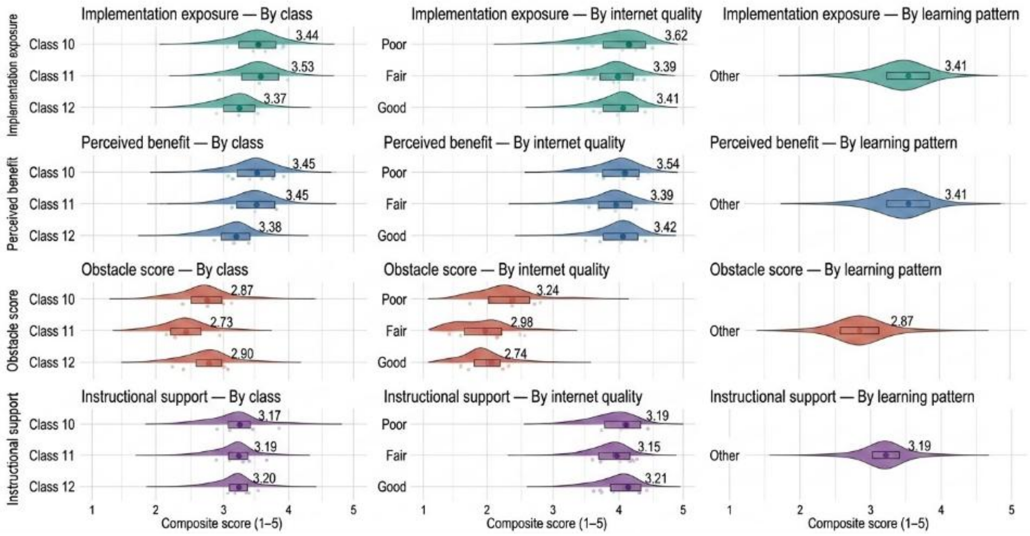

Figure 4. Comparative profiles of core student experience dimensions

Across the four-core student-experience dimensions, the mean scores clustered in the moderate range, suggesting that digital pedagogy was experienced as functional and somewhat beneficial, but not yet as consistently high-quality or transformative. Implementation exposure was broadly similar across class groups, with Grade 11 students reporting slightly higher exposure (3.53) than Grade 10 (3.44) and Grade 12 (3.37), a pattern that is consistent with studies showing that once school-wide digital routines are established, exposure tends to become relatively uniform across cohorts even if the depth of engagement remains variable. Perceived benefit was also moderately positive across groups, ranging from 3.38 to 3.54, indicating that students generally recognised value in digital pedagogy for supporting access, continuity, and learning flexibility. Instructional support remained in a narrow moderate band, suggesting that teacher guidance, feedback, and scaffolding were present but not strong enough to consistently convert digital participation into richer interactive learning experiences, as also noted in research on uneven teacher digital-pedagogical capacity (Bentri & Hidayati, 2023; Simelane-Mnisi & Mokgala-Fleischmann, 2022). Taken together, the profile shown in Figure 4 indicates that students did not perceive digital pedagogy as either highly ineffective or highly empowering; rather, they experienced it as a moderately supportive system that functioned reasonably well while still leaving substantial room for pedagogical improvement (Mustafa, 2025; Masripah et al., 2025).

Descriptive variation appeared more clearly when the four dimensions were viewed by internet quality rather than by grade level. Students with poor internet reported the highest implementation exposure (3.62) and perceived benefit (3.54), but they also recorded the highest obstacle score (3.24), compared with students with fair (2.98) and good internet (2.74). This pattern indicates that students with poorer connectivity remained

p-ISSN: 2597-7792 / e-ISSN: 2549-8525
DOI: https://doi.org/10.20961/ijpte.v10i1.116892

engaged in digital pedagogy, although they experienced greater obstacles in the process. Figure 4 also shows that moderately positive benefit scores were still reported across internet-quality groups despite differences in obstacle levels. Taken together, these results suggest that internet quality was an important condition shaping how students experienced digital pedagogy across the four core dimensions.

Implementation barriers and frictions

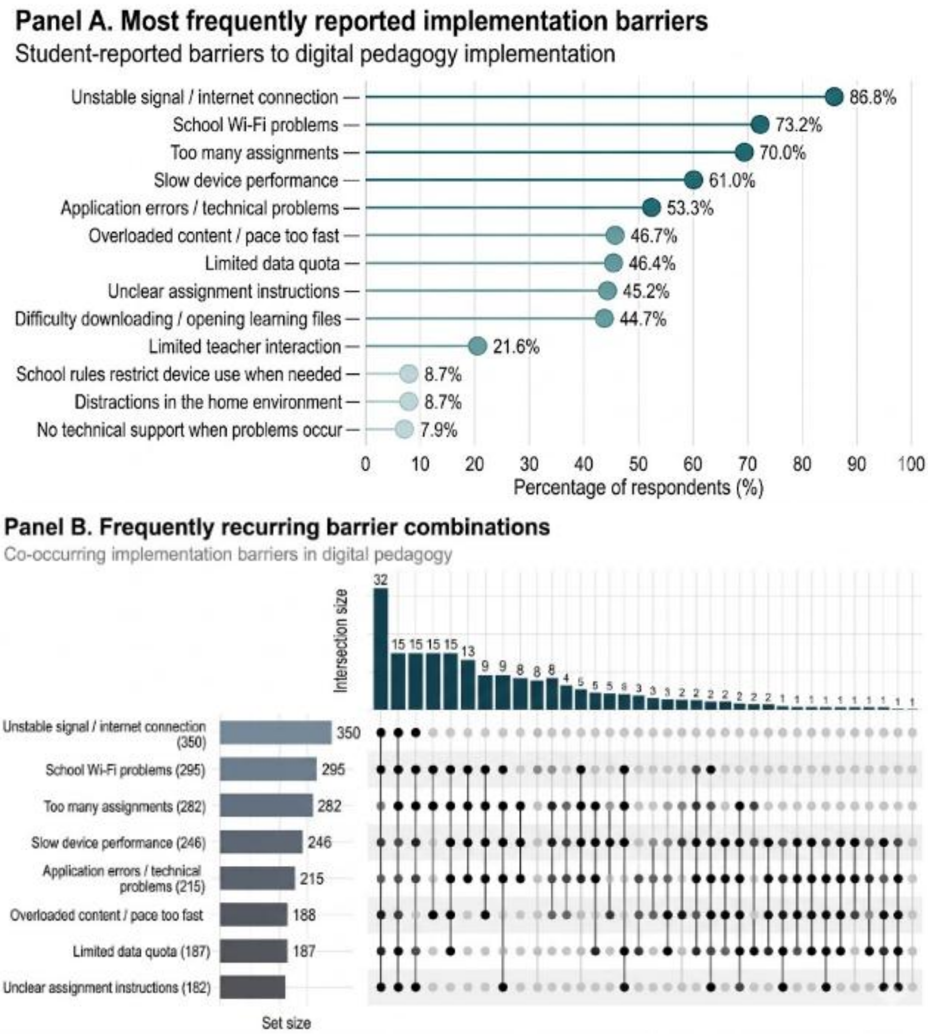

Figure 5. Student-reported implementation barriers and recurring barrier patterns

Implementation barriers were dominated by connectivity instability, workload pressure, and technical friction rather than by simple lack of device ownership. The most frequently reported barrier was unstable signal or internet connection (86.8%), followed by school Wi-Fi problems (73.2%) and too many assignments (70.0%), while slow device performance (61.0%) and application or technical errors (53.3%) were also highly prevalent. Students further reported overloaded content or fast pacing (46.7%), limited data quota (46.4%), unclear assignment instructions (45.2%), and difficulty downloading or opening files (44.7%), indicating that barriers emerged not only from infrastructure but also from the way learning activities were organised. Although limited teacher interaction, home distractions, school rules restricting device use, and lack of technical support were less frequent, they still point to secondary layers of disruption that can intensify already fragile participation. As shown in Figure 5, this pattern suggests that the main constraints of digital pedagogy were rooted in the broader implementation ecology of connectivity, pacing, and platform usability, which is consistent with studies showing that digital participation often breaks down because of infrastructural and design-related frictions rather than

p-ISSN: 2597-7792 / e-ISSN: 2549-8525
DOI: https://doi.org/10.20961/ijpte.v10i1.116892

device absence alone (Gikundi et al., 2023; Daclan, 2025).

The barrier-combination analysis further indicates that these frictions were cumulative rather than isolated. The largest recurring sets were built around unstable internet connection, school Wi-Fi problems, excessive assignments, and slow device performance, while technical issues related to applications or devices also appeared repeatedly within co-occurring barrier clusters. This means that many students were not facing one single obstacle, but a layered burden in which connectivity failures, technical inefficiencies, and workload overload reinforced one another and increased the practical cost of participation. The multiple repeated intersections shown in Figure 5 suggest that there was no single dominant disruption pathway; instead, several recurring combinations repeatedly undermined continuity, efficiency, and learning comfort, a pattern that mirrors broader evidence on the systemic nature of digital learning constraints in mixed-resource settings (Sinyinza, 2025; Hilliger et al., 2023). Overall, the findings indicate that implementation frictions in digital pedagogy should be understood as an ecosystem problem requiring bundled responses across connectivity support, workload governance, technical reliability, and clearer instructional design, rather than as a set of separate single-factor issues (Jia et al., 2024; Butler, 2024).

Helpful student experiences from open-ended responses

Students' positive open-ended responses were consolidated into four major clusters of helpful experiences, with Figure 6 indicating that access to materials and relearning was the most prevalent category (42.8%). This pattern suggests that students most strongly valued digital learning environments that allowed them to revisit content, regulate the pace of study, and reinforce understanding through repeated exposure to recorded lessons, downloadable resources, and other asynchronous materials (Bello, 2023; Locke et al., 2024). Such preferences are consistent with research on flipped and blended learning, which shows that replayable content can strengthen preparation, confidence, and readiness for more applied learning activities when supported by clear instructional guidance (Mishra, 2025; Linford & Sim, 2023). Figure 6 also shows that collaboration, literacy, and autonomy formed the second-largest cluster (20.4%), indicating that students appreciated digital pedagogy not only for access and flexibility but also for its capacity to support interaction, literacy development, and independent learning. This interpretation aligns with evidence that well-structured online collaboration can enhance communication competence, digital literacies, engagement, and metacognitive development when tasks are clearly scaffolded and moderated (Golikova & Tarasova, 2023; Chong, 2025). Taken together, these two dominant clusters suggest that students perceived digital learning as most helpful when it combined self-paced access to knowledge with opportunities for purposeful interaction and growing learner autonomy.

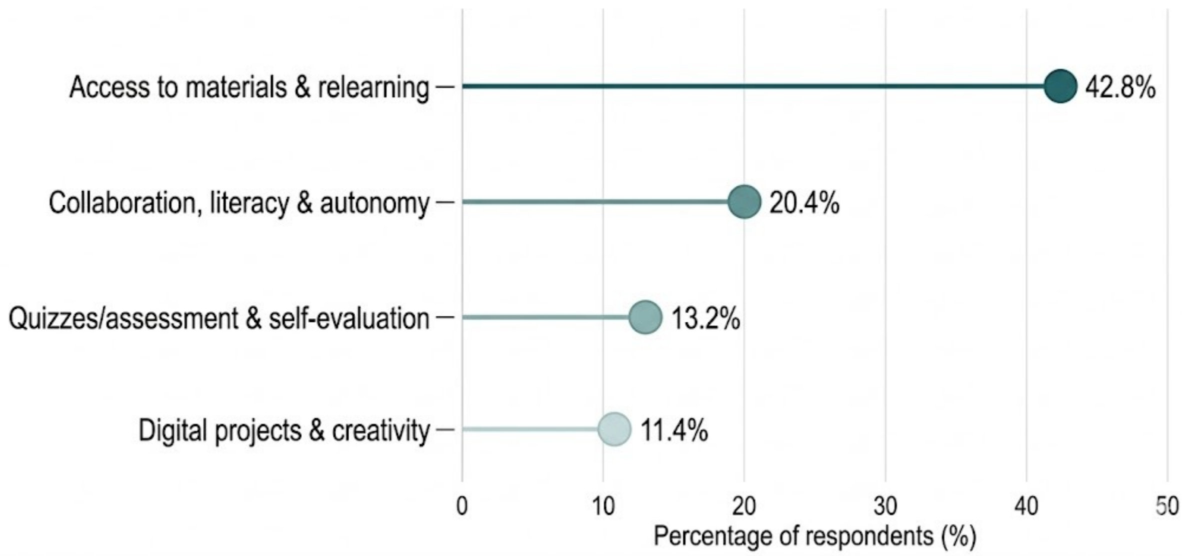

Figure 6. Cluster prevalence of helpful learning experiences

p-ISSN: 2597-7792 / e-ISSN: 2549-8525
DOI: https://doi.org/10.20961/ijpte.v10i1.116892

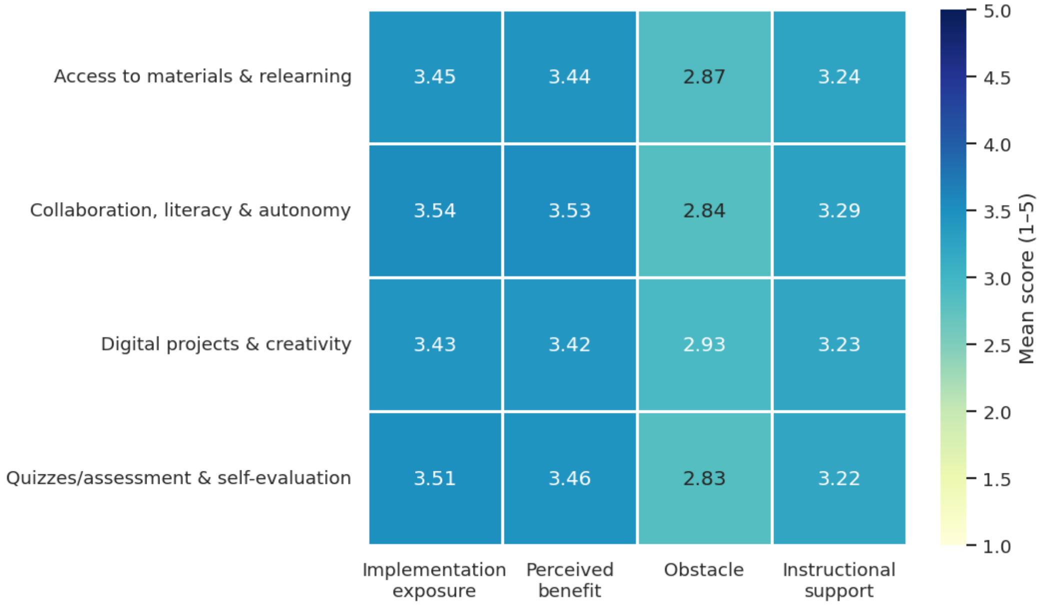

Figure 7. Profile of helpful-experience clusters across core student experience dimensions

Differences across the cluster profiles in Figure 7 further show that students' perceptions of helpfulness were shaped not only by what digital activities were used, but by how effectively those activities were implemented and supported. Collaboration, literacy, and autonomy demonstrated one of the strongest combinations of implementation exposure (3.54) and perceived benefit (3.53), while quizzes/assessment and self-evaluation also showed a strong profile in exposure (3.51) and benefit (3.46), reinforcing the value of formative checking, recursive feedback, and self-monitoring in digital environments (Chong, 2025; Yu et al., 2023). Access to materials and relearning displayed a balanced positive pattern across all dimensions, including relatively solid instructional support (3.24), which suggests that material availability was meaningfully strengthened by teacher scaffolding rather than functioning as a passive resource alone (Mishra, 2025; Devlin et al., 2024). Digital projects and creativity, although positively perceived, showed a slightly higher obstacle score (2.93), indicating that creative and project-based digital tasks may offer meaningful learning opportunities while also generating greater technical, workload, and accessibility challenges (Morgado et al., 2023; OECD, 2021). Overall, Figure 7 implies that students valued digital pedagogy most when it enabled them to revisit materials, learn with a degree of independence, monitor their own progress, and engage in meaningful tasks, but it also highlights that the perceived benefits of more ambitious digital activities depend heavily on careful instructional design and the reduction of practical barriers (Konstantinidou & Nisiforou, 2022; Bello, 2023).

Most disruptive barriers from open-ended responses

Students' open-ended responses on the most disruptive barriers were grouped into five thematic clusters, as shown in Figure 8, with connectivity and access emerging as the dominant category (65.4%). This distribution indicates that disruption in digital learning was driven primarily by infrastructural constraints, especially unstable internet, limited bandwidth, and uneven access conditions that interrupted participation and reduced the practical quality of engagement even when students remained nominally connected (Gikundi et al., 2023; Daclan, 2025). Device and application technical issues formed the second-largest cluster (26.1%), suggesting that software failures, upload problems, file incompatibility, and device limitations constituted a substantial secondary layer of disruption that often-compounded access-related difficulties (Morgado et al., 2023; Marques & Pombo, 2021). Workload and time appeared less frequently (7.0%) but remained pedagogically significant, as overload and compressed deadlines can intensify the negative effects of technical barriers and increase stress, disengagement, and reduced learning quality (Vallee, 2023; Hilliger et al., 2023). Taken together, the prevalence pattern in Figure 8 suggests that students' most common disruptions were rooted not in isolated classroom practices, but in structural conditions that shaped whether digital participation was feasible, stable, and sustainable across learning tasks (Jia et al., 2024; Li et al., 2024).

p-ISSN: 2597-7792 / e-ISSN: 2549-8525
DOI: https://doi.org/10.20961/ijpte.v10i1.116892

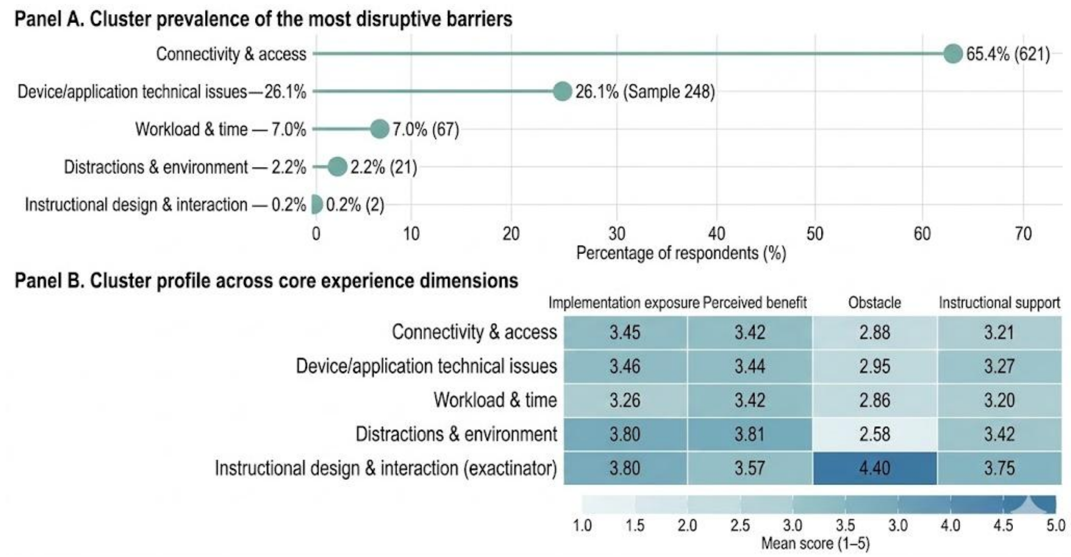

Figure 8. Cluster prevalence and profile of the most disruptive barriers

Cluster profiles in Figure 8 nevertheless show that prevalence alone does not determine severity. Instructional design and interaction, although representing only 0.2% of responses, recorded the highest obstacle score (4.40) and the highest instructional support score (3.75), indicating that pedagogical breakdowns were rare but highly disruptive when they occurred, particularly when expectations, facilitation, or interactional structures were not well aligned with students' needs (Konstantinidou & Nisiforou, 2022; Yu et al., 2023). Distractions and environment showed relatively high implementation exposure (3.80) and perceived benefit (3.81) but a lower obstacle score (2.58), implying that environmental pressures such as noise or shared space did not always prevent participation, especially where students could rely on flexible or asynchronous forms of engagement (Cochrane et al., 2020). Device and application technical issues displayed a moderately elevated obstacle score (2.95), reinforcing the view that operational friction in platforms and hardware can meaningfully erode learning continuity even when connectivity is available (OECD, 2021; Pappa et al., 2023). Overall, Figure 7 points to a two-layered interpretation: the most widespread barriers were infrastructural, but the most acute friction could also arise from weaknesses in instructional design and interaction, which means that effective intervention must address both large-scale access inequities and smaller yet high-impact pedagogical failures (Sharma, 2025; Bentri & Hidayati, 2023).

Students' improvement priorities and Alignment between barrier domains and improvement priorities

Students' open-ended suggestions were clustered into five improvement priorities, with strengthening access and infrastructure emerging as the most frequently reported priority (46.5%) in Figure 9. This pattern indicates that students continued to view reliable connectivity, stable platforms, and affordable access as the foundational conditions for effective digital learning, which is consistent with broader evidence showing that weak infrastructure limits participation, increases the practical cost of engagement, and reduces the educational value of otherwise well-designed digital activities (Gikundi et al., 2023; Daclan, 2025). Improving instructions, materials, and assessment ranked second (18.7%), suggesting that students were not only concerned with technological access but also with the clarity, organisation, and usability of learning design. This interpretation is reinforced by the cluster profile in Figure 10, where improving instructions, materials, and assessment carried the highest obstacle score (3.00), while technical support, literacy, and blended model showed the highest implementation exposure (3.62) together with high perceived benefit (3.52). Interaction and learning strategies, although smaller in prevalence (5.5%), also showed relatively strong perceived benefit (3.48) and instructional support (3.31), indicating that students valued more engaging forms of pedagogy when they were meaningfully supported. Taken together, these patterns suggest that students were asking not simply for better access, but for a more coherent digital learning environment in which infrastructure, teaching materials, assessment practices, and support systems worked together to reduce friction and improve learning quality (Konstantinidou & Nisiforou, 2022; Sharma, 2025).

p-ISSN: 2597-7792 / e-ISSN: 2549-8525
DOI: https://doi.org/10.20961/ijpte.v10i1.116892

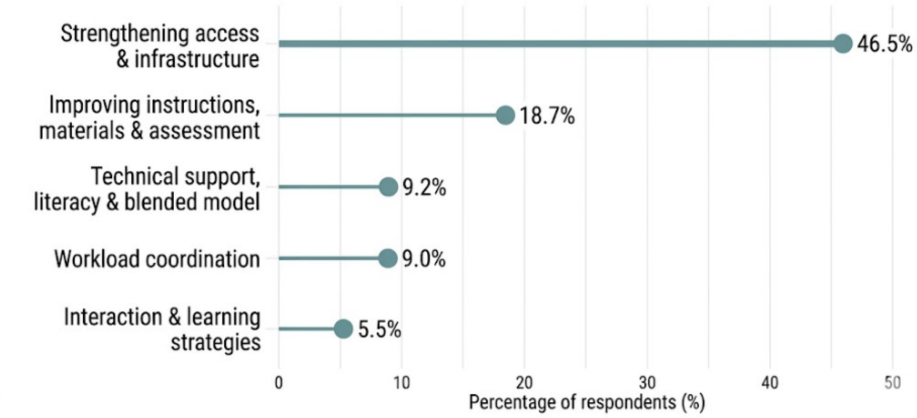

Figure 9. Prevalence of student-reported improvement priorities

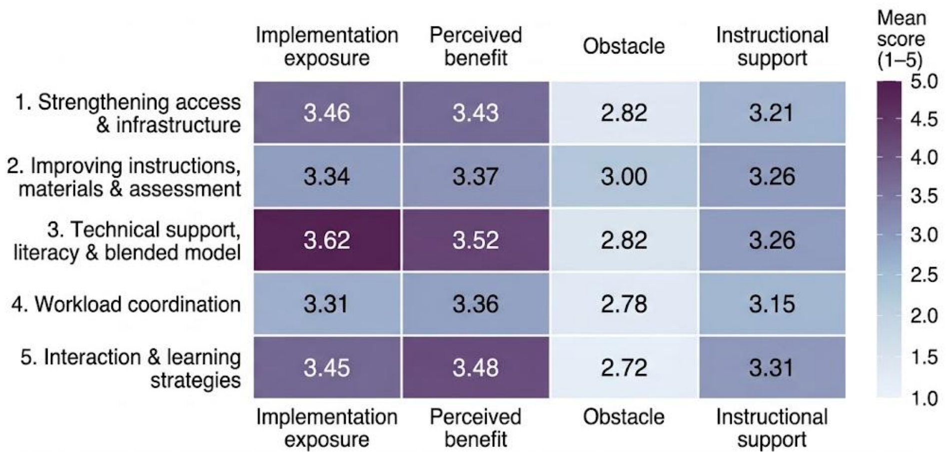

Figure 10. Heatmap of improvement-priority clusters across core experience dimensions

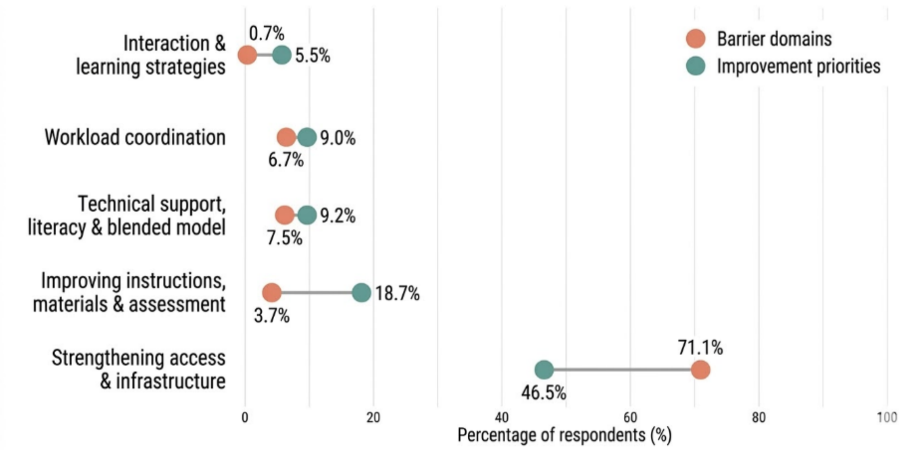

Figure 11. Dumbbell plot of barrier domains versus improvement priorities

The comparison in Figure 11 shows how student-reported barrier domains corresponded with improvement priorities. Strengthening access and infrastructure accounted for the largest share on both the barrier side (71.1%) and the priority side (46.5%). Improving instructions, materials, and assessment represented a smaller share of reported barriers (3.7%) than of improvement priorities (18.7%). A similar pattern appeared for technical support, literacy, and blended model, with 7.5% on the barrier side and 9.2% on the priority side.

p-ISSN: 2597-7792 / e-ISSN: 2549-8525
DOI: https://doi.org/10.20961/ijpte.v10i1.116892

Workload coordination showed relatively close proportions across barriers (6.7%) and priorities (9.0%), whereas interaction and learning strategies remained the smallest category in both distributions, rising from 0.7% in barriers to 5.5% in priorities. Overall, Figure 11 indicates that access and infrastructure were the most prominent concern, while several other domains appeared more strongly as improvement priorities than as directly reported barriers.

4. Discussion

Digital access expanded participation, but not equitable learning conditions

Digital access in this study was broadly available, yet such access did not automatically ensure equitable or high-quality participation in digital pedagogy. As shown in Figure 2, smartphone use was nearly universal (99.3%) and personal device ownership was very high (98.5%), indicating that most students were formally connected to digitally supported learning. However, the same results also show that access remained strongly mobile-based, learning was largely home-based, and a notable proportion of students still experienced limited data quota, suggesting that formal access did not necessarily translate into stable and comfortable participation. In this sense, device ownership should not be interpreted as equivalent to meaningful digital inclusion, because students' actual experience depended on whether connectivity, bandwidth, affordability, and home learning conditions were sufficient to support sustained engagement. This interpretation is reinforced by Figure 4, which shows that students with poorer internet quality recorded the highest obstacle score, even while remaining actively engaged in digital learning. That pattern is important because it indicates that digital inequality in this context was shaped less by exclusion from technology and more by the unequal burden of participation under weak access conditions. Students with poor internet still participated, but their participation was accompanied by greater friction, interruption, and effort. Visible engagement, therefore, did not necessarily mean that learning conditions were equitable. Such a finding supports the broader argument in the literature that digital pedagogy cannot be judged only by the presence of devices or platforms, because the actual quality of learning is mediated by connectivity, usability, teacher support, and instructional design (Gikundi et al., 2023; Duwal, 2023; Butler, 2024; Bentri & Hidayati, 2023; Jia et al., 2024).

Further support for this interpretation comes from Figure 5, where unstable internet connection, school Wi-Fi problems, excessive assignments, slow device performance, and application errors emerged as the most prevalent barriers. These results show that participation problems were not singular or isolated. Students were often working within an ecology of layered frictions, where technical instability, device inefficiency, and organisational overload interacted cumulatively. Because of that, digital pedagogy in this setting may be understood as operating under conditions of surface inclusion but uneven functionality. Most students could enter the system, but not all could participate smoothly, consistently, or with the same degree of educational benefit. That distinction is central, because it shifts the interpretation of access from a binary question of entry to a more substantive question of participation quality and educational equity (Masripah et al., 2025; Daclan, 2025; Hilliger et al., 2023).

Digital pedagogy operated as a pragmatic and low-friction delivery model

The activity and platform landscape presented in Figure 3 suggests that digital pedagogy in this school was implemented primarily as a pragmatic delivery system. Instructional videos, assignments, presentations, digital projects, access to learning materials, and quizzes were highly prevalent, while discussion-based and simulation-rich learning remained far less common. This pattern indicates that digital pedagogy was already embedded in classroom routines, but mainly in forms that supported content delivery, task submission, and routine assessment rather than deeper collaborative inquiry or immersive interaction. Such a profile is consistent with literature showing that many school-based digital implementations remain operationally efficient yet pedagogically shallow when instructional redesign is limited (Mallillin et al., 2020; OECD, 2021; Seleke, 2024; Omarsaib, 2024). The platform configuration strengthens this interpretation. Microsoft Teams, Canva, WhatsApp or Telegram, Quizizz or Kahoot, and Google Forms were the dominant tools, and these platforms are especially suitable for communication, material sharing, assignment management, and low-friction assessment. Their prominence suggests that schools and teachers likely prioritised tools that were relatively easy to distribute, monitor, and sustain in mobile-first and time-constrained contexts. Rather than viewing this as a simple

p-ISSN: 2597-7792 / e-ISSN: 2549-8525
DOI: https://doi.org/10.20961/ijpte.v10i1.116892

pedagogical weakness, this pattern can be read as a contextually rational adaptation to uneven infrastructure and practical implementation demands. In other words, digital pedagogy here was not absent, but selectively operational: strongest where it could maintain continuity, preserve observable participation, and reduce coordination costs (Lavidas et al., 2020; Bello, 2023; Daclan, 2025).

Helpful-experience patterns in Figure 6 clarify why this pragmatic model still carried substantial educational value. The most prevalent helpful cluster was access to materials and relearning (42.8%), followed by collaboration, literacy, and autonomy (20.4%). These results suggest that students did not experience digital pedagogy merely as a system of task delivery. Students valued the ability to revisit materials, regulate the pace of study, and reinforce understanding through replayable and reusable resources. Students also appreciated opportunities for interaction, digital literacy development, and independent learning when those activities were clearly structured. Such findings align with research showing that digital environments can be educationally meaningful even when they are not highly immersive, provided that they support self-paced learning, scaffolded engagement, and productive student autonomy (Locke et al., 2024; Mishra, 2025; Devlin et al., 2024; Golikova & Tarasova, 2023; Chong, 2025).

Tension nevertheless remains visible in the Figure 7. Digital projects and creativity were positively perceived but also carried a somewhat higher obstacle score, indicating that richer and more ambitious forms of digital activity may offer stronger learning value while also demanding greater technical readiness, coordination, and instructional scaffolding. That pattern helps explain why the overall implementation tended toward a material–tasks–quizzes model. Schools appear to have balanced educational aspiration with operational sustainability, favouring forms of pedagogy that were manageable under constrained conditions. Digital pedagogy in this context therefore seems best understood not as underdeveloped in a simple sense, but as institutionally adaptive yet pedagogically selective, with greater strength in continuity and access than in sustained dialogue, immersive simulation, or higher-order collaborative knowledge construction (Morgado et al., 2023; OECD, 2021; Konstantinidou & Nisiforou, 2022).

Student voice reveals that disruption was layered, and severity did not always follow frequency

The open-ended findings deepen the interpretation of implementation barriers by showing that disruption in digital pedagogy was both layered and uneven in severity. While Figure 5 already shows that unstable internet, Wi-Fi problems, workload pressure, device slowness, and technical errors were common, Figure 8 demonstrates that the most disruptive barriers from students' own narratives were dominated by connectivity and access (65.4%), followed by device and application technical issues (26.1%). This confirms that students most often experienced disruption through infrastructural conditions rather than through isolated classroom incidents. Participation could continue under these conditions, but at greater practical and emotional cost. That pattern is consistent with broader studies showing that digital learning often breaks down not because students lack devices altogether, but because access quality and system reliability are too fragile to sustain stable engagement (Gikundi et al., 2023; Daclan, 2025; Jia et al., 2024).

Severity, however, did not always mirror prevalence. Figure 8 also shows that instructional design and interaction accounted for only a very small proportion of responses, yet this category carried the highest obstacle score. Such a pattern is analytically important, because it indicates that pedagogical failures may be less frequent than infrastructural failures but can be highly disruptive when they occur. Unclear expectations, weak facilitation, or poor interaction design may affect fewer students overall, yet they can produce very intense dissatisfaction and sharply reduce the educational value of participation. This finding suggests that digital pedagogy should not be improved by focusing only on the most common barriers. Improvement also requires attention to lower-frequency but high-impact weaknesses in instructional design and classroom interaction (Konstantinidou & Nisiforou, 2022; Yu et al., 2023; Bentri & Hidayati, 2023).

Interpretation of the student-experience profile in Figure 4 becomes clearer when read together with

p-ISSN: 2597-7792 / e-ISSN: 2549-8525
DOI: https://doi.org/10.20961/ijpte.v10i1.116892

Figure 8. Students generally reported moderate exposure, moderate benefit, and moderate instructional support, which might initially suggest a reasonably functional system. However, qualitative evidence shows that these moderate averages concealed unequal burdens and qualitatively different forms of disruption. Some students were mainly challenged by poor connectivity, whereas others were more strongly affected by unclear design, weak interaction, or technical breakdowns. These findings suggest that average scores alone are insufficient to capture the lived complexity of digital pedagogy (Ashiq et al., 2023). A mixed-methods reading is particularly valuable here because it reveals not only how often students experienced certain conditions, but also which types of friction were most educationally consequential.

Improvement requires both infrastructural strengthening and pedagogical redesign

The strongest contribution of student voice in this study lies in showing that improvement in digital pedagogy requires a dual agenda. Figure 9 indicates that strengthening access and infrastructure was the most frequently reported improvement priority (46.5%), while improving instructions, materials, and assessment ranked second (18.7%). Such a distribution shows that students were not asking merely for smoother technology. They were also asking for clearer, better organised, and more educationally coherent learning experiences. Infrastructure remained the foundation, but pedagogy was the mechanism through which access could be converted into actual learning value. The alignment analysis in Figure 11 sharpens this argument further. Access and infrastructure dominated both barrier recognition and improvement demand, confirming that infrastructural instability remained the most visible source of disruption. At the same time, improving instructions, materials, and assessment accounted for a much larger share of improvement priorities than of reported barriers. That discrepancy is highly revealing. Students may not always describe pedagogical quality as the main immediate obstacle, but they still see it as a major lever for meaningful improvement once baseline access is secured. Similar logic appears in workload coordination and interaction strategies, whose roles in the priority structure suggest that students wanted digital learning to become not only technically possible, but also more manageable, coherent, and engaging. In other words, student recommendations moved beyond complaint and toward a more nuanced view of improvement, one that combines technical reliability with better instructional design and learning management (Sharma, 2025; Sugiyanto et al., 2024; Afonso et al., 2025).

Together, the findings from Figures 4, 5, 9, and 11 suggest that, within this school context, effective digital pedagogy depended on the joint development of access and instructional design. Infrastructure made participation possible, but instructional design shaped whether that participation became manageable and educationally meaningful. More reliable connectivity alone might have improved the technical smoothness of participation, yet without clearer instructions, better-organised materials, balanced workload, and stronger interaction, the educational quality of that participation would likely have remained uneven. Stronger pedagogy without reliable access would also have been difficult to sustain in practice. These findings therefore indicate that improvement required both infrastructural support and pedagogical redesign (OECD, 2021; Sharma, 2025).

This interpretation also carries a broader conceptual implication. Digital pedagogy should be understood not simply as technology provision or platform adoption, but as a process through which access is translated into usable, supported, and meaningful learning participation (Loh & Chib, 2021; OECD, 2021). From a learner-centred perspective, the quality of digital pedagogy emerged from the interaction between infrastructure, instructional organisation, and support conditions rather than from access alone (Masripah et al., 2025; Butler, 2024). In this way, the study contributes by clarifying that digital inclusion in school learning is not exhausted by device availability, but depends on how access is pedagogically organised and sustained in everyday learning practice (Jia et al., 2024; Masripah et al., 2025).

5. CONCLUSION

This study shows that digital pedagogy in the investigated school context was widely accessible but uneven in quality. Although most students were able to participate through smartphones and other digital tools, access alone did not ensure stable, meaningful, or equitable learning experiences. Students' participation

p-ISSN: 2597-7792 / e-ISSN: 2549-8525
DOI: https://doi.org/10.20961/ijpte.v10i1.116892

remained constrained by connectivity problems, limited quota, technical difficulties, workload pressure, and a predominantly home-based learning environment. Digital pedagogy also tended to operate in a pragmatic form centred on videos, assignments, presentations, and quizzes, while more interactive and simulation-rich activities remained limited. Taken together, the findings suggest that the central challenge of school digital pedagogy lies not in access alone, but in how access is translated into manageable, meaningful, and educationally valuable participation. Within this context, improvement requires both stronger infrastructural support and better instructional design.

6. REFERENCES

A'yun, Q., Awalluddin, & Hasan, A. M. (2024). Optimizing digital pedagogy in education: Exploring human resource management approaches. Mimbar Ilmu, 29(3), 492–499. https://doi.org/10.23887/mi.v29i3.90051

Adhikari, B. P. (2023). The impact of dimensions of e-learning on the successful implementation and development of digital pedagogy in Nepalese higher-level educational institutions. OCEM Journal of Management, Technology & Social Sciences, 2(2), 15–55. https://doi.org/10.3126/ocemjmtss.v2i2.54229f

Afonso, A. P., Carvalho, I. C., Bidarra, J., Morgado, L., & Rocha, M. A. (2025). Improve teachers' innovative digital skills across Europe. Etic Net Revista Científica Electrónica De Educación Y Comunicación En La Sociedad Del Conocimiento, 25(1), 1–30. https://doi.org/10.30827/eticanet.v25i1.31247

Ashiq, M., Rehman, S. U., Yousaf, A., & Safdar, M. (2023). Exploring the use of mobile technologies for learning: An empirical study of library and information science (LIS) students. Digital Library Perspectives, 39(4), 604–619. https://doi.org/10.1108/dlp-04-2023-0032

Barche, A., Nayak, V., Pandey, A., Bhandarkar, A., Nayak, S., & Nayak, K. (2022). Student perceptions towards online learning in medical education during the COVID-19 pandemic: A mixed-methods study. F1000Research, 11, 979. https://doi.org/10.12688/f1000research.123582.1

Baynit, M., Mnyanyi, C., & Msoroka, M. (2025). The influence of instructors employed digital pedagogies on students' learning outcomes: The case of selected higher learning institutions in Tanzania. Afr. Quarterly S.S. Review, 2(1), 148–159. https://doi.org/10.51867/aqssr.2.1.12

Bello, L. K. (2023). Exploring the acceptance of instructional videos to bridge knowledge gaps in physical geography among senior secondary school students in Oyo State Nigeria. Amjd, 12(2), 153–167. https://doi.org/10.59568/amjd-2023-12-2-15

Bentri, A., & Hidayati, A. (2023). Improving digital pedagogy competence through in-service training for elementary school teacher. Journal of Physics: Conference Series, 2582(1), 012064. https://doi.org/10.1088/1742-6596/2582/1/012064

Bình, B. H. V., & Sơn, S. N. Q. (2025). Chuyển đổi số trong giáo dục đại học ngoài công lập: Từ đổi mới công nghệ đến đổi mới sư phạm. T. Chí KH Trg. ĐH Trưng Vương, 1(3). https://doi.org/10.64223/tvj.p2025.v1.i3.a45

Butler, T. (2024). A critical review of digital technology in education: A pause for thought in 2024. https://doi.org/10.31235/osf.io/5q8vg

Chen, X., & Chan, S. (2024). Implementing digital pedagogy in TVET: A connectivist perspective. Vocat Tech Edu, 1(2). https://doi.org/10.54844/vte.2024.0595

Chmyr, V., Корехов, А., ПСЬОЛ, С., & Partyka, S. (2024). Fostering digital transformations in military engineering education: Introduction of a technology-enhanced learning environment. Problems of Education in the 21st Century, 82(2), 162–185. https://doi.org/10.33225/pec/24.82.162

Chong, R. D. S. (2025). Is peerScholar a reflexive pedagogy platform? MLS Educational Research, 9(1). https://doi.org/10.29314/mlser.v9i1.4033

Cochrane, T., Birt, J., Cowie, N., Deneen, C. C., Goldacre, P., Narayan, V., Ransom, L., Sinfield, D., & Worthington, T. (2020). A collaborative design model to support hybrid learning environments during COVID19. https://doi.org/10.14742/ascilite2020.0119

p-ISSN: 2597-7792 / e-ISSN: 2549-8525
DOI: https://doi.org/10.20961/ijpte.v10i1.116892

Daclan, M. D. (2025). Leveraging connectivity to bridge learning gaps in basic education: A resource-based approach. Cognizance Journal of Multidisciplinary Studies, 5(10), 105–118. https://doi.org/10.47760/cognizance.2025.v05i10.011

Devlin, N., Slade, A., McCutcheon, P. K., & Brown-Wilson, P. C. (2024). Nursing students, nursing lecturers and practice staff's understanding on an ePortfolio and the impact on students' self-efficacy: Protocol of a mixed method study. https://doi.org/10.21203/rs.3.rs-3934644/v1

Duwal, B. R. (2023). Factors affecting the online learning outcomes of higher educational institutions in Nepal. International Research Journal of Management Science, 8(1), 57–70. https://doi.org/10.3126/irjms.v8i1.60695

Elvsaas, I., Myrhaug, H., Garnweidner-Holme, L., Kasper, J., Austvoll-Dahlgren, A., & Molin, M. (2024). Using health claims to teach evidence-based practice to healthcare students: A mixed methods study. F1000Research, 13, 224. https://doi.org/10.12688/f1000research.146648.1

Fan, A. (2024). Driving digitalization: Action research to innovate pronunciation pedagogies by building a virtual voice laboratory. International Journal of Second and Foreign Language Education, 3(1), 27–55. https://doi.org/10.33422/ijsfle.v3i1.708

Gikundi, J., Mutegi, R. G., & Riechi, A. R. (2023). The effectiveness of learner support services in blended learning and its influence on quality of education in Kenya's public universities. Journal of Education and Practice, 14(33). https://doi.org/10.7176/JEP/14-33-11

Golikova, T., & Tarasova, A. (2023). Online communication in EFL classes to foster prospective global engineers' complex e-intercultural communication competence. https://doi.org/10.21203/rs.3.rs-2723066/v1

Hilliger, I., Astudillo, G., & Baier, J. A. (2023). Lacking time: A case study of student and faculty perceptions of academic workload in the COVID-19 pandemic. Journal of Engineering Education, 112(3), 796–815. https://doi.org/10.1002/jee.20525

Jia, S., Du, J. T., & Hui, Y. (2024). Towards a comprehensive framework for digital inclusion: A comparison of international measurements. Aslib Journal of Information Management. https://doi.org/10.1108/ajim-06-2024-0494

Jiang, Y., Ruan, X., Feng, Z., & Jiang, P. (2023). Teachers' perceptions of online teaching do not differ across disciplines: A survey. Sustainability, 15(4), 3569. https://doi.org/10.3390/su15043569

Konstantinidou, A., & Nisiforou, E. (2022). Assuring the quality of online learning in higher education: Adaptations in design and implementation. Australasian Journal of Educational Technology, 38(4), 127–142. https://doi.org/10.14742/ajet.7910

Lavidas, K., Athanassopoulos, S., Priovolou, K., Lappa, A., & Voutsina, L. (2020). Investigating practices and perceptions of higher education students concerning the utilization of mobile devices in their studies. Ανοικτή Εκπαίδευση: Το Περιοδικό Για Την Ανοικτή Και Εξ Αποστάσεως Εκπαίδευση Και Την Εκπαιδευτική Τεχνολογία, 15(2), 114. https://doi.org/10.12681/jode.21990

Li, M., Shi, T., Chen, J., Ding, J., Gao, X., Zeng, Q., Zhang, J., Ma, Q., Liu, X., Yu, H., Lu, G., & Li, Y. (2024). The facilitators and barriers to implementing virtual visits in intensive care units: A mixed-methods systematic review. Journal of Evaluation in Clinical Practice, 30(8), 1684–1716. https://doi.org/10.1111/jep.14042

Linford, P., & Sim, K. N. (2023). Pedagogically driven digital education for diverse people and deeper partnerships. Ascilite Publications. https://doi.org/10.14742/apubs.2023.516

Livermon, S., Michel, A., Zhang, Y., Petz, K., Toner, E., Rucker, M., et al. (2025). A mobile intervention to reduce anxiety among university students, faculty, and staff: Mixed methods study on users' experiences. PLOS Digital Health, 4(1), e0000601. https://doi.org/10.1371/journal.pdig.0000601

Locke, K., Ellis, K., & Wolf, K. (2024). Auditory learner. M/C Journal, 27(2). https://doi.org/10.5204/mcj.3029

Loh, Y. A., & Chib, A. (2021). Reconsidering the digital divide: An analytical framework from access to appropriation. Information Technology & People, 35(2), 647–676. https://doi.org/10.1108/itp-09-2019-0505

Mallillin, L. L. D., Mendoza, L. C., Mallillin, J. B., Felix, R. C., & Lipayon, I. C. (2020). Implementation and readiness of online learning pedagogy: A transition to COVID-19 pandemic. European Journal of Open Education and E-Learning Studies, 5(2). https://doi.org/10.46827/ejoe.v5i2.3321

p-ISSN: 2597-7792 / e-ISSN: 2549-8525
DOI: https://doi.org/10.20961/ijpte.v10i1.116892

Marques, M., & Pombo, L. (2021). The impact of teacher training using mobile augmented reality games on their professional development. Education Sciences, 11(8), 404. https://doi.org/10.3390/educsci11080404

Masripah, Anisah, A. S., & Usman, A. T. (2025). Bridging divides in digital pedagogy: A narrative review of emerging tools and inclusive practices. Eduscape, 3(1), 13–27. https://doi.org/10.61978/eduscape.v3i1.932

Mishra, D. (2025). Blended learning and flipped classroom strategies for 21st century teacher education: Pedagogical innovations in the digital age. Vidya - A Journal of Gujarat University, 4(2), 330–335. https://doi.org/10.47413/es2d8g22

Morgado, L., Coelho, A., Beck, D., Gütl, C., Cassola, F., Baptista, R., Zeller, M. V., Pedrosa, D., Cruzeiro, T., Cota, D., Grilo, R., & Schlemmer, E. (2023). Inven!RA architecture for sustainable deployment of immersive learning environments. Sustainability, 15(1), 857. https://doi.org/10.3390/su15010857

Mustafa, M. O. A. (2025). Building a digital learning culture: Strategic educational leadership in smart school ecosystems. Jrem, 4(1), 12–21. https://doi.org/10.71392/jrem.v4i1.88

OECD. (2021). 21st-century readers: Developing literacy skills in a digital world. OECD Publishing. https://doi.org/10.1787/a83d84cb-en

Omarsaib, M. (2024). Integrating a digital pedagogy approach into online teaching: Are academic librarians at universities of technology in South Africa prepared? Information and Learning Sciences, 126(3/4), 192–213. https://doi.org/10.1108/ils-01-2024-0012

Pappa, D., Pawlowski, J. M., Clements, K., & Sotiriou, S. (2023). Technostress in distance learning: The Positive Learn project. https://doi.org/10.36315/2023v2end110

Prosen, M., & Ličen, S. (2025). Evaluating the digital transformation in health sciences education: A thematic analysis of higher education teachers' perspectives. BMC Medical Education, 25(1). https://doi.org/10.1186/s12909-025-07420-3

Seleke, Z. (2024). ICT enhanced approaches for student centred learning: A case of accounting education pedagogy implementation at a selected university in South Africa. Journal of Education and Learning Technology, 9–23. https://doi.org/10.38159/jelt.2024521

Shaikh, Z. (2023). Integration of digital pedagogy and development of holistic learning ecosystem for students: The teachers' perspective. International Journal of Educational Reform, 35(1), 275–298. https://doi.org/10.1177/10567879231193729

Sharma, R. (2025). Synchronized adoption framework to overcome barriers in EdTech implementation. International Journal for Multidisciplinary Research, 7(5). https://doi.org/10.36948/ijfmr.2025.v07i05.57807

Simelane-Mnisi, S., & Mokgala-Fleischmann, N. (2022). Training framework to enhance digital skills and pedagogy of chemistry teachers to use IMFUNDO. https://doi.org/10.5772/intechopen.102003

Sinyinza, P. B. (2025). Challenges and barriers faced by stakeholders in the implementation of blended learning in Temeke Municipality, Tanzania. Journal of Teaching Learning & Curriculum, 1(2), 370–382. https://doi.org/10.61227/jtlc.v1i2.239

Sugiyanto, S., Muryani, C., & Ni'matussyahara, D. (2024). Strengthening student empathy in GeoCapabilities: Digital learning innovations and pedagogical strategies for disaster mitigation. Contemporary Educational Technology, 16(3), ep521. https://doi.org/10.30935/cedtech/14913

Tsekhmister, Y. (2022). Effectiveness of practical experiences in using digital pedagogies in higher education: A meta-analysis. Journal of Higher Education Theory and Practice, 22(15). https://doi.org/10.33423/jhetp.v22i15.5567

Vallee, K. (2023). Student experience of and reactions to online learning on Facebook. Crossing Borders: Student Reflections on Global Social Issues, 5(2). https://doi.org/10.31542/d7r22g06

Yu, Q., Gou, J., Li, Y., Pi, Z., & Yang, J. (2023). Introducing support for learner control: Temporal and organizational cues in instructional videos. British Journal of Educational Technology, 55(3), 933–956. https://doi.org/10.1111/bjet.13408

p-ISSN: 2597-7792 / e-ISSN: 2549-8525
DOI: https://doi.org/10.20961/ijpte.v10i1.116892