

Challenges and Impacts of Technology Adoption in Education: A Systematic Literature Review

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ABSTRACT

This study examines the challenges and impacts of adopting digital technology in education. A systematic literature review was conducted using Scopus and Web of Science databases, focusing on publications from 2019 to 2024. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework guided the selection and screening process, resulting in the identification of 23 relevant articles. The analysis found several barriers for teachers, including inadequate infrastructure, limited technical support, insufficient training, and negative attitudes toward technology. Students experienced challenges such as low digital literacy, limited access to devices and internet connectivity, and reduced social interaction in online learning environments. Despite these issues, the findings also reveal positive impacts, including enhanced teaching efficiency, increased flexibility in learning delivery, and improved engagement through the use of interactive tools. The review highlights the need for targeted policies, continuous professional development, and fair distribution of resources to support effective and inclusive technology integration in Education. This study contributes to the growing body of knowledge on digital transformation in education, providing practical guidance for policymakers, educators, and researchers on how to effectively integrate technology into early learning settings.

Keywords: technology adoption, education, challenges, impacts, systematic literature review

INTRODUCTION

Technology adoption has become an integral part of education, transforming the way lessons are planned, delivered, and experienced. Learning management systems, smartboards, and online platforms have made teaching more interactive and flexible (Law et al. 2022; Machin-Mastromatteo, 2022). The COVID-19 pandemic highlighted the crucial role of technology in maintaining learning during school closures (Sharma et al. 2023). However, when classes returned to face-to-face formats, some teaching materials were less effective compared to online delivery (Zheng et al. 2023). Technology adoption in education refers to the process by which teachers and students accept, utilize, and integrate technology into their learning. Despite the benefits, challenges persist. Teachers often face unstable internet connections, limited infrastructure, and insufficient training (Brocca, 2024). They may also have little time and lack confidence in using new tools. Students often encounter low digital literacy, limited access to devices, and difficulties adapting to online learning (Alowayr, 2022; Patil & Undale, 2023). Reduced social interaction online can also affect skills such as communication and collaboration (Šinko et al. 2024). These challenges are further complicated by the need to ensure age-appropriate use of technology and the reliance on teacher-child interaction for effective learning. While many studies examine the benefits of technology in education, fewer provide a balanced view that addresses both its positive and negative impacts in education. This systematic literature review addresses this gap by synthesising evidence on the challenges and impacts of technology adoption in education, offering insights that can guide educators, policymakers, and researchers in making informed decisions for more effective integration. The study aims to examine the challenges and impacts of technology adoption in the education sector. Specifically, it addresses two main objectives:

To identify the challenges faced by teachers in integrating digital technology into their teaching practices.

To examine the positive and negative impacts of digital technology adoption on teachers' instructional practices and students' learning outcomes.

METHODOLOGY

Study Design

This study used the Scopus and Web of Science (WoS) databases to visualise and identify knowledge and methodological gaps related to the challenges and impacts of technology adoption in education. The data search was conducted between November 1, 2024, to December 31, 2024. Relevant articles were selected based on eligibility criteria to ensure that the review reflects the most recent developments. Scopus and WoS were chosen for their strong track record as globally recognised bibliographic databases (Zhu & Liu, 2020). Both meet the core requirements for a systematic review due to their broad disciplinary coverage, advanced search capabilities, including the use of Boolean operators, and transparent, replicable processes that maintain the integrity of the study (Gusenbauer & Haddaway, 2020). The use of these high-quality databases ensures the accuracy and reliability of conducting the literature review (Zhao, 2014). The review followed the PRISMA guidelines to evaluate and select articles. The process included identification, screening, eligibility assessment, and inclusion. The PRISMA flow chart used in this study (Figure 1) is an adaptation of the original chart developed by Moher et al. (2009) and subsequently modified by Page et al. (2021).

PRISMA Guidelines

This SLR was conducted using PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analysis). The advantage of PRISMA is the element of transparency, consistency, and high standards in the preparation of qualitative study reports through certain processes (Flemming et al. 2019).

Identification

The first phase of the PRISMA process involved identifying relevant literature through a systematic search strategy. Boolean operators, such as AND OR, were used to refine the retrieval. Field-specific searches were applied to the title, abstract, and keywords to enhance the precision of the results. The keywords used in this review were *technology adoption*, *challenges*, *impact*, *education*, and *teachers*. These terms were selected to reflect the study's core focus and were applied to searches in both the Web of Science (WoS) and Scopus databases. The search yielded a total of 1,171 records, comprising 441 articles from WoS and 730 articles from Scopus. The exact search strings used in both databases are presented in Table 1.

Table 1 Search strings used in the databases

Database	Search String
Web of Science	TITLE-(technology AND adoption AND education AND (challenges OR impact) AND teachers)
Scopus	TITLE, ABSTRACT, KEYWORD = (technology AND adoption AND education AND (challenges OR impact) AND teachers)

Screening

The articles are obtained through a process of identification from two databases: the leading Web of Science (441 articles) and Scopus (730 articles), which produce a total of 1,171 articles. These articles are reviewed and combined by using Microsoft Excel to identify duplicates. A total of 8 duplicate articles were removed, leaving 1,163 unique articles to proceed to the next stage of refinement. Next, the selected articles will be screened according to the established criteria. Selection criteria encompass the year of publication, type of publication, language of the documents, and the status of open access (Booth et al. 2016). For this study, only journal articles published between 2019 and 2024, in English, and listed in the Index of Citations in Social Science are selected.

The result of this process was the exclusion of a total of 1,090 articles because they did not meet the set criteria, leaving 73 articles to proceed to the next stage of screening. The selection criteria and exclusion criteria are shown in Table 2 below:

Table 2 Inclusion and exclusion criteria

Criteria	Inclusion Criteria	Exclusion Criteria
Literature type	Impact Article Open Access journal	Low-impact articles, systematic literature reviews, conference proceedings, book series, book chapters
Language	English	Non English
Timeline	2019–2024	≤ 2018
Index	Social Science Citation Index	Non Social Science Citation Index
Countries	Worldwide	No

Eligibility

The eligibility process was conducted to ensure that all selected journal articles met the standards and criteria established for this study (Page et al. 2021). A total of 73 articles were identified and re-examined by reviewing the titles, abstracts, findings, and discussion sections of each article. This review aimed to determine whether the articles were relevant to the research objectives and aligned with the field of technology adoption in education. During this stage, four articles were excluded because they could not be downloaded or accessed. This left 69 articles eligible for further evaluation. A more detailed assessment was then conducted to evaluate the suitability of each article based on its content. As a result, 46 articles were excluded because they were found to be unrelated to the field of technology adoption, education, or teaching. These articles did not align with the primary focus of the study or meet the predetermined selection criteria. Finally, 23 articles were selected as meeting all inclusion criteria. Further checks confirmed that all selected articles were unique, with no duplicates detected.

Quality Assessment

The quality assessment of the articles was conducted using the Kitchenham (2004) guidelines, which were adapted to the context of this study. The process involved evaluating 23 articles using a 15-question quality assessment (QA) checklist that covered key aspects, including research objectives, the context of technology use in education, methodology, findings, and recommendations for future research. Each article was scored on a scale of 1 (Yes), 0.5 (Partially), or 0 (No). The maximum possible score was 15, and the articles were classified into four categories: Excellent (13.5–15), Good (9.5–13), Moderate (5–9), and Poor (0–4.5). The quality assessment questions (QA) used in this study are as follows:

QA 1: Does the study clearly state its main research objectives or problem statement?

QA 2: Does the study clearly describe the context of technology use in the field of education?

QA 3: Does the study identify the main challenges in technology adoption?

QA 4: Does the study explain the types of impacts being examined?

QA 5: Does the study clearly specify its data sources?

QA 6: Does the study mention the data collection methods used?

QA 7: Does the study use appropriate tools to analyse the data?

QA 8: Are the data sources sufficient to support the study's findings?

QA 9: Does the study take steps to minimise bias in the analysis?

QA 10: Does the study use appropriate methods to assess the impact of technology?

QA 11: Are the study's findings presented clearly?

QA 12: Does the study compare its findings with those of previous research?

QA 13: Does the study describe the analytical techniques or research approaches used, with justification?

QA 14: Does the study identify the challenges or limitations of the research?

QA 15: Does the study provide recommendations for future research?

The quality assessment results showed that the average score of the articles was 13.4, with the majority falling into the *Good* category. This indicates that the selected articles met high-quality standards. Overall, the articles demonstrated strengths in several key areas, including a clear statement of research objectives, the use of appropriate tools for data collection and analysis, and the detailed presentation of research findings. The discussion of results and study implications was explained comprehensively. This assessment confirms that all selected articles were suitable for inclusion in the final analysis of this systematic literature review. The results of the quality assessment are presented in Table 3 below.

Table 3 Quality assessment of the article (Kitchenham, 2004)

NO	Author (Year)	Q 1	Q 2	Q 3	Q 4	Q 5	Q 6	Q 7	Q 8	Q 9	Q1 0	Q1 1	Q1 2	Q1 3	Q1 4	Q1 5	Score
1	Zheng et al. (2023)	1	1	0.5	1	1	1	1	1	1	1	1	1	1	1	1	14.5
2	Tripathi et al. (2022)	1	1	1	1	1	1	1	0.5	1	1	1	1	1	1	1	14.5
3	Holzmann et al. (2020)	1	1	1	1	1	1	1	0.5	1	1	1	1	1	1	1	14.5
4	Meccawy, M (2023)	1	1	1	0.5	1	1	1	0.5	0.5	0.5	1	0.5	1	1	0.5	12
5	Alowayr, A (2022)	1	1	0.5	1	1	1	1	1	0.5	1	1	1	1	0.5	1	12.5
6	Kumar & Tandon (2024)	1	1	1	1	1	1	1	1	1	1	1	0.5	1	1	1	14.5
7	Alturki & Aldraiweesh (2022)	1	1	1	1	1	1	1	1	0.5	1	1	0.5	1	1	1	14
8	Patil & Undale (2023)	1	1	1	1	1	1	1	0.5	0.5	1	1	0.5	1	1	1	13.5

9	Xiao et al. (2024)	1	1	1	1	1	1	1	1	1	1	1	0.5	1	1	1	14.5
10	Šinko et al. (2024)	1	1	1	0.5	1	1	1	0.5	0.5	1	1	0.5	1	1	1	13
11	Çakıroğlu et al. (2022)	1	1	1	1	1	1	1	0.5	0.5	1	1	0.5	1	1	1	13.5
12	Quintana-Ordorika et al. (2024)	1	1	0.5	1	1	1	1	0.5	0.5	1	1	1	1	0.5	1	13
13	Tympa et al. (2023)	1	1	1	0.5	1	1	1	0.5	0.5	0.5	1	0.5	1	1	1	12.5
14	Huang et al. (2023)	1	1	1	1	1	1	1	0.5	1	1	1	1	0.5	1	1	14
15	El-Hamamsy et al. (2023)	1	1	1	1	1	1	1	0.5	0.5	1	1	0.5	1	1	1	13.5
16	Law et al. (2023)	1	1	1	1	1	1	1	0.5	0.5	0.5	1	1	1	1	1	13.5
17	Tusiime et al. (2022)	1	1	1	1	1	1	1	0.5	0.5	0.5	1	1	1	1	1	13.5
18	Rey-Ronquillo & Machin-Mastromatteo (2022)	1	1	1	1	1	1	1	1	0.5	0.5	1	0.5	1	1	1	12.5
19	Akram et al. (2021)	1	1	1	0.5	1	1	1	0.5	0.5	0.5	1	0.5	1	1	1	12.5
20	Jose & Jose (2024)	1	1	1	1	1	1	1	0.5	0.5	0.5	1	0.5	1	1	1	13
21	Hibszér & Tracz (2021)	1	1	1	1	1	1	1	0.5	0.5	0.5	1	0	0.5	1	1	12
22	Kabir M. R., (2020)	1	1	1	1	1	1	1	0.5	0.5	1	1	0.5	1	1	1	13.5
23	Veiga & de Andrade (2021)	1	1	1	1	1	1	1	0.5	0.5	1	1	0.5	1	1	1	13.5
	AVERAGE																13.4

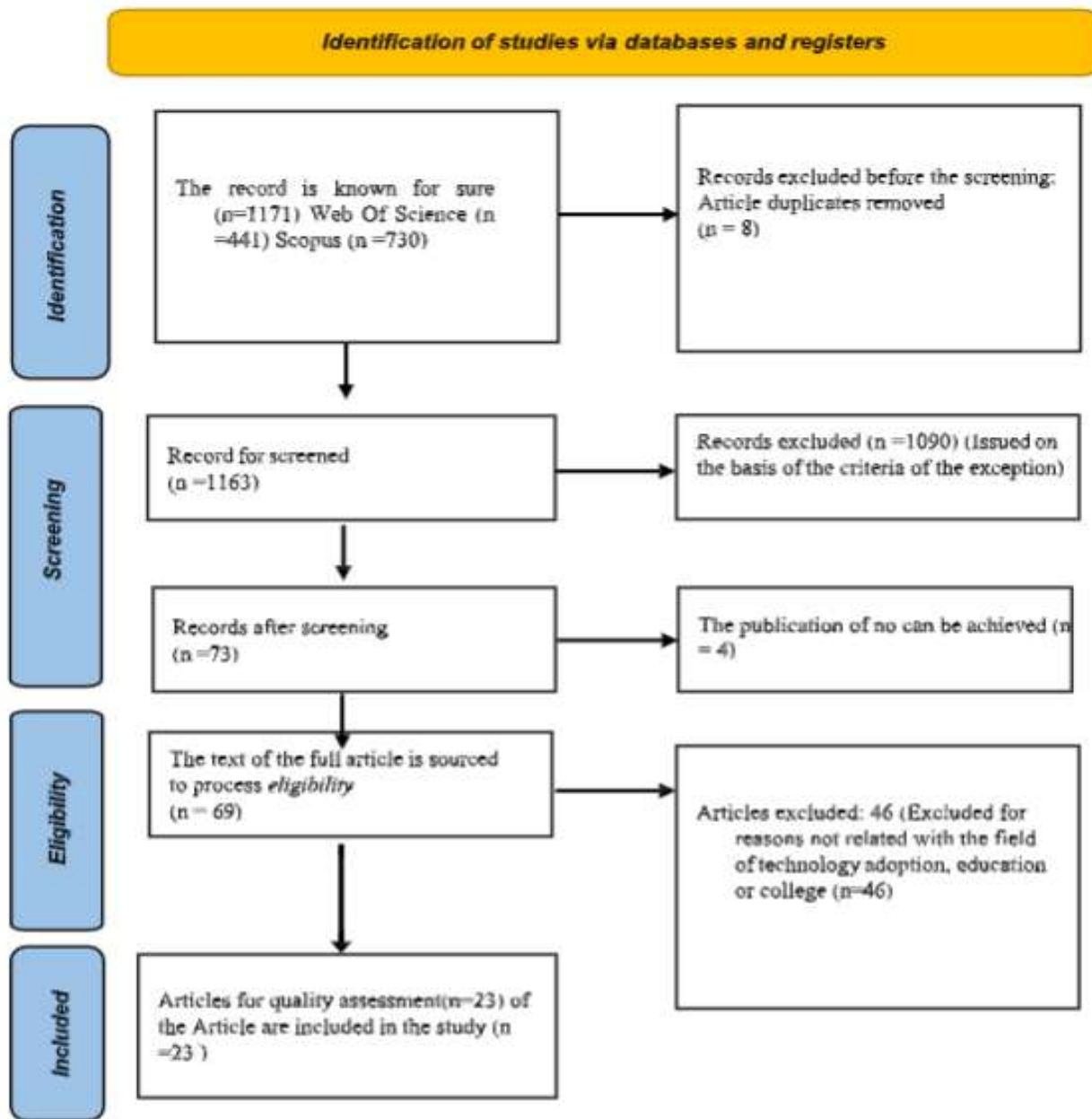


Figure 1: PRISMA systematic literature flow chart adapted from Page et al. (2021)

Data abstraction and analysis

This study employed a systematic review approach focusing on thematic analysis to identify the main themes related to the challenges and impacts of technology adoption in education. Data were extracted from articles that met the eligibility criteria by examining their titles, abstracts, findings, and discussions. The research objectives guided the data extraction process, and the extracted information was organised into tables to facilitate analysis. Thematic analysis, as outlined by Braun and Clarke (2006), was applied to identify patterns and relationships between themes. This method was deemed appropriate due to its flexible and descriptive nature, which allows researchers to organise findings in alignment with the study's objectives systematically.

FINDINGS

Challenges of technology adoption among teachers

In the rapidly evolving digital era, the adoption of technology in education has become a necessity. However, teachers face various obstacles that hinder effective integration into teaching. One major challenge is the lack of

adequate technical support and educational infrastructure. Kabir (2020) highlighted that many institutions lack proper facilities to support online learning. Law et al. (2023) noted that unstable internet connections and limited technical support further disrupt digital teaching. Insufficient training is another significant issue. Tympa et al. (2023) reported that many teachers have not received sufficient training to effectively use technology in their teaching, resulting in them being less confident and less skilled. El-Hamamsy et al. (2023) added that time constraints are a significant barrier to integrating technology into the curriculum.

The mismatch between technological content design and teaching needs is also a hindrance. Huang et al. (2023) found that e-learning platforms not explicitly designed for education can lead to unsatisfactory learning experiences. Negative attitudes towards technology can further reduce teaching quality and student engagement, as noted by Tusiime et al. (2022). A lack of experience in conducting live online lessons exacerbates these challenges, as noted by Xiao et al. (2024), who observe that inexperienced teachers struggle to deliver engaging and practical lessons. Privacy concerns are another recurring issue, with teachers worried about the safety of student data on online platforms. Law et al. (2023) also reported that reduced social interaction in online learning can negatively affect the learning experience. Limited interaction between teachers and students may lower motivation and engagement. Addressing these challenges is essential for teachers to adopt technology more effectively in their teaching.

Challenges of technology adoption among students

Students face several challenges in using technology for learning. One common issue is a lack of digital literacy. Many individuals lack the skills to utilize technology effectively, which hinders their ability to participate in online learning (Alowayr, 2022; Patil & Undale, 2023). This also affects their ability to access information and participate in online classes. Some students also feel uncomfortable with online learning. They may not be ready for this method, which can reduce their interest in joining lessons (Akram et al. 2021). This is often because online learning has less social interaction compared to face-to-face classes, which can make learning less enjoyable (Šinko et al. 2024). Poor access to the internet and devices is another problem. Students in rural areas often face unstable internet connections, making it challenging to attend online classes (Kabir, 2020; Rey-Ronquillo & Machin-Mastromatteo, 2022). Limited access to devices such as computers or tablets also stops them from joining digital lessons fully (Akram et al. 2021). Assessment in online learning can also be a challenge. For some subjects, particularly those requiring practical skills, online tests may not be effective (Holzmann et al. 2020). There are also concerns about cheating in online exams, which can cause stress for students (Akram et al. 2021). In short, while technology can help learning, students still face barriers that limit its use. Schools and universities should provide enough support to help them overcome these problems. Overall, these challenges highlight that while technology offers broad learning opportunities, students must still overcome various barriers that affect the effectiveness of adoption. Institutions must provide adequate support to help students address these issues.

Challenges in educational resources and infrastructure

Educational resources and infrastructure continue to be a significant challenge for many institutions. One of the primary concerns is the lack of technical support and insufficient facilities. Without stable resources, it is difficult for teachers and students to carry out effective teaching and learning (Tripathi et al. 2022; Law et al. 2023). Many schools do not have enough modern devices such as computers and tablets, which creates a digital gap between students in urban and rural areas (Holzmann et al. 2020). This gap affects access to information and limits student participation in digital learning (Kabir, 2020). Technical problems, such as unstable internet connections, also create barriers. Weak connectivity disrupts online classes, causing frustration among students and teachers (Alturki & Aldraiweesh, 2022; Patil & Undale, 2023). The lack of technical support for online platforms can leave teachers and students without guidance. This prevents them from entirely using the technology available (Law et al. 2023). In some cases, online platforms are not user-friendly, making it more challenging for users to navigate and utilize the tools effectively (Xiao et al. 2024). To move forward, education authorities need to invest in resources and infrastructure that support online learning. Without this, efforts to integrate technology in education will remain limited and less effective (Akram et al. 2021). A summary of these challenges is shown in Table 5.

Table 5 Challenges of technology adoption

Category	Challenges	Sources
Teachers	Lack of technical support and educational infrastructure	Tripathi et al. (2022); Law et al. (2023)
	Lack of training	Holzmann et al. (2020); Meccawy (2023); Patil & Undale (2023); Tympa et al. (2023); Law et al. (2023); Kabir (2020)
	Time constraints	El-Hamamsy et al. (2023); Alturki & Aldraiweesh (2022); Hibszer & Tracz (2021)
	Limited skills in technology integration	Zheng et al. (2023); Holzmann et al. (2020); El-Hamamsy et al. (2023)
	Technology content is not aligned with teaching needs	Meccawy (2023)
	Negative attitude towards technology	Tusiime et al. (2022)
	Limited experience in online teaching	Xiao et al. (2024); Çakıroğlu et al. (2022); Rey-Ronquillo & Machin-Mastromatteo (2022)
	Low digital literacy	Hibszer & Tracz (2021); Akram et al. (2021); Šinko et al. (2024)
	Concerns about AI, social interaction, and privacy	Meccawy (2023); Xiao et al. (2024); Šinko et al. (2024); Holzmann et al. (2020); Jose & Jose (2024)
	Uncertainty in technology use	Tripathi et al. (2022); Veiga & de Andrade (2021)
	Online assessment is perceived as less effective	Akram et al. (2021); Šinko et al. (2024)
Students	Low digital literacy	Alowayr (2022); Patil & Undale (2023); Alturki & Aldraiweesh (2022); Šinko et al. (2024)
	Lack of training	Law et al. (2023); Veiga & de Andrade (2021); Alturki & Aldraiweesh (2022)
	Low motivation	Šinko et al. (2024); Akram et al. (2021)
	Discomfort with online learning	Patil & Undale (2023)
Educational Resources and Infrastructures	Limited access to technology, devices, and a stable internet	Kabir (2020); Hibszer & Tracz (2021); Tympa et al. (2023); Akram et al. (2021); Rey-Ronquillo & Machin-Mastromatteo (2022); Holzmann et al. (2020); Tusiime et al. (2022)
	Technical problems	Alturki & Aldraiweesh (2022); Patil & Undale (2023); Šinko et al. (2024); Law et al. (2023); Kabir (2020)
	Digital divide between urban and rural areas	Kabir (2020)
	Unfriendly design of online learning platforms	Xiao et al. (2024); Huang et al. (2023)

Positive impacts of technology adoption in education

The adoption of technology in education has brought several significant benefits. One of the primary advantages is the enhancement of teaching and learning quality through the use of digital teaching tools. These tools enable teachers to present information more engagingly and interactively, thereby enhancing students' understanding (Zheng et al. 2023; Holzmann et al. 2020). Technology also provides flexibility and broader access to education at any time. Students can access online learning materials, enabling them to study at their own pace and convenience (Tympha et al. 2023; Kabir 2020). This is especially valuable in today's busy world, where students may have other commitments outside school hours.

Another positive impact is the development of digital skills among students and teachers. In the digital era, technology skills are essential for academic success and future careers. The use of technology in education helps both teachers and students strengthen these skills, making them better prepared for modern challenges (Rey-Ronquillo & Machin-Mastromatteo, 2022; Alowayr, 2022). Technology also increases student engagement and motivation. Through interactive tools and online learning platforms, students become more actively involved in the learning process, which can boost their motivation (Tusiime et al. 2022; Akram et al. 2021). This ensures that students are not only physically present but also mentally engaged.

Additionally, integrating technology into the curriculum can stimulate creativity and foster critical thinking. Tools such as 3D technology and virtual reality provide unique and immersive learning experiences, helping students better understand complex concepts (Holzmann et al. 2020; Patil & Undale 2023). Overall, the adoption of technology in education not only improves the quality of teaching and learning but also equips students with the skills necessary to succeed in an increasingly digital world. The summary of positive impacts is shown in Table 6.

Table 6 Positive impacts of technology adoption

Aspect	Impact	References
Teaching and learning quality	Improves the quality of teaching and learning	Zheng et al. (2023); Tympha et al. (2023); Akram et al. (2021); Veiga & de Andrade (2021); Holzmann et al. (2020)
Educational access and flexibility	Provides flexibility and access to education anytime and anywhere	Šinko et al. (2024); Kumar & Tandon (2024); Tympha et al. (2023); Patil & Undale (2023); Law et al. (2023); Meccawy (2023); Huang et al. (2023); Rey-Ronquillo & Machin-Mastromatteo (2022); Çakıroğlu et al. (2022); Alowayr (2022); Alturki & Aldraiweesh (2022); Veiga & de Andrade (2021); Hibszer & Tracz (2021); Kabir M.R. (2020)
Digital skills	Enhances digital skills among students and teachers	Quintana-Ordorika et al. (2024); Law et al. (2023); Tympha et al. (2023); Rey-Ronquillo & Machin-Mastromatteo (2022); Alowayr (2022); Hibszer & Tracz (2021); Akram et al. (2021)
Student engagement and motivation	Increases student engagement and motivation in learning	Jose & Jose (2024); Quintana-Ordorika et al. (2024); Kumar & Tandon (2024); Meccawy (2023); Huang et al. (2023); Tusiime et al. (2022); Alowayr (2022); Alturki & Aldraiweesh (2022); Veiga & de Andrade (2021); Akram et al. (2021)
Curriculum integration	Facilitates integration of the curriculum with modern technology	Jose & Jose (2024); Zheng et al. (2023); Akram et al. (2021)
Creativity and critical thinking	Stimulates creativity and critical thinking	Patil & Undale (2023); Holzmann et al. (2020)

Negative Impacts of technology adoption in education

Although the adoption of technology in education offers numerous benefits, it also has negative impacts that need to be considered. One common issue is student dissatisfaction with the use of technology. Some students may feel stressed when required to use new digital tools, which can reduce their overall learning experience (Alowayr 2022; Tripathi et al. 2022). Over-reliance on technology may also cause students to lose interest in more interactive traditional learning methods. Another challenge is access and the digital divide. Students in urban areas often have better access to technology compared to those in rural areas. This inequality can lead to gaps in academic achievement and learning experiences (Quintana-Ordorika et al. 2024; Tympa et al. 2023). The lack of necessary devices and internet connectivity for online learning can prevent some students from reaching their full potential. Excessive use of technology may also reduce face-to-face social interaction among students. In an increasingly digital environment, students may prefer interacting through screens rather than in person. This can affect the development of social skills and face-to-face communication abilities (Kumar & Tandon, 2024; Patil & Undale, 2023). Reduced social interaction can hurt students' emotional and social development.

Additionally, both teachers and students may feel stressed and struggle to adapt to new technologies in teaching. Learning processes involving technology require training and adjustment, which not all individuals can easily manage (Rey-Ronquillo & Machin-Mastromatteo, 2022; Tripathi et al. 2022). This stress can disrupt the teaching and learning process, making the educational experience less satisfying. Overall, while technology has the potential to improve education, negative impacts such as student dissatisfaction, the digital divide, reduced social interaction, and adaptation stress need to be addressed to ensure effective technology adoption. A summary of these negative impacts is presented in Table 7.

Table 7 Negative impacts of technology adoption

Aspect	Impact	Articles
Negative Impact	Reduced quality of teaching and learning due to a lack of infrastructure and support	Law et al. (2023); Tusiime et al. (2022); Akram et al. (2021)
	Student dissatisfaction and over-reliance on technology	Quintana-Ordorika et al. (2024); Huang et al. (2023); Alowayr (2022); Tripathi et al. (2022)
	Access issues and the digital gap	Quintana-Ordorika et al. (2024); Tympa et al. (2023); Law et al. (2023); Hibszer & Tracz (2021)
	Reduced social interaction and weaknesses in online assessment systems (students cheating in exams)	Kumar & Tandon (2024); Šinko et al. (2024); Tympa et al. (2023); Huang et al. (2023); Law et al. (2023); Patil & Undale (2023); Çakıroğlu et al. (2022); Akram et al. (2021)
	Stress in adapting to new technology	Kumar & Tandon (2024); Šinko et al. (2024); Rey-Ronquillo & Machin-Mastromatteo (2022); Tripathi et al. (2022); Alturki & Aldraiweesh (2022); Veiga & de Andrade (2021)

DISCUSSION

The analysis showed that the main challenges of technology adoption in education are the lack of digital skills among both teachers and students. As reported by Law et al. (2023) and Tripathi et al. (2022), this limitation not only hinders the effective use of technological tools in the classroom but also creates stress among teachers, which subsequently lowers teaching quality and affects students' motivation. Rey-Ronquillo and Machin-Mastromatteo (2022) also emphasised that structured training and continuous support are essential to improve teachers' technological competence. This challenge is closely linked to the negative impacts shown in Table 7, where the pressure of adapting to new technology often acts as a barrier to effective teaching. In addition, the digital divide between students in urban and rural areas remains a significant concern. Studies by Quintana-

Ordorika et al. (2024) and Tympa et al. (2023) suggest that disparities in access to devices and the internet directly lead to gaps in academic achievement. This finding supports Kabir (2020), who highlighted that such disparities reduce fairness and equity in learning opportunities. These results underscore the need for policy interventions to enhance technology infrastructure in underserved areas. External factors, such as family and community support, may also influence technology adoption. Students with limited access to supportive environments may continue to face disadvantages despite institutional or governmental investment in infrastructure.

The challenges of the digital divide and insufficient digital skills are interconnected, creating a compounded negative effect on educational outcomes. The digital divide establishes an initial barrier, as students in underserved areas lack reliable access to technology and the internet. This disadvantage is intensified when both educators and learners lack the necessary skills to use technological tools effectively, hindering meaningful learning. Consequently, students facing this dual burden of limited access and inadequate support are at a higher risk of lower academic achievement and engagement. These factors collectively exacerbate existing educational inequalities, underscoring the necessity for integrated solutions that address both infrastructure and digital literacy training. This causal relationship suggests that technology adoption cannot be effective without simultaneously addressing both access and competence. Despite these challenges, the analysis also confirms several positive impacts of technology adoption. For example, the findings in Table 6 indicate improvements in teaching and learning quality (Zheng et al. 2023; Holzmänn et al. 2020) and increased flexibility in accessing education (Šinko et al. 2024; Kumar & Tandon, 2024). This is consistent with Veiga and de Andrade (2021), who argued that technology broadens access to educational resources and enables learning without restrictions of location or time. Furthermore, increased student engagement and motivation through the use of interactive tools and digital platforms have been reported by Tusiime et al. (2022) and Akram et al. (2021). These results support the assertion by Jose and Jose (2024) that integrating technology into the curriculum can stimulate students' creativity and critical thinking. However, risks such as reduced social interaction and challenges to online assessment integrity (Kumar & Tandon, 2024; Šinko et al. 2024) must still be addressed to ensure overall learning effectiveness. It should also be recognized that studies reporting positive outcomes are more frequently published, which raises the possibility that publication bias may influence the overall evidence base. Therefore, the findings of this review should be interpreted with caution, as challenges may be underrepresented.

To strengthen the generalisability of findings, future research should include a broader range of studies conducted across diverse geographical contexts, especially in developing countries where educational and technological conditions differ. In addition, longitudinal studies are necessary to capture the long-term effects of technology adoption, providing more profound insights into how benefits and challenges evolve. Future investigations should also consider the influence of external factors, such as family and community support, to provide a more holistic understanding of the technology adoption process and its effectiveness in enhancing learning outcomes.

This study has several limitations. It focused only on articles indexed in Scopus and Web of Science (WoS), potentially excluding relevant research from other databases or grey literature. Most included studies had a limited geographical scope, which reduced generalizability, especially for developing countries. Publication bias is also a concern, as positive results are more likely to be published, potentially skewing the evidence. Additionally, the lack of longitudinal studies hinders our understanding of the long-term impacts. Finally, external factors such as family and community support were not examined. Future studies should broaden coverage, include diverse contexts, adopt longitudinal designs, and address these external influences.

CONCLUSION

This systematic literature review examined the challenges and impacts of technology adoption in education, synthesising evidence from 23 high-quality studies. The findings highlight persistent barriers, including limited digital skills, inadequate infrastructure, and the digital divide, which often lead to unequal learning outcomes and increased stress for both teachers and students. At the same time, technology adoption demonstrates clear benefits, including improved teaching quality, greater learning flexibility, and enhanced student engagement when supported by proper training and resources. These outcomes underscore the dual nature of digital transformation as it creates opportunities while also amplifying inequalities if left unaddressed. To maximise

effectiveness, technology integration should be accompanied by continuous teacher development, equitable access to infrastructure, and the inclusion of family and community support.

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