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# Teachers and Students Perception of Technology and Sustainable Adoption Framework in the Pedagogical Process: A Systematic Review

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**Abstract.** The adoption of technology remains a persistent challenge, but it is an essential endeavour in the pursuit of fostering inclusivity, equity, and a steadfast commitment to providing high-quality learning opportunities for all. This study conducts a systematic review to explore how teachers and students perceive the role of technology in the classroom. It also investigates the key factors that influence teachers' perceptions of technology and the barriers they encounter when adopting technology in the pedagogical process. Following the preferred reporting items for systematic reviews and meta-analyses (PRISMA) guideline, reputable databases were thoroughly examined, including Google Scholar, Semantic Scholar, Web of Science, and Scopus. The search identified 83 relevant publications spanning the years 2010 to 2023. After a comprehensive evaluation, we identified 41 publications most relevant to the study. The study revealed that both teachers and students view technology as a valuable tool to improve the quality of learning and encourage active participation in the classroom. The findings also uncovered the key factors influencing students' and teachers' technology perceptions in education and highlighted the barriers to technology adoption in the pedagogical process. A sustainable framework was provided to ensure the sustainability of technology in the pedagogical process.

**Keywords:** Educational technology; pedagogical process; perception of technology; meta-analysis

## 1. Introduction

The core objective of the 2030 Agenda for Sustainable Development of the United Nations is to prioritise the enhancement of quality education, ultimately ensuring an equitable, inclusive, and high-quality educational experience for everyone (UN, 2016). Amidst the backdrop of a digital age marked by rapid technological advancements and transformation, the educational landscape is undergoing a profound evolution. Traditional classrooms are turning into dynamic hubs of learning, and the integration of technology into the pedagogical process is leading this educational revolution. Haleem et al. (2022) noted that conventional classroom methods fall short in providing immediate learning environments, quicker evaluations, and increased engagement, all of which are areas where technology plays a pivotal role. Technology is ubiquitous and intertwined in many aspects of modern life and society. The global digital revolution has started to seep into the field of education. Since technology is quickly changing the way students learn, it is anticipated that it will enhance education by making it more affordable and accessible (Cañas et al., 2003; Jalil et al., 2023; Olujuwon et al., 2021).

Due to the widespread use of technology in teaching, learning, and evaluation, education has undergone significant transformation, as posited by Dwivedi et al. (2022), Salim et al. (2023), and Jimoh et al. (2020). In the 21st century, technology has developed into a vital tool that influences how people engage in the political sphere, corporate community, and knowledge sector. Technology has become not merely a supplementary tool but an integral component, shaping teaching and learning experiences for both teachers and students, opening the road for AI-based adaptive learning systems and giving educational providers additional financial possibilities (Kabudi et al., 2021).

### 1.1 ICT in Pedagogical Process

Information and communication technology (ICT) in pedagogical process refers to the strategic integration of technology within the field of education to enhance teaching and learning processes. According to Grassini (2023), ICT has drastically changed the pedagogical process, changing how teachers instruct and the way students are taught. Computers, tablets, and instructional software are examples of ICT resources that are utilised to create dynamic and captivating learning environments (DeCoito & Estaiteyeh, 2022).

The adoption of ICT has changed students' roles from passive recipients of knowledge to active creators of knowledge (Abedi, 2023). ICT has also made it easier for teachers to collaborate with each other by enabling them to interact with subject matter experts, access resources from around the world, and provide students with access to superior instructional materials (Louw, 2017). However, students are less likely to participate in collaborative learning despite having access to a wealth of teaching and learning resources; this could be because they interact and discuss less than in typical classroom settings (Dumford & Miller, 2018).

ICT tools and resources, according to Fernández-Batanero et al. (2022), support inclusive learning by facilitating personalised learning experiences, allowing for a variety of learning styles, offering accessibility features for students with disabilities, and empowering teachers to adapt instruction to each student's specific needs. This has improved teachers' efficacy in providing high-quality education by making it easier for students to understand and engage with the material, regardless of their learning profiles (Iriyani et al., 2022; Mwei, 2020).

## 1.2 Rationale of the Study

As posited by Lewin et al. (2019), technology affects society profoundly, especially in the area of education, and it also has an impact on how the public views educational institutions and how they change the educational sector over time. The relationship between teachers and technology has deepened (Phoon et al., 2021; Trujillo-Torres et al., 2020), so it is imperative to understand the perception of teachers and students regarding technology in the educational context. This comprehension is vital for identifying strategies to enhance teachers' ICT skills, improve professional development programmes, reform pedagogical approaches, and develop suitable technologies and courseware to fill the gap in the pedagogical process. This systematic review is designed to investigate the fundamental factors that shape teachers' perceptions of technology in education and aims to establish a sustainable framework for the integration of technology in the pedagogical process. Through this study, we intend to uncover insights that can facilitate a more informed approach to technology adoption and long-term success in educational settings. To achieve this objective, the following research questions acted as our guidelines.

1. How do teachers and students perceive the role of technology in the classroom?
2. What are the key factors that shape teachers' and students' perceptions of technology in education?
3. What are the barriers to adopting technology in the educational process?
4. Which sustainable framework can guarantee the adoption and ensure the long-term success of technology integration in the pedagogical process?

## 1.3 ICT Adoption Model

According to Granić (2022), and Mohammad & Mohamad (2022), technology acceptance and adoption theories and models are frequently utilised to inform research in the educational environment since education is an area of significant interest in absorbing new technologies. A wide range of prospective users of different technologies that are incorporated in the teaching, learning, and assessment processes describe this kind of setting. Several highly prominent theoretical frameworks include the following (arranged chronologically with pertinent illustrative research examples):

- Concern-based adoption model (CBAM) is used to assess curriculum changes by concentrating on how people behave and react to these changes (Hall & Hord, 2016). This approach suggests that the interests, concerns, and requirements of teachers are primarily linked to their professional development with relation to technology integration. The CBAM is highly regarded in the field of educational research for its effectiveness in empowering participants to recognise educational

innovations. This acclaim is due to its emphasis on addressing individuals' concerns regarding the adoption of innovative practices, as noted by Alghamdi (2020).

- The integrated model of technology adoption (IMTA), which Alghamdi (2020) introduced, was based on Beauchamp's model (2004). The IMTA model is a good tool to classify teachers' levels of proficiency in utilising educational technologies in the classroom.
- The technology acceptance model (TAM) (Davis, 1986, 1989) is a reputable and trustworthy model covering a variety of developments in the educational context and was created for the research of new educational technology. These technologies include virtual reality (Lemay et al., 2018), teaching assistance robots (Park & Kwon, 2016), social media platforms (Yu, 2020), and simulators (Jang et al., 2021).
- The technological pedagogical content knowledge theory states that the use of technology has a big impact on how content is delivered (Koehler and Mishra, 2005). The dynamic interaction between technology and topic structure shapes the examples used in instruction (Koehler & Mishra, 2005; Bielefeldt, 2012). Furthermore, the teacher's expertise in the subject matter influences the approach and technologies they select. Since the integration of technology, content, and pedagogy is crucial, the use of technology and the particular subject being taught depend on the teacher's understanding of pedagogy (Zimlich, 2015). Accordingly, when content, proper pedagogical techniques, and technology deployment are all in harmony, as per Koehler and Mishra's (2005) technological pedagogical content knowledge hypothesis, this is when technology is used most effectively.

## 2. Research Methodology

This section elaborates on the research approach employed in this study. The research design adopted is a systematic review (Bamiro et al., 2023; Komalasari et al., 2023), and the methodology follows a qualitative approach, with the intention of covering representative material from reputable publications, while also filtering and limiting the search. This systematic review's study focus has been on understanding the most widely accepted and utilised theoretical models, as well as the most important determinants of the different technologies employed in the educational system. The following sections address the many phases that make up the research scope.

### 2.1 Article Selection

#### 2.1.1 Initial Pooling

The databases Google Scholar, Semantic Scholar, Web of Science, and Scopus provided the first collection of articles for this systematic study. Relevant phrases associated with the Boolean operators "OR" and "AND" were used in the search, specifically "teachers" AND "students"; "theory" OR "model"; AND ("technology") AND ("adoption" OR "acceptance"). The operator "AND" was used to combine the search terms with the previously specified ones in order to find research that was about education. For example, the search term "technology" was used to look for literature that included the words "technology"

and “technologies.” The truncation was used to cover all permutations of specific keywords.

Studies with the provided search phrases included in the publication title were found using the ‘TITLE’ filter. Additionally, a forward and backward snowballing technique was used on the original set of journal articles. In a literature review, the snowball approach is a strategy for finding more publications based on the present article’s citations and reference list (Wohlin, 2014). For the present study, to lower the possibility of overlooking pertinent research, papers were searched in the reference list and cited articles. The sources (reference section) of journal papers that have made any contribution to the field of online learning were examined using the backward snowball method. In contrast, the forward snowballing strategy looks for contributions in the field of education technology by looking through the articles that cite the journal article under investigation.

### 2.1.2 Inclusion Phase

The first pool of research publications was subjected to the inclusion criteria. To make sure that every article downloaded aligned with our research objective, we reviewed every research article in the initial pool. The articles considered for inclusion were English language articles; we did not exclude any country as this is global research; and the year was open, although we ensured that the articles considered were not more than a decade ago, which helped us to get the latest articles.

### 2.1.3 Exclusion Phase

At the exclusion phase, the titles and abstracts of the journal articles were reviewed to determine whether the articles selected were suitable for our review. At this stage, only articles that met all the criteria were selected for review. Books, book series, book chapters, conference, proceedings, and non-English language articles were all excluded.

**Table 1: Inclusion and exclusion table**

Criterion	Inclusion	Exclusion	Database	Articles Included
<b>Types of Literature</b>	Research articles	Conference proceedings, chapter in a book, books	Google Scholar	21
<b>Language Choice</b>	English language	Other languages	Semantic Scholar	3
<b>Time Range</b>	2010–2023	2009 and earlier	Web of Science	10
<b>Articles Scope</b>	Articles concerning with level of education, and scope including concept and population	Articles not related to education	Scopus	7
<b>Country</b>	Global			

### 2.1.4 Final Pool

Every research article from the initial pool was incorporated into the final selection, with exclusions made based on predefined inclusion/exclusion criteria. The data extraction shown in Table 2 details the major journals included in the final pool. Figure 1 illustrates the analysis of reviewed articles, categorising them according to the applied inclusion and exclusion criteria.

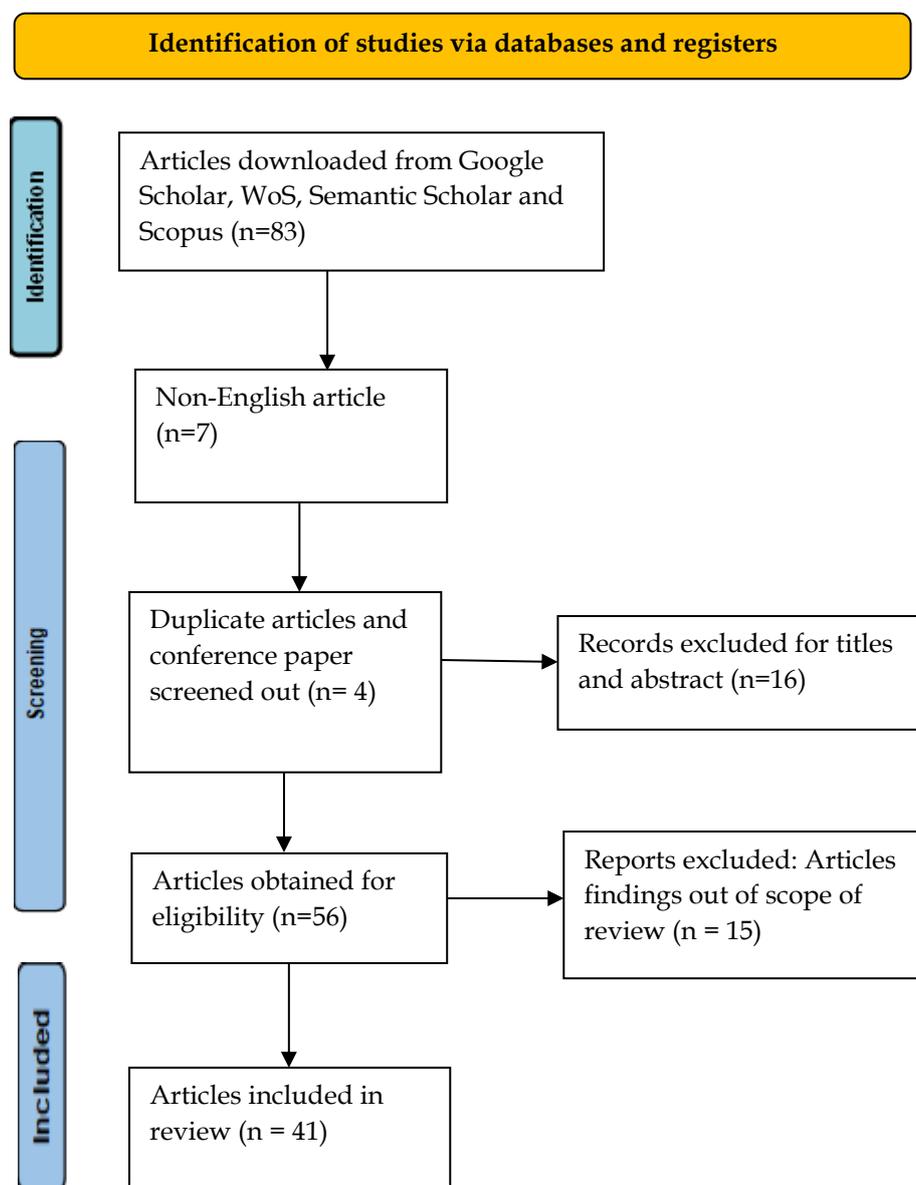


Figure 1: PRISMA flow chart

### 3. Data Extraction Table and Analysis

Table 2 shows the publications that align with the objectives of this study. Additionally, the data has been analysed to retrieve the following information: authors' names, publication year, research methodology, country, research findings, and journal titles.

Table 2: Data extraction table

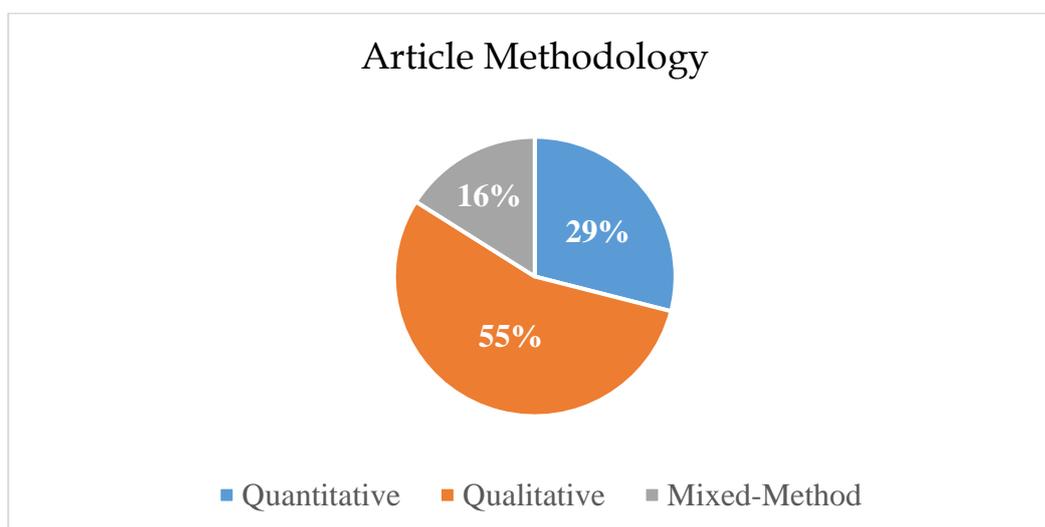
S/N	Authors & Year	Country	Method	Insight	Journal
1	Gerez (2019)	USA	Qualitative	Teachers and students perceive technology as an effective tool for increasing student engagement and improving teaching and learning practices in the classroom.	<i>Educational Leadership</i>
2	DeCoito and Richardson (2018)	Canada	Mixed Method	According to this study, educators saw technology more as a tool than as a seamless component of instruction.	<i>Contemporary Issues in Technology and Teacher Education</i>
3	Domingo and Gargante (2016)	Spain	Qualitative	The findings indicate that teachers' perceptions of how technology improves learning are connected to their choice of applications.	<i>Computers in Human Behavior</i>
4	Muthuprasad et al. (2021)	India	Mixed Method	The study showed that, following the coronavirus, the majority of students had a favourable attitude toward taking lessons online.	<i>Social Sciences &amp; Humanities Open</i>
5	Zimlich (2015)	USA	Mixed Method	The research's conclusions show that factors such as teacher attitudes and expertise have an impact on how educational technology is used with pupils.	<i>Journal of Information Technology Education: Innovations in Practice</i>
6	Hartman et al. (2019)	USA	Qualitative	Teachers believe that technology improves learning.	<i>Journal of Research in Innovative Teaching &amp; Learning</i>
7	Ohlin (2019)	Sweden	Qualitative	Technology is seen as a tool by both teachers and students to improve learning and participation in the classroom.	<i>Social Sciences and Technology</i>
8	Harper (2018)	USA	Qualitative	Teachers see technology as a tool that encourages teachers and students to work together on learning activities.	<i>Journal of Research on Technology in Education</i>
9	Vatsadze (2022)	Georgia	Qualitative	Teachers and students perceive technology as invaluable resources in the classroom.	<i>Language and Culture</i>
10	Harvil (2018)	USA	Qualitative	Teachers view technology as a universal strategy to use with all students	<i>Liberty University</i>
11	Fletcher et al. (2019)	New Zealand	Mixed Method	Most teachers and students view technology in the classroom favourably, but they still place a higher priority on the efficiency of educators and their instructional methods.	<i>New Zealand Journal of Educational Studies</i>
12	Emre (2019)	USA	Qualitative	The results showed that successful technology use and its integration into the curriculum are important determinants of teachers' perceptions of technology in the classroom.	<i>Contemporary Educational Technology</i>
13	Siyam (2019)	UAE	Quantitative	Training, institutional support, and pedagogical beliefs are factors shaping teachers' perception of technology	<i>Education and Information Technologies</i>
14	Dogan et al. (2021)	Finland, USA	Quantitative	Teachers' perceived technical abilities, confidence in using technology, and views about using it are the main elements influencing how they view technology in the classroom.	<i>Education and Information Technologies</i>
15	Peled and Perzon (2021)	Israel	Qualitative	School administration support, previous technology use, and level of experience in the classroom are the main factors that impact teachers' perceptions of technology in education.	<i>Education and Information Technologies</i>
16	Alberola-Mulet et al. (2021)	Spain	Qualitative	Teachers' perceptions of technology in education are shaped by their beliefs about its usefulness and ease of use.	<i>Education Sciences</i>
17	Trujillo-Torres et al. (2020)	Spain	Quantitative	The primary factors that influence teachers' perspectives on the use of technology in the classroom are digital self-efficacy, perceived school support, attitude, perception, gender, and experience.	<i>MDPI</i>
18	Badia et al. (2014)	Spain	Quantitative	Teachers' perceptions of technology are most influenced by their field of study, level of digital	<i>Procedia-Social and Behavioral Sciences</i>

				literacy, ICT training, and frequency of Internet use.	
19	Liu et al. (2018)	China, USA	Quantitative	The usefulness and ease of use of ICT are seen as factors that shape teacher perceptions.	<i>Journal of Educational Computing Research</i>
20	Nordlöf et al. (2019)	Sweden	Qualitative	Experience, education, and interest are factors that shape the perception of technology	<i>International Journal of Technology and Design Education</i>
21	Akram et al. (2022)	China, Saudi Arabia, Jordan, Pakistan	Qualitative	According to this study, the challenges to technology adoption in the pedagogical process were the slow internet speed, load shedding, lack of infrastructure, lack of experience with online teaching, and training.	<i>Frontiers In Psychology</i>
22	Francom (2019)	USA	Quantitative	The findings show that barriers to the adoption of technology in the pedagogical process are access, time, administrative support, training and technical support, and teachers' beliefs.	<i>Journal of Research on Technology in Education</i>
23	Hsu (2016)	USA	Mixed Method	This study views the following as barriers: instructors' lack of computer literacy; lack of technology training; lack of time for implementing technology-integrated education; and lack of technical support.	<i>TechTrends</i>
24	Johnson et al. (2016)	USA	Qualitative	The findings show that barriers to technology adoption in the pedagogical process are access, inadequate training, support, teachers' attitudes and beliefs, teachers' resistance and the knowledge and skills of teachers.	<i>Adaptive Educational Technologies for Literacy Instruction</i>
25	Francom (2016)	USA	Quantitative	Access to technology tools and resources, technological training and support, administrative support, time to plan and prepare for technology integration, and attitudes regarding the significance and usefulness of technology tools and resources are among the barriers to technology adoption in the pedagogical process.	<i>Journal of Information Technology Education: Research</i>
26	Dassa and Vaughn (2018)	USA	Qualitative	The distractions caused by social networks and the struggle to integrate technology effectively are barriers to the adoption of technology in the pedagogical process.	<i>A Journal of Educational Strategies, Issues and Ideas</i>
27	Mas'od et al. (2013)	Malaysia	Quantitative	Most teachers are highly motivated and have positive attitudes toward using instructional technology in the classroom.	<i>ISQA</i>
28	Granić (2022)	Croatia	Qualitative	The most common predictors of the adoption of educational technology were anxiety, system accessibility, and technical complexity.	<i>Education and Information Technologies</i>
29	Kim and Jang (2020)	South Korea	Quantitative	Teachers experience positive change in the classroom.	<i>Sustainability</i>
30	Rudhumbu et al. (2021)	South Africa	Quantitative	Lack of technology training, inadequate resources, internet cost and speed of internet connectivity are barriers to adoption of technology in the pedagogical process.	<i>International Journal of Learning, Teaching, and Educational Research</i>
31	Ng and Yunus (2021).	Malaysia	Mixed Method	Barriers to technology in the pedagogical process include a lack of basic technology infrastructure and facilities, teachers' attitudes, students' participation, and parents' abilities.	<i>Creative Education</i>
32	Romero et al. (2019).	Chile	Qualitative	Technology resources, training, internet connection, and platform operation are the barriers to technology adoption in the pedagogical process	<i>Digital Education Review</i>
33	Koh et al. (2022)	Singapore, Canada	Qualitative	Competency and autonomy, user attitudes, and environmental conditions are factors that shape teachers' perceptions of technology in education.	<i>European Physical Education Review</i>
34	Mwei (2020)	Kenya	Quantitative	The results show that voluntariness and computer experience influenced instructors' opinions of elements that affect ICT integration for educational objectives.	<i>International Journal of Educational Technology and Learning</i>

35	Hechter et al. (2012)	Australia	Qualitative	The TPCK framework, which includes the role of context, offers a sustainable approach to technology integration in education.	<i>Education Research and Perspectives,</i>
36	Hsu and Sharma (2010)	USA	Qualitative	The paper proposes a framework that includes people, process activities, and systems to maintain technology integration in educational settings	<i>World Future Review</i>
37	Leite and Lagstedt (2021)	Finland	Qualitative	The paper proposes the collective integration of technology (CIT) model as a sustainable framework for technology integration in the pedagogical process.	<i>International Journal of Education and Development using Information and Communication Technology.</i>
38	García-Hernández et al. (2022)	Spain	Qualitative	The evaluation of technology promotes the sustainability and effectiveness of technology in the pedagogical process.	<i>Education Science</i>
39	Sánchez-Prieto et al. (2017)	Spain	Qualitative	The results indicate that the TAM model is a valuable instrument for examining the variables motivating educators to employ a certain technology.	<i>Research Institute for Educational Sciences</i>
40	El-Hamamsy et al. (2023)	Switzerland	Quantitative	The results validate that the curriculum reform model for digital education fosters positive self-efficacy in advancing digital education.	<i>Educational and Information Technologies</i>
41	Rafi et al. (2019)	China	Qualitative	The study findings disclosed that student digital exposure aid technology sustainability in education	<i>Information Discovery and Delivery</i>

### 3.1 Analysis for Methodology Description

The analysis for methodology description intends to show the analysis of the methodology adopted in all the articles that were used for this systematic review. The analysis shows that 55% of the articles use the qualitative method ( $n = 21$ ), 29% use the quantitative method, and 16% of the articles use the mixed-method, which is the combination of both qualitative and quantitative methods. These percentages represent 11 papers and 6 papers respectively, as shown in Figure 2.



**Figure 2: Methodology analysis**

### 3.2 Year of Publication

The chart of Figure 3 shows how the articles are distributed by year, and that the majority of the articles are from the year 2019, followed by 2021 and 2018.

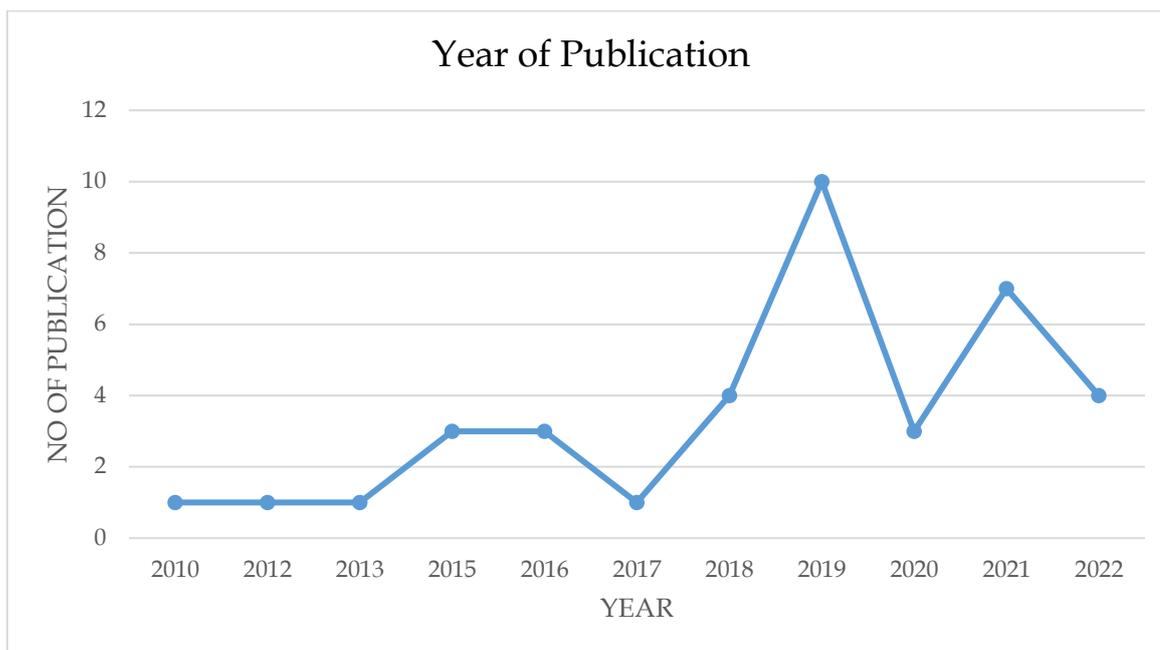


Figure 3: Distribution of publications by year

### 3.3 Research Country Affiliation

It is evident that academics from around the globe are curious about how educators and learners view technology and the framework for sustainable use in the classroom, as shown in Figure 4. The USA accounted for the majority of the identified studies ( $N = 15$ ), with relevant research from Spain coming in second ( $N = 4$ ). Canada, China, Sweden, Finland, and Malaysia each contributed two studies ( $N = 2$ ), and the remaining countries (listed in alphabetical order) only had one study piloted. These countries include Australia, Chile, Croatia, Georgia, India, Israel, Jordan, Kenya, New Zealand, Pakistan, Saudi Arabia, Singapore, South Africa, South Korea, and UAE.

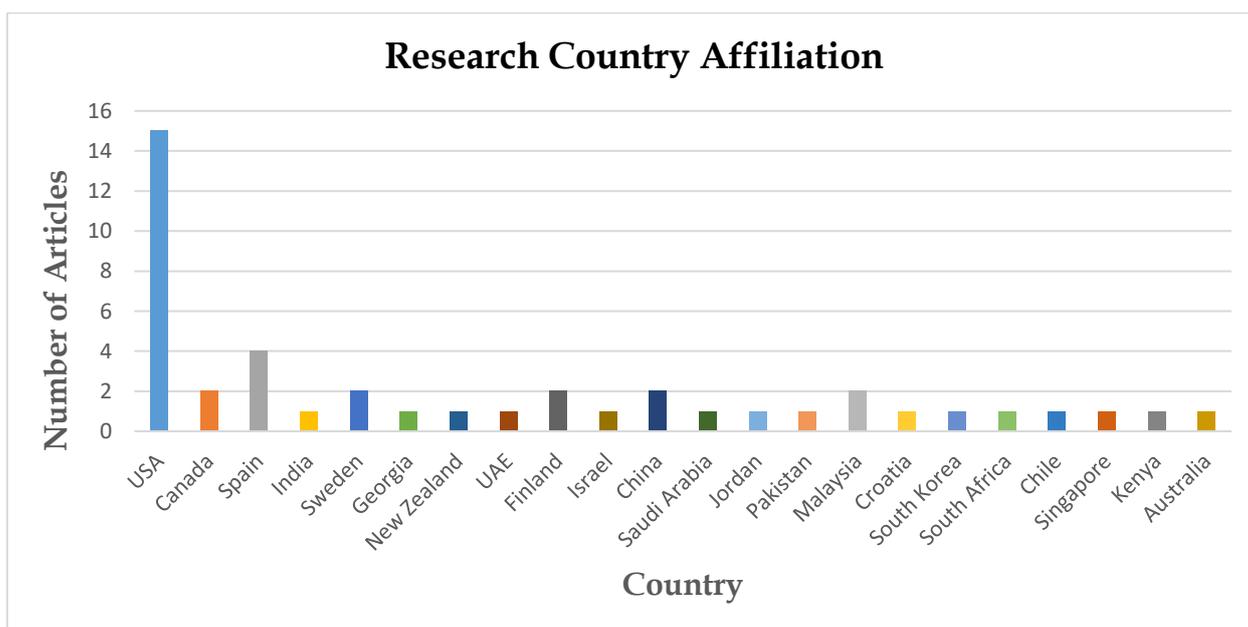


Figure 4: Articles by country

### 3.4 Authors' Country Affiliation

The authors, by country affiliation, are shown in Figure 5.

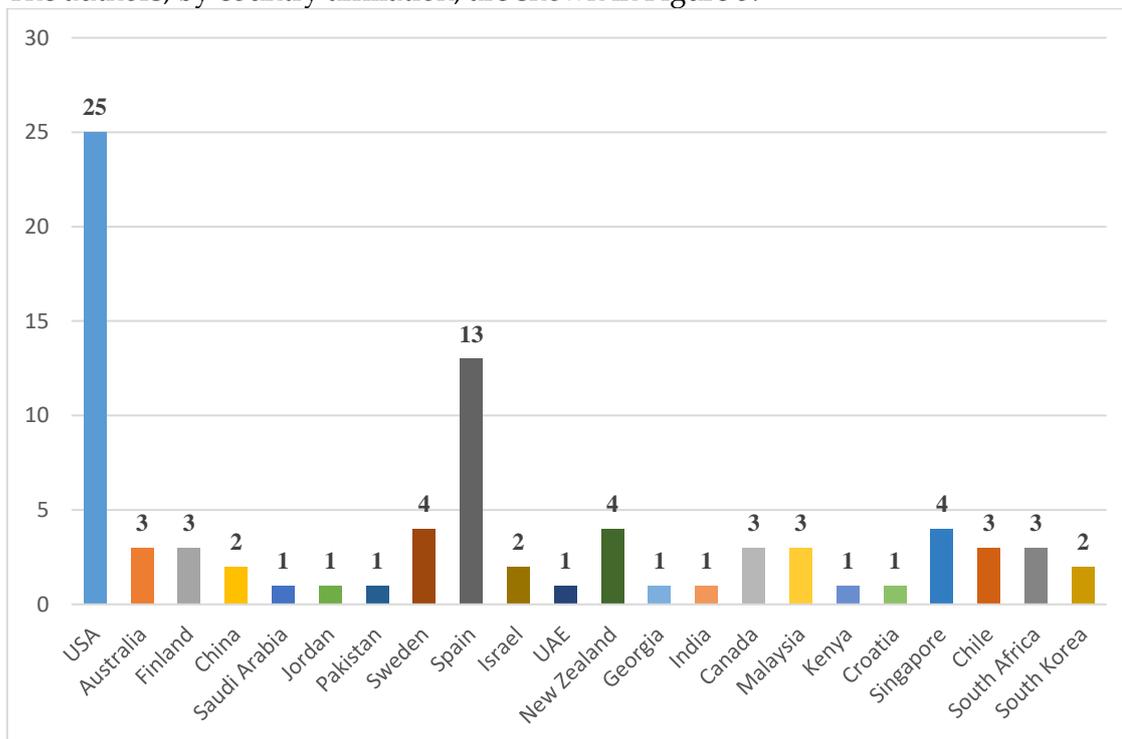


Figure 5: Author's country affiliation

### 3.5 Contribution by Continent

The study showed a global reach that spans all continents, with North America emerging as the main contributor in terms of percentage share, leading with 40% (N=17), followed by Asia 27% (N=12), Europe contributed 24% (N=10), Oceanic and Africa both had 4%, respectively (N=2) and South America contributed the least with 2% (N=1).

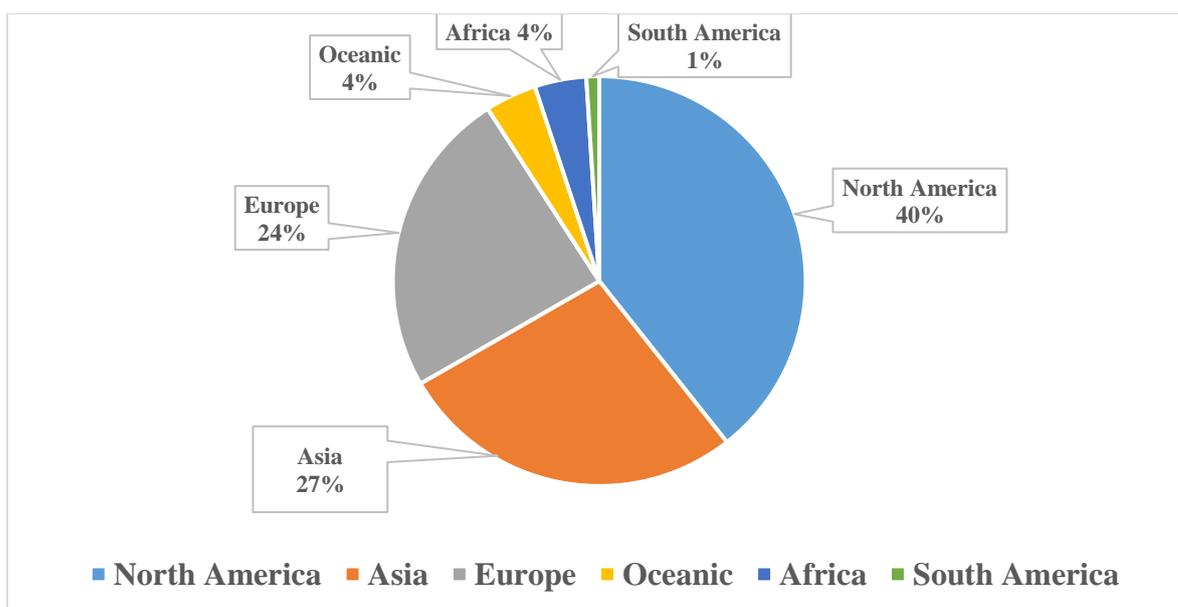


Figure 6: Contribution by continent

### 3.6 Analysis of articles in developed and developing countries

We classified the research papers according to the developmental status of the countries involved. This delineates the degree of participation of both developed and developing nations in the subject matter we investigated. It is noteworthy that developing countries accounted for 64% of the total contributions, whereas developed countries comprised of 36%. However, it is also worth highlighting that, despite having a greater number of countries among the developing nations, the developed countries contributed a higher percentage of papers, with 66% (N=29) compared to 34% (N=15) from developing countries in terms of the number of articles.

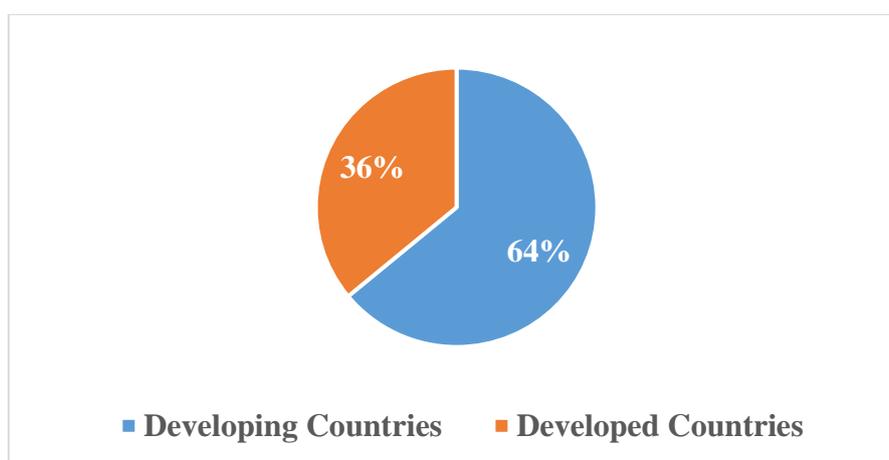


Figure 7: Articles in developed and developing countries

## 4. Results and discussion

### Research Question 1: How do teachers and students perceive the role of technology in the classroom?

Teachers and students perceive the role of technology in the classroom in various ways (Gerez, 2019). Teachers see technology as a useful tool for boosting student engagement and enhancing teaching and learning methods in the classroom.

When integrating technology in their teaching practices, the majority of teachers reported good levels of student engagement, according to this study's results. This aligns with the insights presented by Domingo and Gargante (2016); the findings indicate that teachers believe that technology plays a crucial role in improving access to information, offering innovative avenues for learning, and fostering higher levels of engagement within the learning process. Also, Hartman et al. (2019) reported that teachers hold the belief that technology has a positive impact on enhancing the learning experience.

Based on the research conducted by Harper (2018), it was found that teachers regard technology as a facilitative tool that promotes collaboration between educators and students in engaging learning activities in the classroom. DeCoito and Richardson (2018) indicated that teachers view technology as a classroom tool for learning process, while in the research conducted by Harvil (2018), teachers

held the perspective that technology served as a universal strategy applicable to all students, regardless of individual differences or needs.

Teachers exhibit high motivation and maintain positive attitudes when it comes to integrating instructional technology into their classroom practices (Kim & Jang 2020; Mas'od et al., 2013). Muthuprasad et al. (2021) viewed student perception regarding technology in the classroom and found that the students exhibited a notably positive attitude and receptivity toward participating in online classes, reflecting a strong inclination for this mode of education.

In Ohlin's (2019) analysis, both teachers and students were the subjects of examination regarding their perceptions. The study revealed a unanimous perspective among teachers and students, emphasising technology as a valuable tool to enhance learning quality and promote active participation in the classroom. Both Fletcher et al. (2019) and Vatsadze (2022) found a prevailing positive view of technology among teachers and students, underscoring its perceived value within the classroom environment.

The consensus is that technology has the potential to enhance student engagement, encourage collaboration, and provide access to a diverse array of educational resources, a sentiment shared by both teachers and students.

### **Research Question 2: What are the key factors shaping teachers' and students' perceptions of technology in education?**

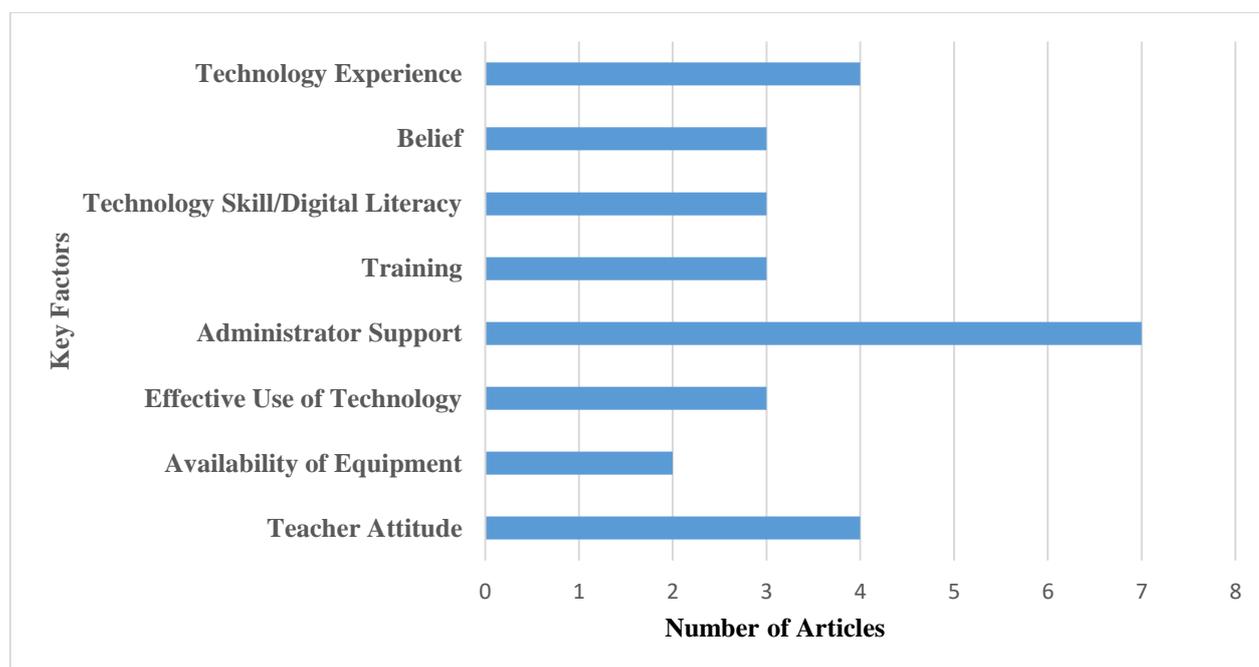
Several important factors influence how teachers view the use of technology in the classroom. According to the findings of Zimlich's (2015) research, the usage of educational technology is influenced by a number of elements, including teacher attitudes, expertise, the availability of equipment and support, and pedagogical judgments linked to technology integration. Emre (2019) mentioned that the main elements influencing teachers' perceptions of technology in education are efficient use of technology, incorporating it into the course curriculum, boosting engagement, visualising the material, collaborating with administrators to integrate technology, and being able to instruct using technology.

Siyam (2019) also suggested that teachers' perceptions of technology are shaped by several factors, notably including training, institutional support, and pedagogical beliefs. According to the findings of Dogan et al. (2021), teachers' perceived technological skills, their level of comfort using it, and their attitudes on it as a whole were shown to be the most important factors affecting how they use technology. In other words, teachers are more likely to include technology in their pedagogical process when they feel comfortable using it. This is supported by the research conducted by Peled and Perzon (2021). It was discovered that support from the school administration, prior technological experience, and level of classroom teaching expertise are the key factors in teachers' perceptions of technology in education.

Trujillo-Torres et al. (2020) also mentioned that the main factors that influence how teachers perceive the use of technology in the education sector include factors such as digital self-efficacy, perceived school support, attitude, perception,

gender, and the teachers' level of experience. Digital literacy, the subject of study, ICT training, and how frequently one accesses the Internet were found to be the main factors in teachers' perceptions of technology in education (Badia et al., 2014).

According to Liu et al. (2018), teachers' perceptions are significantly shaped by their perceptions of the perceived ease of use and utility of technology while Nordlöf et al. (2019) mentioned experience, level of education and teachers' interest in technology as key factors shaping teachers' perceptions of technology in education. Figure 8 gives these results of the key factors shaping teachers' perceptions of technology in education.



**Figure 8: The key factors shaping teachers' perceptions of technology in education**

### **Research Question 3: What are the barriers to the adoption of technology in the pedagogical process?**

There are several barriers to technology adoption in the pedagogical process. According to Romero et al. (2019), barriers to technology adoption and the pedagogical process encompass factors like the availability of technology resources, training, Internet connectivity, and proficiency in operating the technology platform.

The lack of fundamental technological infrastructure and facilities, teachers' attitudes toward technology, student participation, and parents' technological aptitude are the barriers to technology adoption in the pedagogical process (Ng & Yunus, 2021).

Rudhumbu et al. (2021) stated that technology training, inadequate resources, the cost of the internet, and internet connectivity speed as the barriers to technology adoption in the pedagogical process.

According to Granić (2022), the most common obstacles to educational technology adoption were fear, system accessibility, and (technical) complexity, while Dassa and Vaughn (2018) posited that distractions caused by social networks and the struggle to integrate technology effectively are barriers to technology adoption in the pedagogical process.

As noted by Francom in two of his studies (Francom 2016, 2019), access to technology tools and resources, technological training and support, administrative support, time allotted for planning and preparation for technology integration, and teachers' perceptions of the value and practicality of technology tools and resources are some of the factors that impede the adoption of technology in the pedagogical process.

Other barriers outlined by Johnson et al. (2016) are access, inadequate training, and support, teachers' attitudes and beliefs, teachers' resistance, and teacher knowledge and skills. Akram et al. (2022) identified a number of barriers to the adoption of technology in the pedagogical process, including load shedding, slow internet speeds, infrastructural gaps, a lack of experience with online teaching, and inadequate training. These barriers are presented in the following chart of Figure 9.

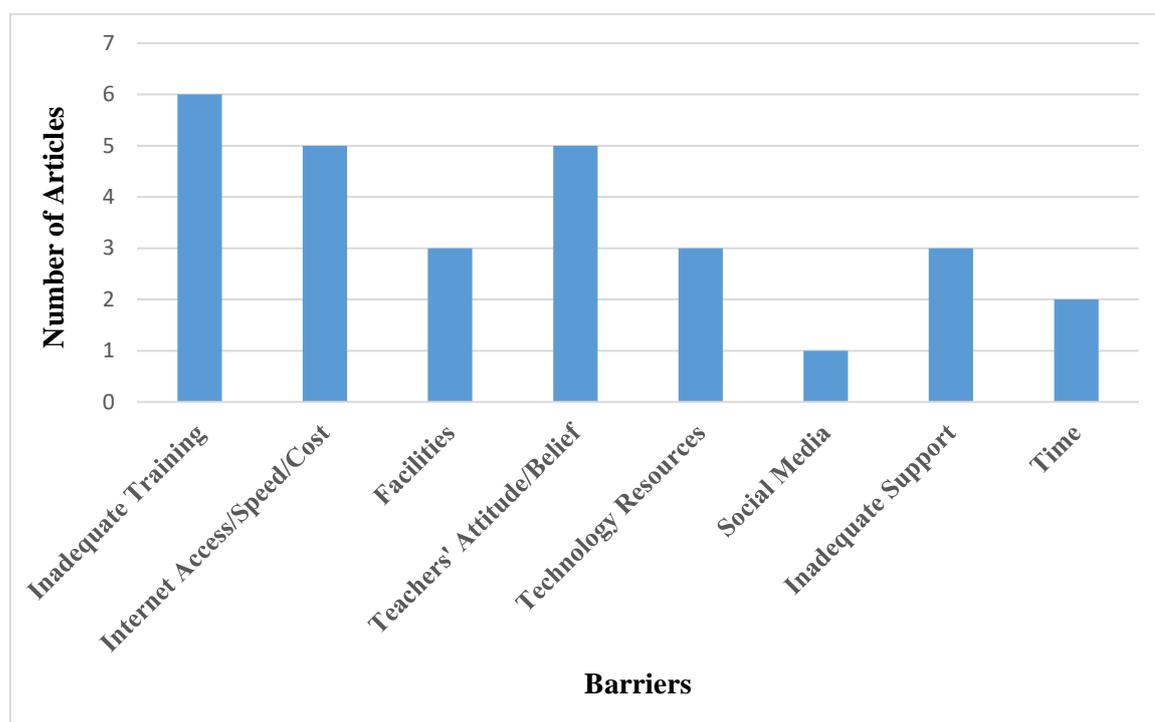


Figure 9: Barriers to technology adoption

**Research Question 4: Which sustainable framework can guarantee adoption and ensure technology integration's long-term success in the pedagogical process?**

Table 3 shows the model component of the articles reviewed.

**Table 3: Model Component**

Authors' Details	Model Component		
	Criterion Variable	Intermediate Variable	Outcome variable
Sánchez-Prieto et al. (2017)	Attitude towards the use	Behavioural intention	Actual use
El-Hamamsy et al. (2023)	Support	Perceived usefulness	Adoption
Peled and Perzon (2021)	Support from management	Attitude towards technology	Technology integration
Rafi et al. (2019)	Attitude towards use	Intention to use	Actual use
Leite and Lagstedt (2021)	Experience	Behavioural intention	Technological use
Alghamdi (2020).	Infusion	Integration	Transformation
Kim and Jang (2020)	Integration frequency	Perceived student change	Continuance intention
Rudhumbu et al. (2021)	ICT support services	Use of ICT in teaching	Behavioural intention to adopt ICT
Romero et al. (2019).	Feedback	Platform acceptance	Adapting technology to pedagogical process
Koh et al. (2022)	Competency	Users' attitudes	Adoption of ICT in physical education
Gerez (2019)	Teacher pedagogical and technology planning	Increased teacher motivation and practice	Successful technological implementation
Siyam (2019)	Attitude towards usage	Behavioural intention to use	Actual usage
Dogan et al. (2021)	Support from a technological specialist	Perceived skills and belief	Teacher use of application software
Liu et al. (2018)	Facilitating condition	Technology behaviour	Ease of use
Nordlöf et al. (2019)	Attitude	Behavioural intention	Behaviour

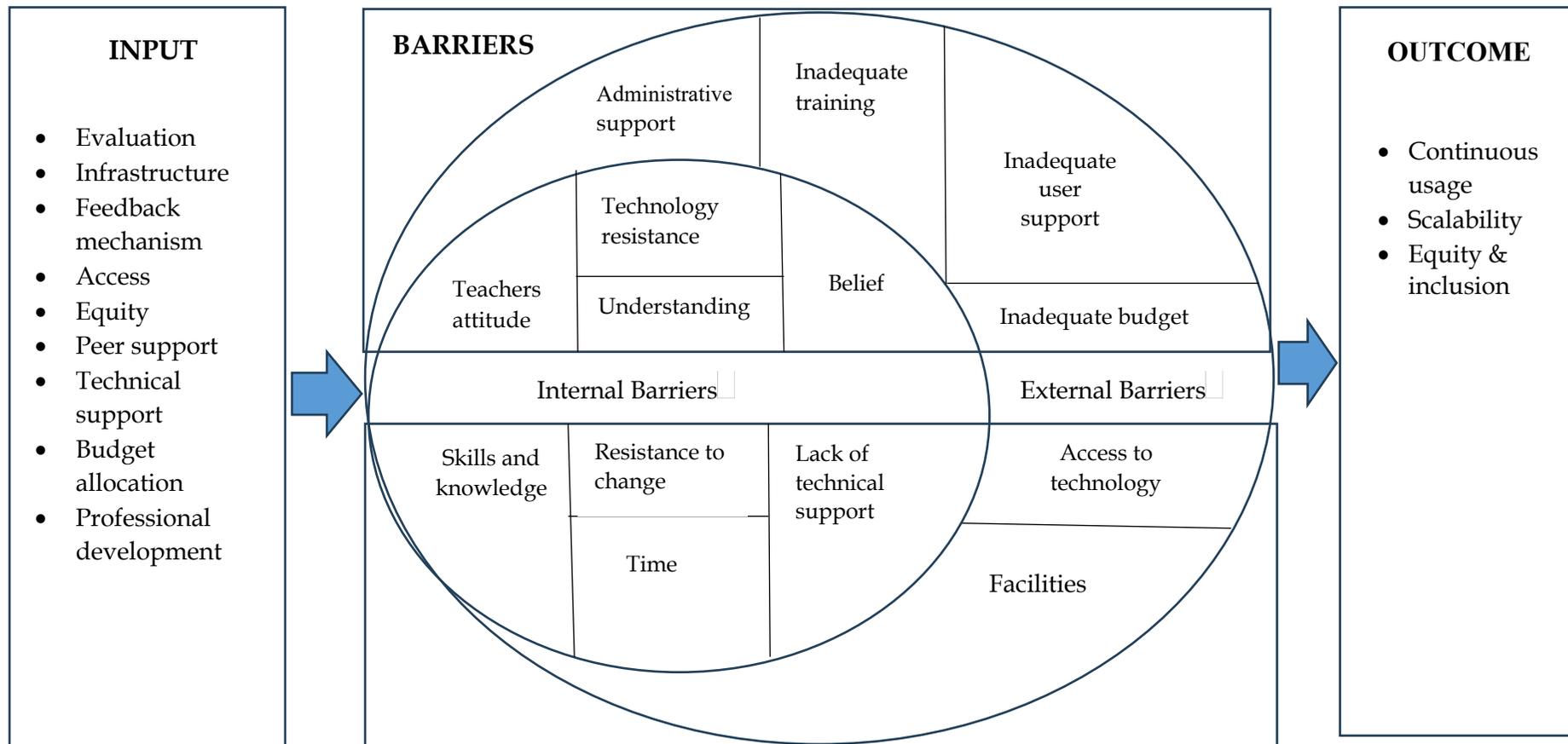


Figure 10: A sustainable adoption of technology by author

The research endeavoured to address the question of how to create a sustainable framework that not only facilitates the initial adoption of technology in education but also ensures its lasting success within the pedagogical process. We acknowledge that the mere act of implementing technology is insufficient; it must be accompanied by a comprehensive framework designed for long-term sustainability (Shirrell & Spillane, 2020; Tikkanen et al., 2020).

Johnson et al. (2016) identified barriers to the integration of technology, categorising them into internal and external groups. External barriers, including limited access, insufficient training, and inadequate support, impede the widespread adoption of technology; while internal barriers are skills and knowledge, students' and teachers' belief, and attitude towards technology.

Ensuring equitable access to essential equipment is foundational, providing all teachers and students with equal opportunities to leverage technology (Johnson et al., 2016). The integration of technology into the pedagogical process faces various challenges, encompassing training, administrative support, equipment availability, and facilities (Johnson et al., 2016; Ng & Yunus, 2021; Romero et al., 2019). Our framework prioritises continuous support for teachers and students, access to necessary equipment, and ongoing evaluation as integral components for sustaining and enhancing the promotion of technology. This approach aligns with the findings of El-Hamamsy et al. (2023), García-Hernández et al. (2022).

As emphasised by Ertmer et al. (2012), one of the most commonly acknowledged causes of technological unsustainability in the classroom is the absence of adequate professional development and training. To promote and sustain technology in the pedagogical process, it is imperative to provide the necessary training and peer support, a factor acknowledged by Sánchez-Prieto et al. (2017) as influential in shaping teachers' attitudes toward technology and inclusivity.

However, inclusivity alone does not guarantee sustainability, as reinforced by previous research (Shirrell & Spillane, 2020; Tikkanen et al., 2020). To address this, we introduced a system of ongoing evaluation, acting as a feedback loop to monitor user challenges and maintain technology's sustainability. This approach promotes ease of use, scalability by ensuring widespread access to technology in every classroom, and serviceability by monitoring and evaluating technology equipment regularly, which is supported by the findings of Hsu and Sharma (2010) in their Triple-S framework.

In summary, our proposed framework not only surmounts initial barriers to technology adoption but also establishes a continuously improving system of technology integration in the pedagogical process. This comprehensive approach ensures that technology remains a valuable and enduring tool for education, directly addressing the question of how to guarantee adoption and ensure technology integration's long-term success in the pedagogical process.

## **5. Conclusion**

The purpose of this study has been to conduct a comprehensive and systematic review of how teachers and students perceive the role of technology in the

classroom, the key factors shaping teachers' perceptions of technology in education, and the barriers to technology adaptation in the pedagogical process; it also provides a framework to sustain technology in the pedagogical process. Following the use of the PRISMA approach for a systematic literature search, our findings revealed that teachers and students perceive technology as a valuable tool for enhancing the quality of learning and active participation within the classroom setting. We identified the key factors shaping teachers' perceptions of technology in education and the barriers to technology adoption in the pedagogical process, which are inadequate training, internet access and speed, facilities, and technology resources.

Finally, we provided a framework for the sustainability of technology in the pedagogical process. While the findings of this innovative systematic literature review (SLR), employing PRISMA methodology are indeed noteworthy, it is essential to recognise that this represents an initial exploration into teachers' and students' perceptions of technology and the sustainable adoption framework in the pedagogical process. It should be noted that the research findings of this qualitative study are based on a small number of scholarly articles, only 41 in all. Due to the exploratory nature of this study, more thorough empirical research must be carried out in the future. Structured surveys, interviews, or focus groups should be used to gather primary data from a larger and more diverse pool of respondents. As such, it is critical to proceed cautiously with the study's conclusions and maintain a receptive and enquiring mindset for additional research and validation.

## **6. Implications for Management Practices and Curriculum Planner**

This model emphasises how the government, school administration, and other relevant authorities play a major role in the effective integration and long-term viability of technology in the pedagogical process. Curriculum planners and school administrators must prioritise providing teachers with technology integration training and support for the integration of technology. Understanding the key factors that shape teachers' perceptions of technology is vital. By investing in training programmes and resources that address these factors, management can ensure that educators are more comfortable and effective in using technology for teaching, while also ensuring that resources and infrastructure are not neglected. Based on the model barrier, this would ensure that technology is accessible both for the teachers and students.

The framework provided to sustain technology in the pedagogical process can be a valuable resource for curriculum planners. They should consider implementing this framework to guarantee the long-term success of technology integration in the curriculum. Subsequent research endeavours may explore the variations in perceptions of technology and sustainable adoption frameworks within diverse educational contexts, encompassing primary and secondary education, higher education, and vocational training.

## **7. Suggestions for Future Research**

Performing comprehensive research on how technology directly affects learning outcomes is crucial and has great potential. Future research initiatives should

focus on conducting a comprehensive assessment of the effectiveness of technological integration, taking into account aspects such as student performance, involvement, and other relevant academic indicators. This can be done by gathering primary data using techniques such as structured questionnaires and interviews from a larger and more varied group of respondents.

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