Advancing Education through Technology Integration, Innovative Pedagogies and Emerging Trends: A Systematic Literature Review

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ARTICLE INFO	ABSTRACT
	The integration of technology in education, along with innovative pedagogies and emerging trends, is driving a transformation in the learning landscape. This advancement aims to enhance student engagement, critical thinking skills, and access to resources. Methods: This paper reviews studies conducted between 2019 and 2023 that focus on advancing education through technology integration, innovative pedagogies, and emerging trends. The PRISMA approach, a systematic literature review standard, is employed, and the analysis includes training, validation, and testing stages. The search is based on the keyword 'educational technologies,' and document types, year, country, authors, field research, and place of publication are examined. Results: The review reveals the potential of technology integration, innovative pedagogies, and emerging trends in transforming education. The use of project-based learning, flipped classrooms, and collaborative learning promotes active student participation and fosters creativity and problem-solving abilities. Personalized learning, adaptive learning platforms, and virtual reality offer tailored and immersive educational experiences. Conclusions: While the reviewed studies highlight the benefits of technology integration, innovative pedagogies, and emerging trends, limitations in current methodologies exist. Further research is needed to overcome these limitations and develop effective solutions. The findings of this study provide a foundation for future research and inspire the exploration of new approaches to advancing education through technology integration, innovative pedagogies, and emerging trends.

1. Introduction

The global health, social, and economic challenges experienced worldwide have led to significant advancements in educational styles and learning environments [1]. These reflections of the COVID-19 pandemic have not only reshaped perceptions of the future of education but also created anticipation for new scenarios in the field. For developers of next-generation Education Technology (EdTech), the use of Learning Analytics (LA) has become a crucial competitive advantage due to its increasing prevalence in EdTech [1]. LA involves leveraging Artificial Intelligence and Analytics to analyse data generated by technology-mediated learning, providing valuable insights into students'

learning processes, particularly in large student cohorts (Aladsani *et al.,*). The surge in the adoption of Learning Analytics aligns with the global movement focused on "Ethical AI," aiming to address questions surrounding personal agency, freedoms, and privacy in the context of AI and Analytics [2]. However, there is currently a significant lack of actionable information and supporting technologies that would facilitate the alignment of goals between these two communities [2]

In large introductory computer science courses, one effective method of introducing active learning is through in-class coding exercises that allow students to solve problems [3]. Although it is widely recognized that re-solving problems after receiving feedback enhances understanding and performance, practical constraints such as limited time and logistics often prevent students from having multiple attempts at in-class exercises [3]. Despite the enthusiasm for technology in school education and the extensive changes brought about by the adoption of digital technologies, research provides limited evidence of improved outcomes for learners [4]. Given the significant investments in technology and its potential to enhance learning outcomes, education systems and schools need access to tools and frameworks that support effective technology use in education [4].

In the field of interior design, traditional techniques like manual and digital drawing have limitations in meeting various modelling needs, emphasizing the importance of interior space modelling. The fixed nature of existing physical interior models hampers the interior design study process, impacting students' engagement and motivation [5]. In the context of engineering education certification, the cultivation of students' innovation, competition, and employment competitiveness has become crucial [6]. To achieve these objectives, a curriculum cluster teaching model called the Zongheng group model is proposed, integrating software projects across multiple courses to balance academic knowledge, integrate course resources, and foster innovation, competition, and employment competitiveness [6].

The availability of Mixed Reality (MR) technologies, such as wearable devices like the MicrosoftHoloLens, is challenging pedagogy in vocational education [7]. These technologies are being incorporated into nursing education programs and explored in other subject areas like construction, architecture, and engineering [7]. While digital platforms have facilitated increased interaction between students and instructors, their development for complex project-based and open-ended education content is still incomplete [8]. Real-world interactions play a crucial role in project-based learning environments, encouraging exploration and implementation, and immersive technologies like AR/VR have shown promise but also face limitations [8].

The dynamic nature of education technology necessitates ongoing evolution and adaptation, with the COVID-19 pandemic serving as a catalyst for its rapid adoption. Recognizing the potential and challenges presented by educational technology, it is essential to approach its integration with careful planning, comprehensive teacher training, and alignment with pedagogical objectives. By addressing digital inequalities, promoting ethical AI practices, exploring emerging technologies like mixed reality, and fostering project-based and open-ended learning environments, we can drive the advancement of education technology and create meaningful improvements in learning outcomes. This calls for a collaborative effort among policymakers, educators, technology developers, and stakeholders to shape the future of education and unlock its full potential through innovative and responsible use of technology.

In recent years, the integration of Virtual Reality (VR) in classrooms has become a topic of interest for educators seeking to enhance student learning experiences. Castaneda *et al.,* conducted a study with six high school teachers and 277 students to explore the pedagogical implications and challenges of coordinating assessments with the use of VR in classrooms. Teachers developed new assessment strategies to capture the deep, constructivist learning that they observed in their students through VR, but students suggested the need for more explicit goals in class activities. In another study,

Marimon-Martí *et al.,* conducted a quantitative, non-experimental study with 3029 first-year undergraduate students in Education in Catalonia and Andorra. They found that while students had a high self-perception, it did not align with the reality of their performance, possibly due to the Covid-19 situation and the adaptation of environments to online and hybrid formats. [11] explored the long-term effects of a large ed-tech intervention that connected some of China's best teachers to over 100 million rural students through satellite internet. They found that exposure to the program improved academic achievement, lab or performance, and computer usage, indicating that education technology can have long-lasting positive effects on various outcomes. [12] found that technology, such as LMS, zoom meetings, and Google forms, were positively perceived by students and stakeholders in Islamic higher education, demonstrating how technology can enhance the quality of education in diverse settings.

The importance of effective value creation, delivery, and capture in the field of education technology is highlighted in the study by von Maltitz & van der Lingen. The findings emphasized the need for education technology entrepreneurs to develop mature products that gain the trust and endorsement of teachers. Additionally, building a comprehensive support network, including an advisory board and low-cost infrastructure providers, was identified as crucial. The study also emphasized the significance of diversifying revenue streams from both private and public sectors. Better government policies and procurement implementation were recommended to provide simpler and more predictable revenue streams for EdTech providers. Sonnenberg *et al.,* conducted a study to validate an educational technology framework for higher education across Canada. The framework emphasizes the necessary capabilities, competencies, and example activities required in the evolving landscape of higher education. It highlights the importance of teams collaborating, designing, developing, administering, and leading within institutions. The study emphasizes the need to foster broader communities of practice and collaborations between different institutions, as educational technology teams play a pivotal role in transforming the academic experience for learners and teaching faculty, ultimately shaping the direction of teaching and learning in higher education.

Examining the impact of smartphone use on teachers' work lives in low-income Indian schools, Varanasi *et al.,* conducted a mixed methods study. The findings revealed that while smartphones aided teaching and administrative functions, they also significantly predicted burnout among teachers. Technostress emerged as a major factor contributing to this relationship. The study shed light on the constant surveillance and monitoring of teachers' work through technology, as well as the control and repurposing of teachers' personal smartphones by higher management. The study emphasized the need for better support structures for teachers and a revaluation of smartphone usage in their work.

Varanasi *et al.,* addressed the emerging issue of digital education in preschool settings in Russia. While digitalization has permeated the education system, concerns have been raised regarding the potential negative impact of digital education technologies on children's personality development. The study acknowledged the limited research in this area but highlighted the insights gained from exploring the educational process organized with the use of digital technologies. Qing & Yan focused on the integration of ideological and political education into the art curriculum using the technical means of "Internet +." They provided an overview of the current situation and challenges in integrating ideological and political teaching into art courses. The article proposed targeted strategies to enhance the effectiveness of curriculum integration, aiming to benefit practitioners in the field.

Research in the field of education has explored the application of Virtual Reality (VR) and Augmented Reality (AR) to adolescent cognitive development in primary and secondary schools [17].

However, there are still few studies focusing on the construction of a new teaching method that combines "multi-mode + human-computer collaboration" and utilizes Mixed Reality (MR) technology to enhance cognitive development teaching by incorporating multi-mode data representation such as vision, hearing, and touch. Therefore, this paper aims to address this research gap by investigating the potential of VR and cognitive development teaching based on MR technology. In college English teaching, the integration of information education technology has become commonplace, with many students using English Apps for learning [18]. However, challenges remain, including students' poor self-control and the abundance of distracting English education App advertisements. To overcome these issues, it is essential to enhance the hardware and software of information education technology and reduce spam advertisements. Additionally, cultivating students' ability to autonomously utilize English education apps can significantly improve the English learning experience.

The use of new information and communication technologies in teaching humanities, particularly history in higher education, has presented various challenges [19]. Distance learning has highlighted the need to explore new teaching methods that leverage innovative information tools and approaches. Special attention should be given to the advantages of distance learning methods, while emphasizing the importance of integrating information technology into higher education to keep up with the demands of an information society. Ahshan highlights the effectiveness of combining technologies, synchronous teaching, and active learning activities for interactive learning. This approach enhances student engagement, particularly in remote or online teaching and learning environments, contributing to ongoing research on technology-enhanced active student engagement in engineering education. Vatolkina & Dos Santos Cardoso identify the need for changes in content and experience management strategies, organizational culture, operational models, decision-making tools, and project management to facilitate the digital transformation of educational technologies. While digital transformation has made significant progress in education and business sectors, there are still ample opportunities for future growth. Furthermore, Kizilcec *et al.,* found that mobile learning serves as a supplementary tool for formal and informal schooling, particularly during disruptions. Parents play a crucial role in ensuring continuity in education by leveraging mobile learning technologies.

The Ministry of Education in Singapore has made significant efforts to ensure the successful implementation of educational initiatives by providing schools with the necessary infrastructure, leadership, and teacher training. These implementations serve as valuable lessons for other regional and international education systems aiming to integrate Information and Communications Technology (ICT) into their own systems (Natarajan *et al.,*). By analysing the discursive work of two educational philanthropies in the US and India, this study sheds light on how global education philanthropies inscribe and direct global forces, connections, and imaginaries towards specific local goals. The use of technocratic discourses in shaping the educational futures of marginalized communities is examined, emphasizing the theoretical concerns surrounding globalization and neoliberalism in education and highlighting specific local adaptations [24]. Even in remote rural areas of the US, technology has become an integral part of schooling. This article explores stakeholders' perceptions of educational technology in six rural districts in Idaho. While stakeholders believe that technology is necessary and beneficial in their districts, they also acknowledge the complex challenges associated with resource allocation despite efforts to promote educational equity. The article emphasizes the need for a contextualized view of technology-oriented change that values and leverages the unique characteristics of rural communities [25]. Drawing on a critical discourse analysis of the National Education Technology Plans (NETP) released by the US Department of Education in 2010 and 2016, this research examines the influence of data analytics companies on

educational policy development. The analysis reveals the promotion of marketization processes, the construction of an idealized learner, and the emphasis on ubiquitous digital access in the NETP documents, indicating an educational agenda that benefits corporate and private interests [26].

This study investigates the utilization of smart devices in teaching and learning in Jordanian universities from the perspective of instructors. While a significant percentage of respondents expressed opposition to technology use, they still acknowledged employing technology in various ways. Drawbacks such as distraction, misuse, and lack of skills were identified, while enriched interaction and excitement were reported as motivating factors for instructors to incorporate technology in the teaching process [27]. While the generation of test problems has been explored in the past, the importance of generating solutions alongside the problems has been largely overlooked. This study addresses this gap by exploring the generation of problems and solutions based on graphical processes, going beyond traditional multiple-choice questions and language-based problems. The authors emphasize the benefits of rapidly generating questions and solutions to enhance the educational process for both educators and students [28].

Augmented reality (AR) has demonstrated its potential in aiding users during assembly tasks, providing a magic-lens view of physical objects and simplifying the process. This study explores the use of AR to enhance the learning experience of assemblers, turning physical objects into smart objects that interact with users and provide a deeper understanding of both assembly hardware and software components. The findings highlight the effectiveness of the Pedagogical Virtual Machine (PVM) with AR approach in terms of learning achievement, enjoyment, and usefulness [29]. By analysing the exchange of citations between Educational Technology (ET) and Library and Information Science (LIS), this study explores the interdisciplinary impact between the two disciplines. The findings suggest a moderate level of exchange, indicating slightly stronger impact of LIS on ET research. Specific journals, such as the Journal of Education for Library and Information Science and the Journal of Documentation, were frequently cited across disciplines, highlighting the links and impact between ET and LIS [30].

This paper presents key changes in Australian educational areas in recent years that are important and relevant to the subject of education innovation and philosophy in achieving outcomes in training and sustainable economic development, as anticipated by the community and government [31]. The swift incorporation of new technologies in education courses and curricula has transformed teaching methods, emphasizing the need for complementary and supplemental courses that produce multi-skilled and creative graduates, with significant emphasis on self-development skills and less focus on traditional content. The current trend is a move towards a horizontal focus and a student-centric balance, displacing vertical over-specialization of learning. Despite these changes, the central role of the educator is still seen as appropriate and necessary in equipping graduates with creative and adaptive skills (Nguyen *et al.,*).

Furthermore, the research focuses on the pedagogical use of tablets in higher education, specifically in a sample of 902 students from eight countries and universities [32]. The study reveals a lack of knowledge about the pedagogical function of tablets, as well as limited recognition of their use and identification of learning scenarios. It highlights the need to integrate tablets into the change of traditional pedagogical practices to enhance critical thinking, metacognition, and self-regulation formation among university students (García *et al.,*).Reflecting on the experience serving on the University of California's Standardized Testing Task Force, the author argues that the COVID-19 pandemic has accelerated the trend of US higher education institutions moving away from current standardized tests [33]. This shift will lead to the production of new educational assessments and the exploration of different assessment approaches to meet the evolving needs of students. The field of educational measurement has much to offer and learn in this process.

The article explores the concept of the 'smart classroom' as a new frontier for universities and provides a conceptual map of its scope and limitations within the context of smart university initiatives [34]. It examines how the smart classroom is conceptualized, its applications, and its integration into smart campuses. Additionally, it delves into the ethical implications of the smart classroom and recommends new regulations to ensure its constructive use in the pedagogical process. Another study examines the prevalence of technological interventions in education in emergencies, focusing on private participation in Syrian refugee education in Jordan, Lebanon, and Turkey [35]. The research highlights the optimistic view of education technology in emergencies but raises concerns about the disproportionate focus on technology and the lack of contextualized interventions. It emphasizes the need to counter the overwhelming optimism and consider the implications of interventions developed in the Global North for refugee education in the Global South.

Additionally, the paper explores the adoption of educational technology in higher education institutions and its impact on student learning [36]. The research examines the adoption rates and the fitness for purpose of an instant student-lecturer feedback system, emphasizing the importance of adoption in determining the effectiveness of educational technology. It concludes by recommending a framework for adoption. Moreover, the analysis focuses on modern education technologies that enhance students' soft skills, particularly in distant education and blended learning approaches [37]. The study presents a new education course model developed using the Flipped Classroom approach, which promotes self-regulation and personal development skills in students. The research shows that blended learning with elements of self-reflection is more effective than traditional approaches in developing students' self-regulation and soft skills.

The current study is important because there is a scarcity of research that provides a comprehensive picture of the education technology. Moreover, existing systematic review articles on the subject fail to provide detailed information on the review procedures used. This includes keyword identification, article screening, and article eligibility. Furthermore, prospective researchers were unable to reconstruct the inquiry, authorise the interpretation, or evaluate the breadth of data due to this situation. In addition, this study is important because it provides researchers an understanding of the peer literature review that help researchers achieve a better understanding of education technology issues requiring academic and government attention. The current systemic analysis was developed to answer the main research question: How advancing education through technology integration, innovative pedagogies, and emerging trends has become a driving force in transforming the learning landscape? The investigation's main focus was on people's perceptions of quality education.

In contrast, the following section describes the procedure used to respond to the research question raised by the current report. The third section then performs a systematic analysis and synthesis of the scientific literature to identify, select, and analyse necessary research on advancing education through technology integration, innovative pedagogies, and emerging trends has become a driving force in transforming the learning landscape. Finally, the section addresses the steps that must be taken, emphasising potential scholars about the problems presented.

2. Methodology

A large number of current studies related to systematic assessments have been undertaken around the globe. This section addresses the need for a systemic analysis of advancing education through technology integration, innovative pedagogies, and emerging trends. In contrast, the

following section presents the method used to find answers to the research formulated by the current research. This review will be broken down into three sections:

    i.   Technology Integration in Education
    ii.   Innovative Approaches in Teaching and Learning Technology Integration
    iii.   Emerging Trends and Issues in Educational Technology.

Next, this section systematically reviews and synthesises scientific literature to distinguish, select, and analyse the impact of Professional Learning Communities practice on Teacher Development and Instructional Quality. Lastly, the last addresses what action should be taken concerning the posed problems by reflecting upon potential scholars. The pre-recording systematic reviews and meta-analysis (PRISMA) approach is applied in this analysis, a published standard for conducting a systematic literature review. Publication guidelines are generally necessary for guiding writers to assess and review the accuracy and rigour of a review with relevant and necessary details. PRISMA also highlights the randomised studies evaluations survey, which can be a key factor in systematic analysis reports for other study forms (Moher *et al.*,) (Figure 2).

In terms of tools, two key databases, Scopus and Eric, were used to evaluate the methodology of this research in light of their robust nature. It covered several studies, including education studies. However, like Scopus and Eric, no database is perfect and detailed (Schmidt *et al.*,; Kokol and Vošner; Yeung). In addition, this section provides an overview of the four significant sub-sections: identification, screening, eligibility, and data abstraction.

2.1 Identification

In choosing several appropriate papers for this report, the systematic review process consists of three main phases. The first step is keyword recognition and the quest for linked, similar terms based on the thesaurus, dictionaries, encyclopaedia, and previous studies. Accordingly, after all the relevant keywords were decided, search strings on Scopus and Eric (see Table 1) database have been created. In the first step of the systematic review process, the present research work successfully retrieved 6343 papers from both databases.

Table 1
The search strings

Scopus	TITLE-ABS-KEY ("education technology") AND (LIMIT-TO (PUBSTAGE , "final")) AND (LIMIT-TO (PUBYEAR , 2023) OR LIMIT-TO (PUBYEAR , 2022) OR LIMIT-TO (PUBYEAR , 2021) OR LIMIT-TO (PUBYEAR , 2020) OR LIMIT-TO (PUBYEAR , 2019)) AND (LIMIT-TO (DOCTYPE , "ar") OR LIMIT-TO (DOCTYPE , "cp")) AND (LIMIT-TO (SUBJAREA , "SOCI")) AND (LIMIT-TO (EXACTKEYWORD , "Education Technology")) AND (LIMIT-TO (LANGUAGE , "English")) AND (LIMIT-TO (SRCTYPE , "j") OR LIMIT-TO (SRCTYPE , "p"))
ERIC	("education technology") AND (LIMIT-TO (PUBSTAGE , "final")) AND (LIMIT-TO (PUBYEAR , 2023) OR LIMIT-TO (PUBYEAR , 2022) OR LIMIT-TO (PUBYEAR , 2021) OR LIMIT-TO (PUBYEAR , 2020) OR LIMIT-TO (PUBYEAR , 2019)) AND (LIMIT-TO (DOCTYPE , "ar") OR LIMIT-TO (DOCTYPE , "cp")) AND (LIMIT-TO (SUBJAREA , "SOCI")) AND (LIMIT-TO (EXACTKEYWORD , "Education Technology")) AND (LIMIT-TO (LANGUAGE , "English")) AND (LIMIT-TO (SRCTYPE , "j") OR LIMIT-TO (SRCTYPE , "p"))

2.2 Screening

During the initial round of screening, duplicate papers were eliminated. The first stage of the study rejected 399 papers, whereas the second stage screened 161 papers based on the scholars'

various exclusion and inclusion criteria. As literature (research articles) is the major source of practical advice, it was the first criterion used. It also covers systematic reviews, reviews, meta-synthesis, meta-analysis, books, book series, chapters, and conference proceedings excluded from the latest research. Furthermore, the review was limited to English-language publications. It is important to keep in mind that the plan was established for the past five-year period (2019-2023). In all, 5374 publications were eliminated predicated on particular criteria.

Table 2
The selection criterion is searching

Criterion	Inclusion	Exclusion
Language	English	Non-English
Time line	2019 – 2023	< 2019
Literature type	Journal (Article)	Conference, Book, Review
Publication Stage	Final	In Press
Subject Area	Social Science	Besides Social Science

2.3 Eligibility

A total of 238 articles are included in the third level, called eligibility. At this stage, all article titles and important text were carefully scrutinized to confirm that the inclusion criteria were satisfied and that the articles were appropriate for the current study's research objectives. As a result, 208 papers were removed since their due to the out of field (n=67), title not significantly (n=58), abstract not related on the objective of the study (n=31) and no full text (cannot access) (n=52) relevant to the study's objective based on empirical data. Finally, 30 articles have been made available for review (see Figure 1).

2.4 Data Abstraction and Analysis

An integrative analysis was performed in this study, which was one of the examination techniques used to analyse and synthesise different research designs (qualitative, quantitative, and mixed methods). Expert research centred on developing appropriate topics and sub-topics. The first step in the development of the theme was the data collection phase. The authors have carefully reviewed a group of 30 papers for statements or information addressing questions from this current research. In the second step, the authors and expert then exploring the technology integration in education, innovative approaches in teaching and learning technology integration and emerging trends and issues in educational technology. The authors resumed each developed theme from here, including any themes, concepts, or ideas having any relationship. Within the framework of this study, the corresponding author worked with other co-authors to establish themes based on the findings. Here, a log was maintained during the data analysis process to document any analysis, opinions, puzzles, or other ideas relevant to the data interpretation. The authors also compared the findings to resolve any discrepancies in the theme creation process. Note that if any inconsistencies on the themes arose, the authors address them with one another.

Finally, the developed themes were tweaked to ensure their consistency. By establishing domain validity, two experts from different universities were selected based on their extensive experience of more than 15 years in the field of education are review phase helps assure the clarity, importance, and suitability of each sub-theme. On the basis of comments and professional judgments, the writer makes amendments to his or her judgment. The expert review phase helped ensure each sub-

theme's clarity, importance, and adequacy by establishing domain validity. Adjustments based on the discretion of the author based on feedback and comments by experts have been made.
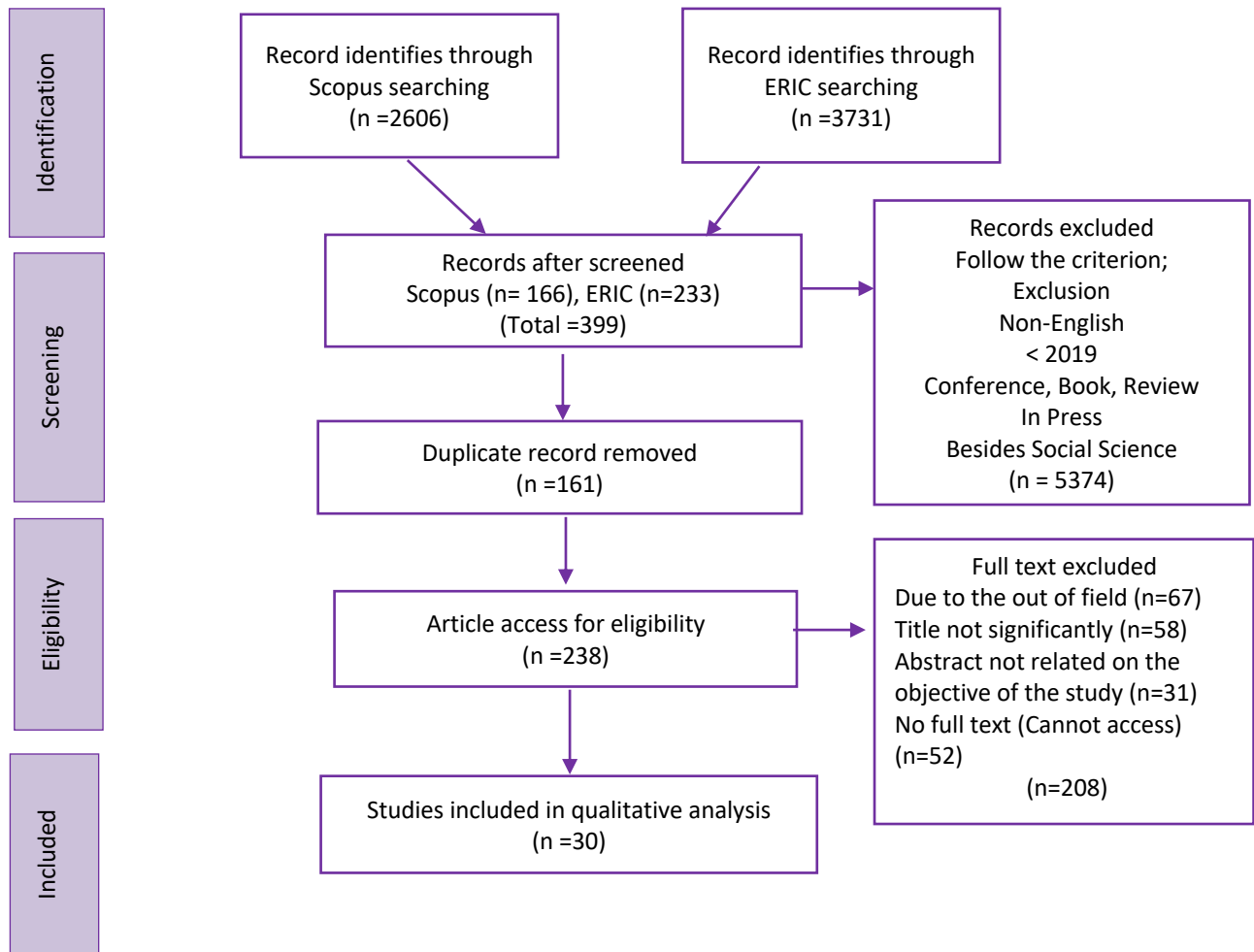

Fig. 1. Flow diagram of the proposed searching study [38]

3. Results

3.1 Theme 1: Technology Integration in Education

The results from the CFAs, as stated by Kohler *et al.,* confirmed the presence of between three and six factors per instrument, comprising 8–24 items per instrument. Furthermore, the authors found that each instrument demonstrated a satisfactory level of reliability. The EdTech Context Inventory, as emphasized by Kohler *et al.,* offers valuable tools for creating robust profiles of district EdTech implementation contexts, and it has practical applications for supporting educators' EdTech implementation efforts. According to Tzivinikou *et al.,* the aim of this study was to evaluate the psychometric properties (factor structure, reliability, and construct validity) of the Brief Distance Education Attitudes (DEA) scale. The study involved 422 SEND teachers who completed socio-demographic data forms and the DEAS. Using Principal Components Analysis, factors were extracted through Exploratory Factor Analysis (EFA) and confirmed through Analysis of Moment Structures. No floor-ceiling effects were observed, and there were no significant differences in skewness and kurtosis between the two domains.

The Confirmatory Factor Analysis (CFA) yielded satisfactory goodness-of-fit indices, with TLI = 0.962(>0.95), RMSEA = 0.035 (< 0.08), CFI = 0.943 ($\geq$ 0.90), $\chi^2(34)$ = 57.93, p = 0.000, and SRMR =

0.034 (< 0.08). The internal consistency of the scale was measured using Cronbach's alpha, resulting in a value of $\alpha = 0.764$. The study highlighted that SEND teachers' attitudes towards Efficacy in Distance Education and Difficulties Related to Distance Education are significant factors for the successful implementation of distance education, particularly during the COVID-19 crisis. As emphasized by Tzivinikou *et al.,* universities, education technology corporations, and policy makers should consider these factors to provide training and support for SEND teachers in emergency remote-teaching scenarios. The findings of this study offer valuable insights for enhancing distance education practices in the context of SEND, ensuring that teachers are well-prepared and adequately supported.

During the COVID-19 pandemic, the global education sector has faced significant challenges affecting various aspects of people's lives, including social, economic, and educational domains. In response to the disruptions caused by the pandemic, extensive efforts have been made to adapt educational systems, including the widespread adoption of online learning. This study utilizes Structural Equation Modelling (SEM) to investigate the effectiveness of the education system's response, particularly concerning online lectures, during the COVID-19 pandemic. The Technology Acceptance Model (TAM) serves as the theoretical framework for this study. The research employs Partial Least Squares Structural Equation Modelling to evaluate and analyse the proposed model. Data for this study were collected through a survey involving 112 postgraduate students between January and December 2021. The findings indicate that

 i. the proposed variables based on TAM effectively explain the usage patterns of postgraduate students in online classes during the pandemic

 ii. perceived ease of use and perceived usefulness significantly influence actual system usage through behavioural intentions to use

 iii. there were no significant indirect effects observed from perceived ease of use and perceived usefulness on actual system usage through behavioural intentions to use [41].

In Nigeria, educational technology, despite its crucial role in the global education system, has been neglected for years. However, the COVID-19 pandemic has brought about a new reality where educational technology plays a vital role in addressing the challenges posed by such a global crisis. The pandemic has disrupted various human activities worldwide, leading to adjustments in the academic calendar, extended graduation dates, and decreased research output. To address these challenges, many education systems have embraced educational technology, bringing about a paradigm shift from the traditional norms (see Figure 2). For this new approach to education to be sustainable, it is crucial for the education system to adopt a pragmatic attitude towards the implementation of innovative solutions, rather than maintaining a conservative stance. Drawing on the diffusion theory of innovation, this paper argues that the necessity caused by the pandemic has compelled the compulsory adoption of innovation in the Nigerian education system. However, the prospects of this transformation appear uncertain as many educational practitioners lack the necessary skills and mindset to embrace these innovations. Therefore, it is concluded that educational practitioners require in-service training to actively participate in these changes. Additionally, the government is encouraged to adopt a systematic approach in procuring and installing ICT facilities that will facilitate the widespread implementation of educational technology in schools [42].This section discusses the results obtained from the surface pressure measurement study. The effects of angle of attack, Reynolds number and leading-edge bluntness are discussed in the next sub section.
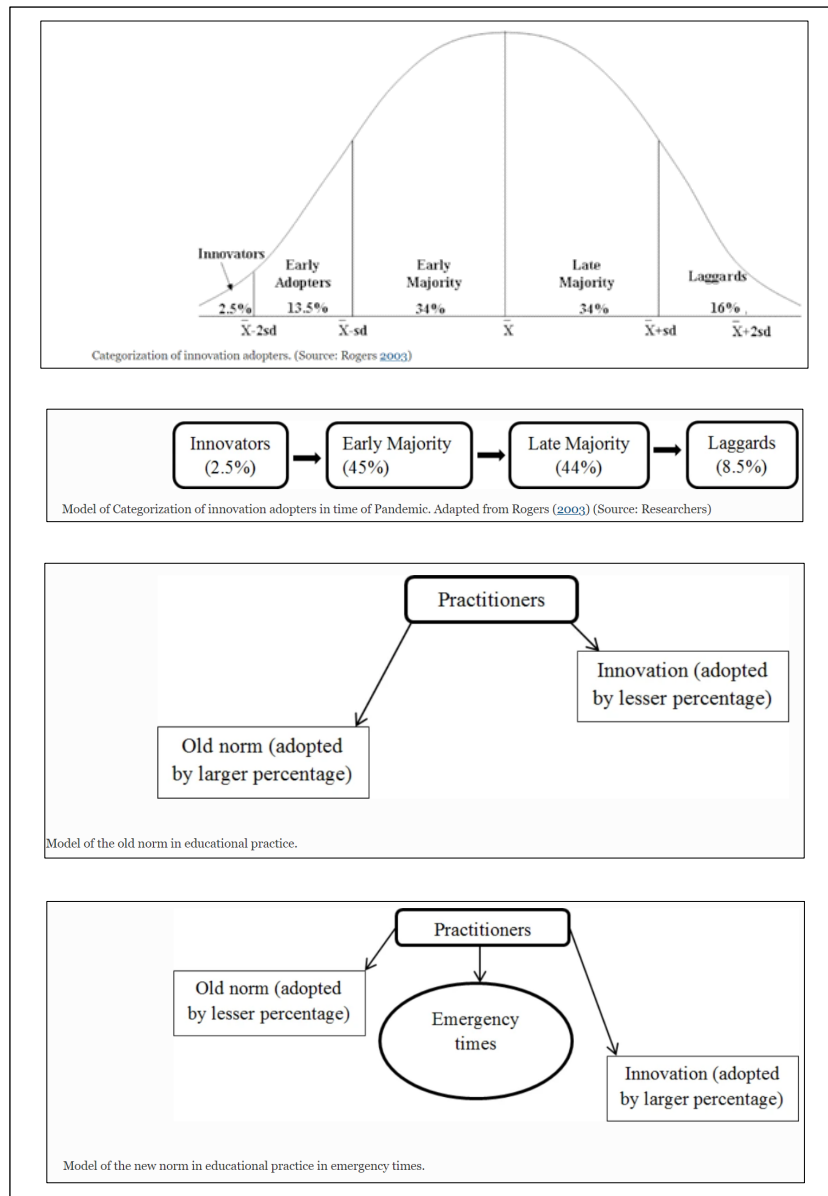
Fig. 2. Education systems have embraced educational technology,
bringing about a paradigm shift from the traditional norms [42]

According to Adil *et al.,* the study aimed to assess the impact of three interventions: Teaching at the right level (TaRL), Fortnightly assessments (FAS), and Digital teacher training sessions (DTS). The results indicated a significant and positive "Intention to Treat" (ITT) impact on the Urdu and English scores of students in the TaRL treatment group, with an increase of 0.56 standard deviations. However, no significant impact was observed on maths scores in the TaRL treatment group. The FAS and DTS interventions were found to contribute to higher English scores, but no significant ITT impact was observed on maths and Urdu scores for these treatment groups. The Local Average Treatment Effect (LATE) analysis revealed positive and significant improvement in Urdu and English scores for students in the TaRL treatment group. Stakeholders interviewed suggested that integrating TaRL into the curriculum could enhance learning outcomes in deprived areas. These findings are crucial for informing policymakers about the importance of implementing cost-effective, low-tech solutions to address learning gaps.

In a different study, Cai and King explored the use of education technology for online learning and assessment during times of crisis. The paper examined the utilization of online learning and

teaching tools by administrators, teachers, and students. Although online learning tools raise security concerns, they offer advantages such as feasibility, flexibility, and accessibility. The study also compared twelve proctoring systems for online assessment and proposed an evaluation framework and factors to consider when choosing proctoring systems. Based on their findings, a combination of options in utilizing proctoring systems is recommended. Education technology plays a vital role in enabling educational institutions to take effective action and maximize students' learning outcomes.

In a study by Popov *et al.,* a Delphi method was used to explore the challenges of mobile learning across different sectors. The study involved four rounds conducted online and face-to-face. During the study, experts in mobile learning identified four major challenge themes that were common across all sectors: risk-taking, matching technology to its use, know-how, and infrastructure. These challenges encompassed attitudes toward experimentation, using technology effectively, accessing information resources, and supporting structures and systems. The findings showed that K-12 and higher education sectors faced challenges related to pedagogy and policies, while the industry sector focused more on technological challenges. The study also provided transferable solutions for these challenges, offering practical strategies that can be applied in mobile learning across sectors.

Fergencs *et al.,* conducted a study in South African primary schools to explore the challenges of implementing a new learning management system for mathematics education. The aim was to understand the obstacles to successful implementation and uncover the difficulties faced by teachers and schools. Field-based observations and interviews were conducted with teachers, school principals, and the directors of the company that developed the learning management system. Additionally, a survey was distributed to collect attitudinal information from multiple schools. The findings revealed that implementing technology-enhanced learning requires more than just providing digital tools. It requires a profound institutional change. The success of implementation depends on factors such as teachers' mindset flexibility, the administrative workload of teachers, and the accessibility and usability of the technology. This study highlights the importance of addressing these challenges to ensure the effective integration of digital learning in classrooms. By understanding and overcoming these difficulties, schools can provide a fairer and more accessible education for students.

In the 21st century, being technologically adept is a key characteristic of learners. Technology has a significant contribution to modern-day education in the heyday of Learning Management Systems (LMS) and Massive Open Online Courses (MOOCs). The integration of technology in education aims to help learners adapt to the fast-changing world that relies on information systems and information technology. Further, being adept at technology fosters lifelong learning skills since information can now be easily stored, read, and learned through the world wide web. In the Philippines, the education system is adapting to technology, with teachers adapting to technology and using LMS as an extension to their classes. However, using LMS entails additional financial costs to teachers and students alike. Rombaoa investigates the cost of adapting technology for public school students by analysing the income of a family in the regular working-class vis-a-vis the cost of technology used for optimal LMS use for students. The research will aid in decision making on full implementation of technology in education for the Philippines and other developing countries with a similar situation.

3.2 Theme 2: Innovative Approaches in Teaching and Learning Technology Integration

Adıgüzel *et al.,* conducted a study focusing on the integration of role modelling strategies into the teaching and learning process as a dimension of self-regulated learning for K-12 teachers. The research aimed to explore the impact of role modelling strategy training through a hybrid professional development model on teachers' instructional competence. The study involved 16

teachers who underwent training and supervision to integrate role-modelling strategies into their teaching context. Data collection included the evaluation of role-modelling-integrated lesson plans, trainer feedback, and analysis of revised lesson plans and online student products. The results indicated that the professional development training positively influenced teachers' role modelling strategy implementation skills, leading to improvements in students' self-regulated learning skills, student-centred learning, and overall self-regulated learning. The study's findings contribute to the design of teacher professional development training, specifically in the role modelling dimension of self-regulated learning.

Bardack *et al.,* conducted a study with a sample of 30 learners from a peri-urban primary school in Malawi who participated in a tablet-based literacy program. The study aimed to investigate the independent contributions of home literacy and language environment, as well as working memory skills, to reading progress in the context of the program. Stepwise logistic regression was used, controlling for children's age, to analyse the data. The results revealed that working memory skills were a significant predictor of high versus low progress in reading, even when considering other factors known to influence early literacy development. These findings emphasize the importance of working memory skills as a key determinant of reading progress in the specific context of a tablet-based literacy program in a developing country. The study's results provide evidence-based insights for identifying and supporting learners who may be at risk of non-progress in reading during similar tablet-based literacy interventions.

The study conducted by Rakes *et al.,* aimed to examine how Teacher Candidates (TCs) implemented technology for Mathematics conceptual understanding through the use of the Professional Development: Research, Implementation, and Evaluation (PrimeD) framework and the Technology Pedagogical Content Knowledge (TPACK) framework. The researchers formed a Networked Improvement Community (NIC) consisting of TCs, classroom mentor teachers, field experience supervisors, and university faculty, who worked together to identify a problem of practice and a change idea to implement in the classroom. The participants then documented their improvement efforts and reported back to the NIC at monthly meetings. The Mathematics Classroom Observation Protocol for Practices (MCOP2) was used to examine the effectiveness of mathematics teaching practices used by TCs. The results showed that TCs increased their use of effective mathematics teaching practices, as indicated by MCOP2 scores. However, there was no significant growth in TPACK, and a relationship between TPACK and MCOP2 was not evident. These findings suggest that explicit focus on using technology for mathematics conceptual understanding may be necessary for TCs to improve their TPACK. The study's use of the PrimeD and TPACK frameworks and the NIC approach provides a useful model for teacher professional development in implementing technology in the classroom [49].
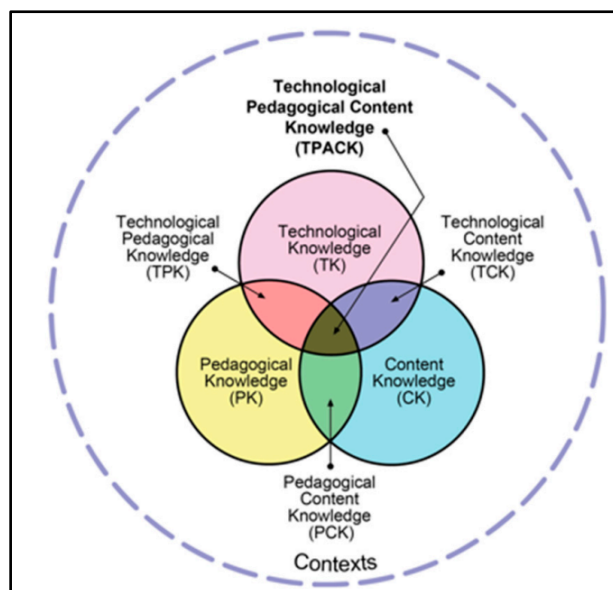
Fig. 3. The TPACK Framework (reproduced by permission of the publisher, © 2012 by tpack.org)

Dhingra emphasizes the critical need for clear descriptions of adult educator support roles in online education and convenient assessment methods for online learning platforms, given their central importance in today's world. The study utilizes heuristic evaluation to gain insights into adult support roles in an online social learning platform, providing valuable and cost-effective understandings. However, the author suggests that more detailed evaluations of online learning interactions are necessary to deepen our understanding of student interactions, their prior experiences, and the role of educator feedback. The paper highlights the significance of educator support roles in fostering inclusion within online learning communities, similar to their role in traditional classroom settings. Specific roles that are crucial for supporting student learning in online settings are described, raising important questions about system design and professional development that all online learning platforms should consider. The author recommends further research to explore various aspects of system design and educator professional development in online learning. Understanding and enhancing educator support roles in online learning is essential, particularly in promoting inclusive learning for all students.

Zhang *et al.,* discuss the use of multiple teaching and learning platforms to meet the diverse needs of specific courses. They propose the concept of designing a blended teaching mode that incorporates several platforms to create a comprehensive learning experience. The implementation of this idea is demonstrated through a programming course, where traditional on-site teaching is enhanced with embedded online learning activities from multiple platforms. Clustering analysis of learning data helps identify different types of learners and provides insights for continuous improvement in teaching.

In the field of language teaching, Wang *et al.,* explore English learners' perceptions of learning and learner engagement in a virtual reality (VR) learning environment. The study involves participants from a university in China and utilizes questionnaires and interviews to collect data. The findings reveal various factors that influence learners' conceptions of learning English, such as presence, motivation, interaction, and understanding. Additionally, the study identifies cognitive, behavioural, emotional, and social engagement as components of learner engagement in a VR setting. The research highlights the benefits and challenges associated with learning in a virtual reality environment.

Linda *et al.,* present an innovative practice that promotes critical thinking and achievement in mathematics using technology. They develop interactive learning modules utilizing GeoGebra, a dynamic mathematics platform. These modules visualize and illustrate the steps of geometry proofs, aiming to enhance students' comprehension of abstract logical processes in problem-solving. A survey study demonstrates the positive impact of these interactive modules on students' learning interests and critical thinking abilities.

3.3 Theme 3: Emerging Trends and Issues in Educational Technology

Wu explore the potential applications of non-fungible tokens (NFTs) in the education industry. They analyse the use of NFTs in various educational contexts, including textbooks, micro-certificates, transcripts, scholarships, learning experiences, and more. The study discusses the impact, value, and challenges associated with NFT applications and also addresses the need to consider the environmental sustainability of education NFTs. Vidanaralage *et al.,* investigate the relationship between video-based learning, schema congruency, emotions, and gamification. The study involves a mixed factorial experiment with young adult participants and explores memory retrieval accuracy, response time, and emotional responses in different learning conditions. The findings highlight the benefits of schema congruency and reveal the potential of gamified learning modes to elicit positive emotions in learners.

Deepa *et al.,* focus on the experiences of children from different socio-economic backgrounds in accessing school education and using technology for learning (refer Figure 4). The qualitative study examines the challenges and strategies faced by underprivileged and privileged children in terms of internet access, affordability of technology devices, quality teachers, parental support, and financial sponsorship. The findings provide insights for policymakers and EdTech companies to develop strategies for effective implementation of universal school education. These studies demonstrate the ongoing exploration of technology integration in education, including the use of NFTs, video-based learning, gamification, and the impact of socio-economic factors on learning experiences.
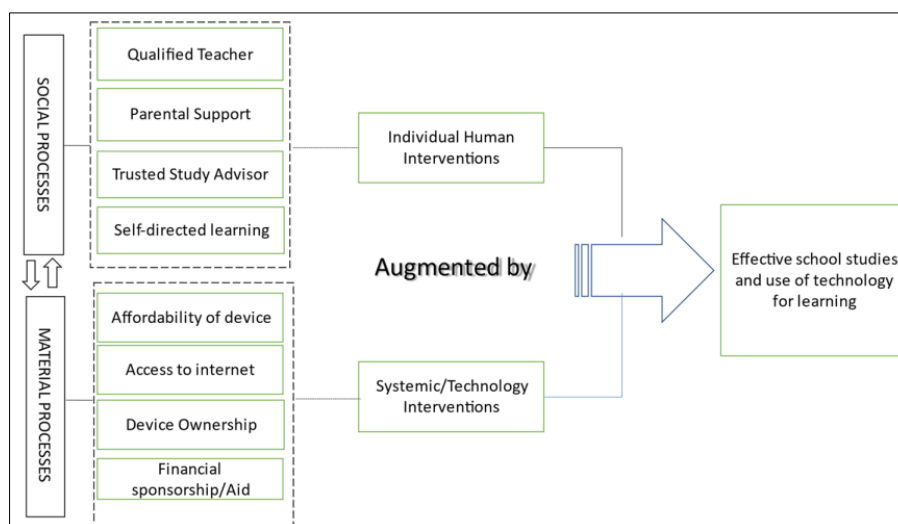
Fig. 4. Framework to understand children's perspective of school studies and use of technology [56]

Balakrishnan Nair examines the role of game-based learning in tourism higher education during the disruptions caused by the COVID-19 pandemic. The study highlights five main advantages of gamification, including increased student engagement, enhanced learning experiences, diversity and

inclusion, simplified assessment and feedback processes, and the development of employability skills. The findings emphasize the effectiveness of game-based learning in vocational disciplines like tourism technologies, particularly in the context of higher education disruptions. Gulson & Witzenberger investigate the incorporation of artificial intelligence (AI) in education governance, focusing on EduTech Australia as a case study. The study explores the connections between different aspects of automated governance and the relationships between participants, companies, and products in the education technology trade show. It highlights how the automated governance assemblage legitimizes EduTech as a policy space and a site of new authorities in education governance. Berquin addresses the environmental impacts of educational technologies and proposes a systematic approach to account for these impacts in the design process. The study uses a cost-benefit approach and examines a case study of a smart classroom model, evaluating environmental indicators such as energy consumption and waste generation, as well as educational benefits such as learning improvement and accessibility. The results shed light on issues related to the use of interactive screens in the classroom model.

Rennie *et al.,* focus on the usage of apps in Australian primary schools and categorize them based on their treatment of identifiable information. The study highlights the influence of the education sector on technology companies and the decision-making processes of teachers in selecting apps. It argues that individual guardian consent alone is inadequate for protecting children and suggests alternative legal and self-regulatory approaches to ensure the proper administration and formation of future digital citizens. These studies contribute to the understanding of the role of gamification in education, the integration of AI in education governance, the environmental impacts of educational technologies, and the governance of apps used in schools.

4. Conclusions
4.1 Theme 1: Technology Integration in Education

The studies discussed in this text highlight the importance of technology in education and how it can improve learning outcomes. One study found that certain interventions, like Teaching at the Right Level (TaRL), had a positive impact on language scores, but not on math scores. Another study showed that online learning tools have advantages like flexibility and accessibility, but they also raise security concerns. The use of proctoring systems for online assessments was recommended. Additionally, a study on mobile learning identified common challenges across different sectors, such as using technology effectively and having the right infrastructure. Another study focused on the challenges of implementing a new learning management system and emphasized the need for institutional change and teacher mindset flexibility.

In summary, these studies highlight that technology can enhance education, but there are challenges that need to be addressed. Policymakers and educators should consider these findings when deciding how to integrate technology effectively, making sure it is accessible and beneficial for all students.

4.2 Theme 2: Innovative Approaches in Teaching and Learning

These studies explore exciting ways to improve teaching and learning. One study shows that when teachers use role modelling strategies, students become better at learning on their own. Another study finds that good memory skills help children make progress in reading, especially when using tablets for learning. Teachers can improve their teaching by learning how to use technology effectively, as shown in another study. In online education, it's important to have supportive adults

and easy assessments. To meet different learning needs, using different teaching platforms together can be helpful. Virtual reality is also being used to teach languages, but it has both advantages and challenges. Lastly, interactive learning modules that visualize math problems can boost students' critical thinking and understanding. These studies offer valuable insights and ideas for improving teaching and learning, including role modelling, memory skills, technology integration, supportive adults, multiple teaching platforms, virtual reality, and interactive learning modules. By adopting these innovative approaches, we can create a great learning experience for students.

4.3 Theme 3: Emerging Trends and Issues in Educational Technology

These studies explore various aspects of technology integration in education. One study examines the potential uses of non-fungible tokens (NFTs) in education, including textbooks, certificates, and learning experiences. Another study focuses on video-based learning, gamification, and their impact on memory retrieval and emotions in learners. The experiences of children from different socio-economic backgrounds in accessing education and using technology are explored in another study, providing insights for policymakers and EdTech companies. The benefits of game-based learning in tourism education and the incorporation of artificial intelligence (AI) in education governance are also examined. The environmental impacts of educational technologies and the categorization of apps used in schools based on data privacy are addressed. These studies contribute to our understanding of gamification, AI integration, environmental considerations, and app governance in education. Overall, these studies provide valuable insights for enhancing teaching and learning through technology integration, addressing socio-economic factors, promoting environmental sustainability, and ensuring responsible use of educational technologies.

5. Conflicts of Interest

The authors declare that they have no conflicts of interest to report regarding the present study.

Acknowledgement

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