Semarak International Journal of STEM Education

Journal homepage:
https://semarakilmu.my/index.php/sijste/index
ISSN: 3030-5152

Engaging Young Minds: A Systematic Literature Review on the Role of Blended Learning Models in Primary Education

Abdullah Abdul Halim[1], Noor Dayana Abd Halim[1,*], Makmum Raharjo[2]

[1] Department of Advanced Learning Technology, Faculty of Educational Science and Technology, Universiti Teknologi Malaysia, 81310 Johor Bharu, Johor, Malaysia
[2] Fakultas Keguruan dan Ilmu Pendidikan, Universitas Sriwijaya, Jl Raya Palembang -Prabumulih, No KM 32, Indralaya Indah, Kec. Indralaya, Kabupaten Ogan Ilir, Sumatera Selatan, 30862 Palembang, Indonesia

ARTICLE INFO

Article history:
Received 20 December 2024
Received in revised form 31 January 2025
Accepted 10 February 2025
Available online 15 March 2025

Keywords:
Blended learning; roles: primary education; review

ABSTRACT

The integration of blended learning models in primary education has gained increasing attention due to their potential to enhance pupil engagement and learning effectiveness especially after pandemic COVID 19. This systematic literature review aims to synthesize existing research on the role of blended learning in fostering young learners' participation, academic development, and instructional adaptability. The problem addressed in this study is the need for a comprehensive understanding of how blended learning models impact primary education and the challenges associated with their implementation. The methodology involved a rigorous search and analysis of indexed and peer-reviewed articles from reputable databases such as Scopus and Web of Science, published between 2019 and 2024. The study followed the PRISMA framework to ensure a systematic selection and review process. A total of (n=32) studies met the predefined inclusion criteria, focusing on various blended learning approaches, including flipped classrooms, station rotation, and hybrid models. The findings were categorized into four main themes (1) Blended Learning and Language Acquisition (2) Blended Learning in STEM and Science Education, (3) Pupil Engagement, Motivation, and Inclusivity (4) COVID-19 and Post-Pandemic Education. Results indicate that blended learning highlight its effectiveness in improving reading comprehension, language proficiency, and STEM achievement, especially for pupils from low-income backgrounds. Integration of Augmented Reality and gamification into blended learning further enhance learning experiences. This review provides valuable insights for future research in explore long-term impacts, adaptive learning technologies, and digital equity in blended learning, especially for underprivileged communities.

1. Introduction

The rapid advancement of technology has revolutionized various sectors, including education. In recent years, blended learning has emerged as a transformative instructional model that combines traditional face-to-face teaching with digital learning tools. This approach is particularly relevant in

* *Corresponding author.*
E-mail address: noordayana@utm.my

https://doi.org/10.37934/sijste.5.1.1436b

primary education, where young learners require interactive, engaging, and flexible learning experiences to develop foundational skills effectively [1,2]. By integrating online and offline learning, blended learning has the potential to enhance pupil engagement, improve learning outcomes, and cater to diverse learning styles [3,4]. However, its implementation in primary education requires careful consideration of pedagogical strategies, technological infrastructure, and teacher readiness to ensure its effectiveness.

The adoption of blended learning in primary education has been significantly influenced by global educational shifts, especially following the COVID-19 pandemic, which highlighted the need for flexible and technology-driven learning solutions. Schools worldwide had to rapidly transition to online or hybrid learning, reinforcing the importance of digital literacy and access to educational technology [5,6]. Post-pandemic, many institutions have continued to integrate blended learning, recognizing its advantages in enhancing pupil-centered learning and providing personalized educational experiences [7]. Additionally, the increasing availability of educational technology (EdTech), such as adaptive learning platforms and gamified content, has further facilitated the adoption of blended learning in primary education [8,9].

One of the key benefits of blended learning is its ability to increase pupil engagement through interactive digital content, multimedia resources, and real-time feedback [10]. Unlike traditional teaching methods, which may not cater to all learning preferences, blended learning allows pupils to learn at their own pace, revisit complex concepts, and actively participate in digital learning activities [11,12]. Furthermore, it supports differentiated instruction, enabling teachers to personalize learning paths based on individual pupil progress. Other benefits include greater flexibility, improved collaboration [13], and enhanced teacher-pupil interactions through virtual discussions [14], online assessments, and digital learning analytics [15].

Despite its advantages, implementing blended learning in primary education presents several challenges, including teacher preparedness [16,17], digital access disparities [18,19], and pupil screen time management [20]. Many educators require additional training to effectively integrate digital tools into their teaching practices, while some pupils, particularly those from low-income backgrounds, may lack access to the necessary technology. Moreover, concerns regarding excessive screen time and its impact on young learners' cognitive and social development must be addressed. Ensuring a balanced approach that combines interactive digital learning with hands-on classroom activities is essential for maximizing the benefits of blended learning while mitigating potential drawbacks.

Given the growing interest in blended learning, this systematic literature review aims to synthesize existing research, identify best practices, and explore the key challenges and opportunities associated with its implementation in primary education. While blended learning has been widely studied in secondary and higher education, research on its effectiveness for younger learners remains relatively scarce. By analyzing previous studies, this review seeks to provide valuable insights for educators, policymakers, and researchers, guiding future innovations in primary education. Therefore, the current systematic analysis was developed to answer the following research questions;

1. How does blended learning impact language acquisition, reading comprehension, and vocabulary development in primary education?
2. How does blended learning impact STEM-related learning outcomes and student achievement in primary education?
3. How does blended learning enhance pupil engagement, motivation, and inclusivity in primary education?

4. How has blended learning evolved as a sustainable educational model in the post-COVID-19 era?

2. Literature Review

Blended learning, which combines traditional classroom methods with online educational tools, has increasingly gained traction in primary education as an effective pedagogical approach that integrates traditional face-to-face instruction with digital learning environments. This method offers flexibility and enhances learning experiences by catering to pupils' diverse needs. Research has highlighted its advantages in language acquisition, pupil engagement, and digital competency among educators [21,22,23]. The integration of blended learning models allows primary school pupils to access richer resources, fostering independent learning and personalized instruction. Moreover, educators have increasingly adopted technology-driven strategies to optimize teaching efficiency, aligning with broader educational reforms and digital transformation initiatives [24,25].

One significant area where blended learning has shown remarkable success is in second-language acquisition. English language learning in primary schools has faced challenges related to language attrition, where pupils struggle to retain previously acquired knowledge. Jin *et al.,* [21] introduced the T-RADIO model, a theoretical framework designed to mitigate language attrition through digital schema intervention. The study found that incorporating digital tools into the curriculum improved pupils' retention and comprehension of English. Similarly, Zilka *et al.,* [26] emphasized the importance of blended environments in sustaining engagement and preventing knowledge loss. Pang *et al.,* [27] further supported these findings by demonstrating how integrating digital and traditional teaching approaches reshapes classroom dynamics and enhances pupil participation, ultimately improving linguistic proficiency.

Pupil engagement remains a central challenge in education, and blended learning offers an innovative solution to this issue. Bond and Bergdahl [22] explored the behavioural, emotional, cognitive, and social aspects of pupil engagement in digital learning environments. Their findings revealed that interactive digital platforms in blended learning models significantly enhance pupils' motivation and participation. Additionally, research by Del-Valle-Rojas *et al.,* [23] suggested that digital training for educators plays a critical role in sustaining pupil interaction, as well-trained teachers are better equipped to design engaging online content. Yang *et al.,* [28] reinforced these conclusions by analyzing the mediating role of teacher agency in increasing pupil involvement. Collectively, these studies indicate that blended learning fosters a more interactive and immersive educational experience, reducing pupil disengagement and promoting active learning.

Educators play a vital role in implementing and optimizing blended learning strategies, with digital literacy being a key factor in their effectiveness. Teacher training programs focused on improving digital competencies have been shown to significantly enhance instructional delivery and classroom experiences. Del-Valle-Rojas *et al.,* [23] examined the digital training framework for public school teachers in Peru, highlighting the need for differentiated support in ICT integration. Zilka *et al.,* [26] also emphasized the necessity of incorporating social interaction into digital learning, suggesting that educators must balance knowledge delivery with interactive methodologies. Shaowei *et al.,* [29] explored blended teaching strategies in physical education, illustrating how structured online resources, combined with practical sessions, improve learning outcomes. These findings underscore the necessity of continuous professional development for teachers to fully leverage blended learning methodologies.

The impact of blended learning extends beyond conventional subjects, as pedagogical innovations have also transformed physical education and vocational training. Research by Shaowei

et al., [29] demonstrated that a blended model enhances physical education instruction by combining digital tutorials with hands-on activities. Firman *et al.,* [30] further examined the application of Learning Management Systems (LMS) in blended learning environments, revealing that the integration of digital resources with traditional methods leads to higher learning motivation and improved academic performance. Similarly, Houwink *et al.,* [31] explored the application of blended learning in healthcare education, emphasizing how structured frameworks such as the CanMEDS model support curriculum development. These studies indicate that blended learning methodologies are versatile and adaptable across various disciplines, offering substantial benefits to pupils in diverse educational settings.

Despite its numerous advantages, the implementation of blended learning is accompanied by significant challenges. Infrastructure limitations, digital divides, and resistance to pedagogical change remain prominent barriers to widespread adoption. Singhania *et al.,* [32] highlighted disparities in digital access between rural and urban educational institutions, noting that educators in underprivileged areas struggle to implement effective online teaching methods. Xu [33] examined the role of technological advancements in education, proposing strategic planning and institutional support as crucial factors for overcoming digital learning barriers. Timmermans *et al.,* [34] emphasized the importance of continuous teacher training and adaptation to evolving technologies to maximize blended learning's potential. Addressing these challenges requires targeted policy interventions, investment in digital infrastructure, and robust support systems for educators and pupils alike.

In conclusion, blended learning has emerged as a transformative force in primary education, effectively addressing challenges such as language attrition, pupil engagement, and teacher training. Research indicates that integrating digital tools into traditional classrooms enhances learning outcomes and fosters personalized, interactive educational experiences. However, the successful implementation of blended learning models requires adequate infrastructure, continuous professional development for teachers, and strategic institutional support. Future research should focus on refining these models, evaluating their long-term impact, and developing strategies to mitigate existing challenges. By harnessing technological advancements and pedagogical innovations, blended learning can continue to revolutionize primary education, ensuring that pupils receive high-quality and inclusive learning experiences.

3. Methodology

3.1 Review Protocol

This Systematic Literature Review (SLR) is guided by PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses). PRISMA is a published standard to conduct a systematic literature review to provide transparent reports on the methodology, findings, and justification [35]. The strategy for document searching was devised and implemented in three systematic phases: identification, screening, and eligibility. Finally, the selected papers were processed through many processes, including data extraction and analysis. The thematic synthesis was performed in analysing the extracted data.

3.2 Formulation of the Research Questions

Two sources were used to formulate the research question: first, ideas from prior studies by Hwang *et al.,* [36] and Huang *et al.,* [37]. Both articles discussed the use of blended learning in primary education. Second, use the mnemonic PICo, which stands for 'P' (population or problem), 'I' (interest),

and 'Co' (context) [38]. Based on these principles, the authors considered three major components in their review: primary education (population), blended learning (interest), and blended learning roles (context). This enabled the authors to construct the study's key question, "How does blended learning play a role in primary school education?"

3.3 Systematic Searching Strategies

Shaffril *et al.,* [39] offered three systematic methods for retrieving relevant publications, including identification, screening, and eligibility. Implementing these techniques enabled the authors to discover and synthesise studies, resulting in a well-organized and transparent systematic literature review.

3.3.1 Identification

This identification stage focuses on the process of searching for identical and similar terms using a thesaurus, dictionaries, suggested related keywords by Scopus and previous studies. As a result, search strings for the Scopus and Web of Science databases were created in January 2025 after all relevant keywords had been identified. These keyword combinations were searched in two databases: Scopus and Web of Science, employing field code functions, phrase searching, wildcards, truncation, and Boolean operators. This identification technique successfully extracted a total of 507 items from both databases. (see Table1).

Table 1
The search strings

Databases	**Searching string and searching terms**
Web of Science	Topic = ((“Blended Learning” OR “Hybrid Learning” OR “Mixed-mode Learning” OR “Flexible Learning” OR “Blended Instruction” OR “Blended Teaching”) AND (“primary school” OR “School child” OR “elementary school”)) Date of access: January 2025
Scopus	TITLE-ABS-KEY ((“Blended Learning” OR “Hybrid Learning” OR “Mixed-mode Learning” OR “Flexible Learning” OR “Blended Instruction” OR “Blended Teaching”) AND (“primary school” OR “School child” OR “elementary school”)) Date of access: January 2025

3.3.2 Screening

In the second step of the systematic review process, 507 publications were evaluated using numerous inclusion and exclusion criteria established by the researchers (see Table 2). The first criterion was literature type, and the researchers decided to focus solely on journals (research articles) because they serve as primary sources of empirical data. As a result, the current study excludes articles in the form of reviews, book series, book chapters, and conference proceedings. Furthermore, to minimise confusion, the review focused solely on papers published in English. Given the importance of’ research field maturity' as stressed by Kraus *et al.,* [40] this study limited the screening process to articles published between 2019 and 2024. The timeline below was chosen due the quantity of published research was adequate to conduct a comprehensive review. Most significantly, articles published solely in the subject of social science were chosen to maximise the likelihood of retrieving relevant articles to the topic. A total of 321 articles were eliminated from the evaluation during this stage because they did not meet the inclusion criteria. The next step was to

identify duplicate articles in both sources. As a result, 26 duplicate articles were removed. This resulted in 160 remaining articles for evaluation in the subsequent stage.

Table 2
Inclusion and exclusion criteria

Criterion	Inclusion	Exclusion
Language	English	Non-English
Timeline	2019 – 2023	< 2019
Literature type	Journal (article)	Conference, book, review
Subject area	Social science	Besides social science
Publication Stage	Final	In Press

3.3.3 Eligibility

The third stage, known as eligibility, involved the preparation of 160 articles. At this step, on a more crucial note, the titles, abstracts, and primary contents of all the articles were thoroughly checked to ensure that they met the inclusion criteria and were appropriate for use in the current study to achieve the current research objectives. As a result, 126 articles were removed because they lacked empirical data, and participant is not pupils in primary schools. Therefore, a total of 34 remaining papers are ready to be analysed.

These papers were further evaluated using Gough [41] Weight of Evidence (see Tables 3). This score system is used in this research since it provides meticulous assessment that can be used to evaluate previous literature, ensuring that only compatible and relevant articles are selected for the current study [41]. Only articles that provide an overall evaluation using the 'excellent' and 'good' criteria are included (see Table 4). Finally, only 32 studies were selected for further review to answer the study's research questions. Figure 1 shows the flow diagrams of the searching process.

Table 3
The weight of evidence [41,42]

Level/ criterion	Methodological quality	Methodological relevance	Topic relevance
Excellent	Excellent research design that justifies all decisions taken, e.g.: sample, instruments, analysis. Clear evidence of measures taken to maximise validity and reliability	Research questions are clearly stated. Methodology is highly relevant to research questions and answer them in detail	Study is very closely aligned to one of the key review questions and provides very strong evidence upon which to base future policy/action
Good	Research design is clearly stated with evidence of sensible decisions taken to provide valid and reliable findings	Research questions are explicit or can be deduced from text Findings address the research questions	Study is broadly in line with one of the key reviews questions and provides useful evidence
Satisfactory	Research design may be implicit but appears sensible and likely to yield useful data	Research questions implicit but appear to be broadly matched by research design and findings	At least part of the study findings is relevant to one of the key review questions
Inadequate	Research design is not stated and contains flaws	Research questions are not stated or not matched by design	Study does not address key questions

Table 4
The weight of evidence for the included and excluded studies

No	Author, year	Methodology quality	Methodology relevance	Topic relevance	Action
1	AlManafi *et al.,* [43] (2023)	Excellent	Excellent	Excellent	Included
2	Assylzhanova *et al.,* [44] (2022)	Excellent	Excellent	Excellent	Included
3	Bārdule [45] (2021)	Good	Excellent	Excellent	Included
4	Wilkes *et al.,* [46] (2020)	Excellent	Good	Excellent	Included
5	Hong and Stapa [47] (2023)	Excellent	Excellent	Excellent	Included
6	Fauzan *et al.,* [48] (2023)	Good	Satisfactory	Satisfactory	Excluded
7	Dey and Bandyopadhyay [3] (2019)	Good	Good	Excellent	Included
8	Hu *et al.,* [49] (2022)	Excellent	Good	Good	Included
9	Choy and Cheung [50] (2022)	Excellent	Good	Excellent	Included
10	Huang *et al.,* [37] (2022)	Excellent	Excellent	Excellent	Included
11	Hwang *et al.,* [36] (2019)	Excellent	Excellent	Excellent	Included
12	Inal and Korkmaz [51] (2019)	Excellent	Excellent	Excellent	Included
13	Kundu *et al.,* [52] (2021)	Excellent	Excellent	Excellent	Included
14	Kwon and Lee [53] (2024)	Excellent	Excellent	Excellent	Included
15	Lang [54] (2023)	Excellent	Good	Satisfactory	Excluded
16	Lee *et al.,* [55] (2021)	Excellent	Excellent	Excellent	Included
17	Macaruso *et al.,*) [56] (2020	Excellent	Excellent	Excellent	Included
18	Macaruso *et al.,* [57] (2019)	Excellent	Good	Excellent	Included
19	Miskiah *et al.,* [58] (2020)	Excellent	Excellent	Excellent	Included
20	Nuryadin *et al.,* [59] (2023)	Good	Excellent	Excellent	Included
21	Ponniah *et al.,* [60] (2022)	Good	Good	Excellent	Included
22	Rachmawati *et al.,* [6] (2022)	Excellent	Excellent	Good	Included
23	Seage and Türegün [61] (2020)	Excellent	Excellent	Excellent	Included
24	Setemen *et al.,* [62] (2023)	Excellent	Excellent	Excellent	Included
25	Sulistyanto *et al.,* [63] (2023)	Excellent	Good	Excellent	Included
26	Taufik *et al.,* [64] (2022)	Good	Excellent	Excellent	Included
27	Tzagkourni *et al.,* [65] (2021)	Good	Good	Good	Included
28	Urankar and Jamšek [66] (2022)	Good	Good	Good	Included
29	Villesseche *et al.,* [67] (2019)	Excellent	Good	Good	Included
30	Yonchai *et al.,* [68] (2023)	Excellent	Excellent	Excellent	Included
31	Meletiou-Mavrotheris *et al.,* [69] (2024)	Excellent	Good	Excellent	Included
32	Paavilainen *et al.,* [70] (2024)	Good	Good	Excellent	Included
33	Siller and Ahmad [71] (2024)	Excellent	Excellent	Excellent	Included
34	Zhang and Huang [72] (2024)	Excellent	Excellent	Excellent	Included

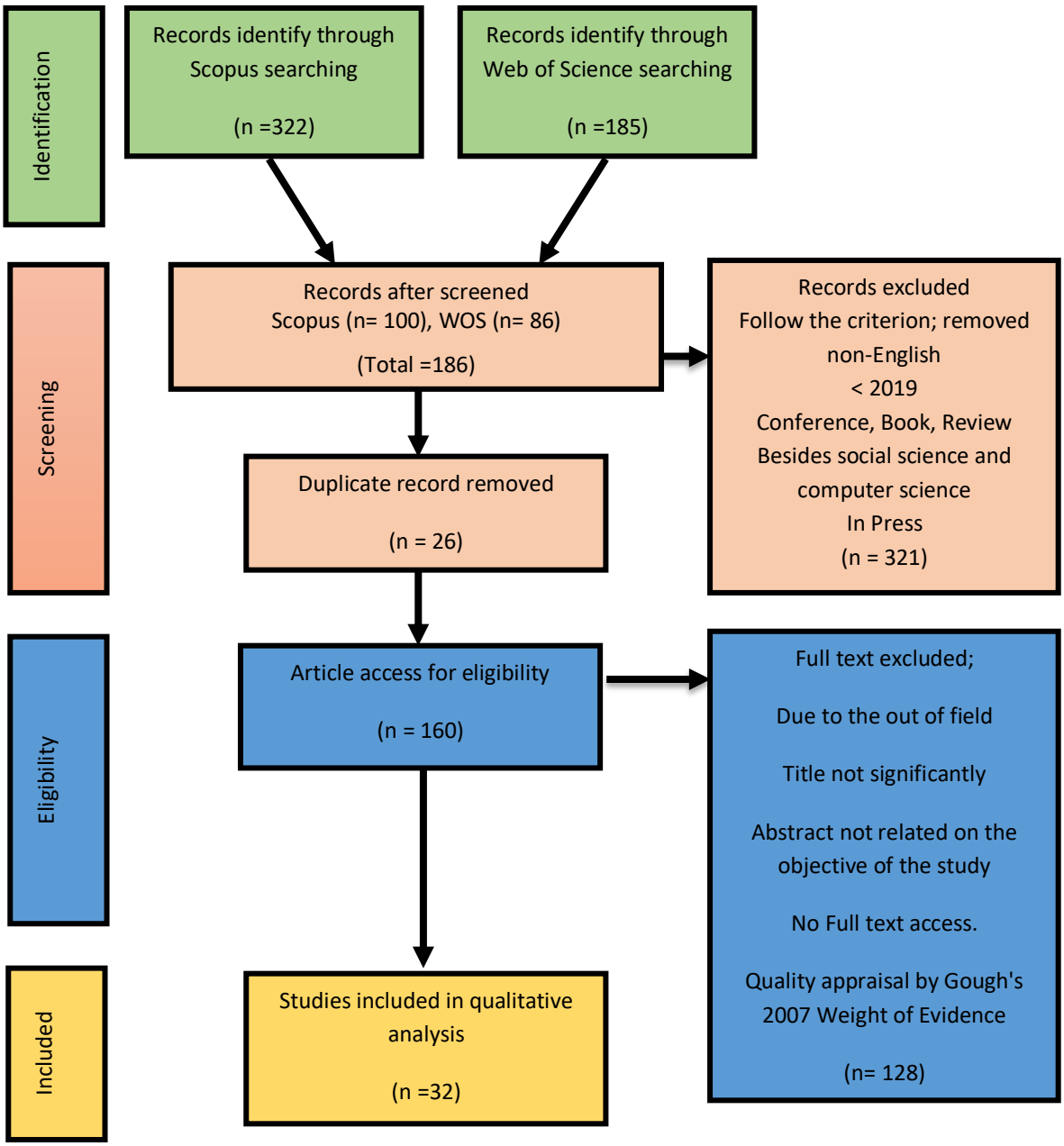

Fig. 1. Flow diagram of the searching process [73,74]

4. Result and Finding

4.1 Background of Selected Studies

Table 5 summarizes the studies, highlighting the authors, years, journals, countries where the studies were conducted, and the participants involved. It provides a clear overview of the research landscape and focus areas within this collection of studies.

Table 5
The characteristic of selected studies

No	Author name	Year	Journal	Countries	Participants
1	AlManafi *et al.,* [43]	2023	International Journal of Instruction	Libya	120 primary stage EFL pupils
2	Assylzhanova *et al.,* [44]	2022	International Journal of Education in Mathematics, Science, and Technology	Kazakhstan	60 elementary school pupils
3	Bārdule [45]	2021	Baltic Journal of Modern Computing	Latvia	Elementary school pupils
4	Choy and Cheung [50]	2022	Journal of Computer Education	Singapore	408 primary four pupils
5	Wilkes *et al.,* [46]	2020	Journal of Computer Assisted Learning	United States	520 kindergarten and first-grade pupils
6	Dey and Bandyopadhyay [3]	2019	Education and Information Technologies	India	Underprivileged primary school pupils
7	Hong and Stapa [47]	2023	Journal of Nusantara Studies	Malaysia	Two classes of primary school pupils
8	Hu *et al.,* [49]	2022	Occupational Therapy International	China	Elementary school pupils
9	Huang *et al.,* [37]	2022	Mobile Information Systems	Taiwan	57 elementary school pupils
10	Hwang *et al.,* [36]	2019	International Journal of Online Pedagogy and Course Design	Taiwan	106 elementary school pupils
11	Inal and Korkmaz [51]	2019	Education and Information Technologies	Turkey	40 fourth-grade pupils
12	Kundu *et al.,* [52]	2020	Education and Information Technologies	India	40 fourth-grade pupils
13	Kwon and Lee [53]	2024	Children's Geographies	South Korea	One 6th grade class
14	Lee *et al.,* [55]	2021	International Journal of Art & Design Education	South Korea	Elementary school third and fourth graders
15	Macaruso *et al.,* [56]	2020	Education Tech Research Dev	USA	2217 elementary school pupils
16	Macaruso *et al.,* [57]	2019	Computers in the Schools	USA	68 kindergarten pupils
17	Miskiah *et al.,* [58]	2020	Universal Journal of Educational Research	Indonesia	61 fifth-grade pupils
18	Nuryadin *et al.,* [59]	2023	Participatory Educational Research (PER)	Indonesia	136 elementary pupils
19	Ponniah *et al.,* [60]	2022	International Journal of Advanced and Applied Sciences	Malaysia	Tamil primary school pupils
20	Rachmawati *et al.,* [6]	2022	The Qualitative Report	Indonesia	Pupils with learning disabilities in primary schools
21	Seage and Turegun [61]	2020	International Journal of Research in Education and Science	USA	129 third to fifth grade pupils
22	Setemen *et al.,* [62]	2023	Nurture Journal	Indonesia	64 fifth-grade pupils
23	Sulistyanto *et al.,* [63]	2023	Asian Journal of University Education	Indonesia	98 elementary school pupils
24	Taufik *et al.,* [64]	2022	Annals of Applied Sport Science	Indonesia	32 fifth-grade pupils
25	Tzagkourni *et al.,* [65]	2021	Education and Information Technologies	Greece	Second-grade primary school pupils
26	Urankar and Jamaiek [66]	2022	CEPS Journal	Slovenia	56 lesson plans for pupils aged 12 years
27	Villesseche *et al.,* [67]	2019	Interactive Technology and Smart Education	France	Fourth and fifth-grade primary school pupils
28	Yonchai *et al.,* [68]	2023	Eurasian Journal of Educational Research	Thailand	Fifteen fifth and sixth-grade pupils

29	Meletiou-Mavrotheris, *et al.,* [69]	2024	Electronic Journal of e-Learning	Cyprus	204 primary school pupils (aged 9-12)
30	Paavilainen *et al.,* [70]	2024	Technology, Knowledge, and Learning	Finland	Two classes of 5th and 6th graders (n=52)
31	Siller and Ahmad [71]	2024	Canadian Journal of Science, Math & Tech Education	Pakistan	87 5th-grade pupils
32	Zhang and Huang [72]	2024	Education and Information Technologies	China	45 elementary school learners

Out of the 32 studies reviewed, five were conducted in Indonesia, four in the USA, and two each in China, Malaysia, India, South Korea, and Taiwan. The remaining studies were conducted in Libya, Kazakhstan, Latvia, Singapore, Turkey, Greece, Slovenia, France, Thailand, Cyprus, Finland, and Pakistan, with one study per country. These studies were conducted between 2019 and 2024, with six studies in 2019, four in 2020, three in 2021, nine in 2022, seven in 2023, and five in 2024, showing a steady increase in research interest in recent years. Meanwhile, all studies focused on primary and elementary education, with participants ranging from kindergarten to sixth-grade pupils. Several studies involved large sample sizes, such as Macaruso *et al.,* (2,217 pupils) and Choy & Cheung (408 pupils), while others focused on smaller classroom-based research, such as Kwon & Lee (one class of sixth graders) and Hong & Stapa (two classes of primary school pupils). Most studies were published in educational technology and pedagogy journals, indicating a strong focus on digital learning, instructional strategies, and innovative teaching methodologies in early education.

4.2 The Developed Themes

The thematic analysis of 32 selected papers yielded four key themes: (1) Blended Learning and Language Acquisition (2) Blended Learning in STEM and Science Education, (3) Pupil Engagement, Motivation, and Inclusivity and (4) COVID-19 and Post-Pandemic Education. These four topics gave solutions to answer the research questions in this review. Table 6 below elaborates the findings of the selected investigations.

Table 6
The findings of selected studies

No	Author, year	Models of blended learning used	Research key focus	Themes			
				BLLA	**BLSE**	**SEMI**	**CPPE**
1	AlManafi *et al.,* [43] (2023)	Flipped Classrooms	Impact of blended learning on reading comprehension of EFL pupils in Libya.	⁄			
2	Assylzhanova *et al.,* [44] (2022)	ICT-Enhanced Blended Learning	Comparing ICT-enhanced and traditional methods on English achievement and attitudes.	⁄			
3	Bārdule [45] (2021)	Flipped Learning	Analysis of ICT tools for flipped learning in elementary schools.			⁄	
4	Choy and Cheung [50] (2022)	Technology-Enhanced Blended Learning	Self-directed and collaborative learning in English writing.	⁄			
5	Wilkes *et al.,* [46] (2020)	Core5 Blended Learning	Impact of Core5 blended learning on early literacy growth.	⁄			
6	Dey and Bandyopadhyay [3] (2019)	Internet-Enabled Blended Learning	Improving quality of education among underprivileged pupils in India.			⁄	
7	Hong and Stapa [47] (2023)	General Blended Learning	Effects on vocabulary development and motivation in an ESL classroom.	⁄			
8	Hu *et al.,* [49] (2022)	AR-Based Learning	AR games for enhancing English pronunciation among children.	⁄			
9	Huang *et al.,* [37] (2022)	Activity System-Based Process Model (ASPM)	Applying AR-based blended learning in elementary school natural science courses.		⁄		
10	Hwang *et al.,* [36] (2019)	Rotational Blended Learning	Improving learning achievement in elementary science education.		⁄		
11	Inal and Korkmaz [51] (2019)	Web-Based Blended Learning (DynED)	Effects on pupils' academic achievement and attitudes in English learning.	⁄			
12	Kundu *et al.,* [52] (2020)	Math & Literacy Blended Learning	Implementation of blended learning routines in Indian elementary classrooms.		⁄		
13	Kwon and Lee [53] (2023)	Synchronous Bi-Directional Online Learning	Impact of online blended learning during COVID-19 in South Korea.				⁄
14	Lee *et al.,* [55] (2021)	AR Blended Learning	Developing AR-based museum education content for primary school children.				⁄
15	Macaruso *et al.,* [56] (2020)	Blended Reading Instruction	Using blended learning for elementary reading instruction.	⁄			
16	Macaruso *et al.,* [57] (2019)	Lexia® Core5® Blended Learning	Longitudinal impact of a blended reading program on low-SES kindergarteners.	⁄			
17	Miskiah *et al.,* [58] (2020)	Blended Learning	Effects on pupils' creativity and activeness in elementary schools.				⁄
18	Nuryadin *et al.,* [59] (2023)	Flipped Classroom Model	Post-pandemic adoption of flipped classrooms in elementary education.			⁄	

19	Ponniah *et al.,* [60] (2022)	Tamil Blended Learning	Implementation of blended learning in Tamil primary schools.			⁄	
20	Rachmawati *et al.,* [6] (2022)	Hybrid Learning for Inclusive Education	Supporting pupils with learning disabilities in primary schools.			⁄	
21	Seage and Turegun [61] (2020)	Blended STEM Learning	Effects on STEM achievement of elementary school pupils.		⁄		
22	Setemen *et al.,* [62] (2023)	Blended Multicultural Learning	Impact on nationalism attitudes in social studies education.			⁄	
23	Sulistyanto *et al.,* [63] (2023)	Hybrid Learning-Based Adaptive Media	Empowering pupils' critical thinking skills using VARK model.		⁄		
24	Taufik *et al.,* [64] (2022)	YouTube-Based Virtual Blended Learning	Fundamental movement skills learning in elementary schools.			⁄	
25	Tzagkourni *et al.,* [65] (2021)	ICT-Enhanced Blended Learning	Using ICT-based approaches in EFL teaching for primary school pupils.	⁄			
26	Urankar and Jama¡ek [66] (2022)	Distance Learning Model	Engineering education practices during COVID-19 in Slovenian primary schools.				⁄
27	Villesseche *et al.,* [67] (2019)	Adaptive E-Learning	Enhancing reading comprehension through adaptive learning.	⁄			
28	Yonchai *et al.,* [68] (2023)	Blended Learning Using Rotating Stations	Developing a rotation-based blended model for small elementary schools.			⁄	
29	Meletiou-Mavrotheris *et al.,* [69] (2024)	Emergency Remote Learning (ERL)	Impact of COVID-19 on primary education and reflections on e-learning adaptation.				⁄
30	Paavilainen *et al.,* [70] (2024)	Learning Analytics in Blended Learning	Supporting self-regulated learning in primary education through analytics			⁄	
31	Siller and Ahmad [71] (2024)	Concrete & Virtual Manipulatives Blended Learning	Effects on elementary pupils' mathematical achievement.		⁄		
32	Zhang and Huang [72] (2024)	Adaptive Gamified Assessment	Gamification's impact on motivation and language proficiency in blended learning.	⁄			

*BLLA = Blended Learning and Language Acquisition; BLSE = Blended Learning in STEM and Science Education; SEMI= Pupil Engagement, Motivation, and Inclusivity; CPPE= COVID-19 and Post-Pandemic Education

4.2.1 Blended learning and language acquisition

Blended learning has significantly transformed language acquisition by integrating digital tools with traditional instruction, fostering greater engagement, and improving literacy outcomes. Studies have demonstrated that such approaches positively impact reading comprehension, vocabulary acquisition, and motivation among primary and elementary pupils. AlManafi *et al.,* [43] emphasized that blended learning enhances reading comprehension in EFL pupils, while Macaruso *et al.,* [56] found that integrating digital literacy programs into early education improved reading proficiency. Similarly, Wilkes *et al.,* [46] noted that the Core5 blended learning model effectively accelerated literacy development, particularly among pupils from low socioeconomic backgrounds. Furthermore, Villesseche *et al.,* [67] highlighted the benefits of adaptive e-learning, emphasizing that pupils, particularly those struggling with comprehension, demonstrated substantial improvements in reading skills through tailored digital interventions.

The effectiveness of blended learning extends beyond literacy, positively influencing vocabulary retention and self-directed learning. Hong and Stapa [47] found that incorporating digital platforms into ESL classrooms significantly improved pupils' vocabulary development and motivation. Similarly, Hu *et al.,* [49] demonstrated that Augmented Reality (AR) games in blended learning environment enhanced English pronunciation skills, supporting the notion that interactive digital tools promote deeper language acquisition. Additionally, Inal and Korkmaz [51] found that web-based blended learning significantly contributed to academic achievement in English courses. Choy and Cheung [50] further reinforced this, noting that ICT-enhanced blended learning fostered self-directed and collaborative learning, particularly in writing instruction. Zhang and Huang [72] expanded on these findings by illustrating how adaptive gamified assessments in blended learning not only improved pupil motivation but also enhanced language proficiency through interactive feedback mechanisms.

Longitudinal research supports the sustained impact of blended learning on language acquisition. Macaruso *et al.,* [57] conducted a three-year study on the Lexia Core5 program and found consistent literacy gains across multiple years, particularly among pupils from disadvantaged backgrounds. Tzagkourni *et al.,* [65] explored the role of ICT-based English instruction, emphasizing its effectiveness in improving alphabet recognition and phonological awareness. Moreover, Villesseche *et al.,* [67] demonstrated that adaptive e-learning platforms, leveraging Item Response Theory, effectively tailored learning experiences to individual pupil needs, reinforcing long-term comprehension skills. While challenges remain, such as teacher training and technological accessibility [43,47], the overwhelming consensus across multiple studies indicates that blended learning enhances literacy, vocabulary, motivation, and self-directed learning, positioning it as a pivotal tool in modern language education.

4.2.2 Blended learning in STEM and science education

Blended learning has significantly transformed science and STEM education by integrating traditional instruction with digital and interactive elements. Studies Hwang *et al.,* [36] and Huang *et al.,* [37] highlight how blended learning environments improve pupil engagement, comprehension, and motivation, particularly in elementary science education. Huang *et al.,* [37] introduced an Augmented Reality-Based Blended Learning (ARBL) model, demonstrating its effectiveness in enhancing spatial visualization and conceptual understanding compared to traditional blended learning methods. Similarly, Sulistyanto *et al.,* [63] emphasized that hybrid learning models, which adapt to various learning styles (VARK), foster critical thinking skills, making scientific concepts more accessible and engaging. These findings indicate that technology-enhanced blended learning

strategies provide more interactive and pupil-centered learning experiences, ultimately improving educational outcomes in science subjects.

In STEM education, blended learning has proven instrumental in bridging achievement gaps and enhancing problem-solving skills. Research by Seage and Türegün [61] found that elementary pupils from low socioeconomic backgrounds achieved higher scores in STEM subjects when engaged in blended learning environments. This aligns with Kundu *et al.,* [52] who reported increased classroom engagement and improved literacy and mathematical outcomes in Indian elementary schools using blended learning approaches. Additionally, Siller and Ahmad [71] demonstrated that incorporating both concrete and virtual manipulatives in mathematics instruction significantly enhances pupils' mathematical achievement, reinforcing the value of integrating digital tools with hands-on learning. These studies underscore that blended learning not only enhances academic performance but also supports diverse learning needs, making STEM education more accessible and effective.

Despite its advantages, successful implementation of blended learning in STEM and science education requires addressing key challenges such as teacher preparedness, technological accessibility, and instructional design. Kundu *et al.,* [52] emphasized the need for extensive teacher training to effectively integrate blended learning strategies into classrooms. Meanwhile, by Seage and Türegün [61] highlighted the digital divide, noting that pupils from underprivileged backgrounds often struggle with limited access to technology, which can hinder learning outcomes. Furthermore, Huang *et al.,* [37] suggested that structured instructional models like the Activity System-Based Process Model (ASPM) are necessary to optimize the balance between online and offline learning components. Moving forward, emerging technologies such as augmented reality and AI-driven adaptive learning systems can further enhance blended learning effectiveness, ensuring that STEM and science education continue to evolve to meet diverse pupil needs.

4.2.3 Pupil engagement, motivation, and inclusivity

Blended learning has significantly influenced pupil engagement, motivation, and inclusivity in primary education by integrating digital tools with traditional teaching methods. Bārdule [45] highlights the flipped learning approach, where pre-class digital interactions and in-class collaborative activities enhance pupil participation. Similarly, Nuryadin *et al.,* [59] found that pupils preferred completing assignments in structured classroom environments rather than independently at home, emphasizing the importance of teacher-guided engagement. Furthermore, Paavilainen *et al.,* [70] demonstrated how learning analytics within blended learning environments provide insights into pupil behaviour, allowing educators to refine instructional strategies for improved engagement.

The impact of blended learning on pupil motivation is evident in studies that emphasize technology-driven learning experiences. Dey and Bandyopadhyay [3] revealed that Internet-enabled blended learning platforms provide underprivileged pupils with access to high-quality educational resources and expert guidance, enhancing their motivation and learning outcomes. Ponniah *et al.,* [60] also reported that Tamil primary school pupils demonstrated high levels of participation and improved performance when exposed to blended learning environments. Additionally, Taufik *et al.,* [64] explored the use of YouTube-based virtual learning and found that integrating multimedia content in education sustains pupil interest, making learning more dynamic and engaging.

Inclusivity in blended learning environments is supported by tailored approaches that address diverse pupil needs. Rachmawati *et al.,* [6] identified key strategies, such as clear instructions and adaptive learning media, to facilitate hybrid learning for pupils with disabilities. Setemen *et al.,* [62] emphasized the role of cultural literacy in blended multicultural learning, which fosters nationalism and social inclusion in primary education. Similarly, Yonchai *et al.,* [68] developed a rotating station

model that enables small elementary schools with limited resources to provide personalized learning experiences. Despite its benefits, challenges such as digital literacy, educator readiness, and unequal access to technology must be addressed to fully realize the potential of blended learning in promoting engagement, motivation, and inclusivity in education.

4.2.4 COVID-19 and post-pandemic education

The COVID-19 pandemic significantly reshaped education by forcing a rapid transition to online and blended learning models. Research by Kwon and Lee [53] highlighted the complex nature of online classrooms, where pupils navigated between institutional control and personal agency. Their study in South Korea revealed that pupils were not merely passive learners but actively shaped their learning experiences through strategic use of digital tools. Similarly, Urankar and Jamšek [66] examined engineering education in Slovenia and found that while online learning provided flexibility, it also exposed disparities in digital literacy and access. These studies emphasized the importance of pupil agency and the necessity for adaptive learning environments that balance structure and autonomy [53,66]

Blended learning emerged as an effective pedagogical approach that integrates online and offline elements to enhance pupil engagement. Lee *et al.,* [55] explored augmented reality (AR) in museum education and found that AR-enhanced blended learning significantly improved pupil interaction and retention of historical knowledge. Meanwhile, Miskiah *et al.,* [58] conducted a study on elementary school pupils in Indonesia and concluded that blended learning fostered creativity and activeness more effectively than conventional teaching methods. Both studies suggested that a well-structured blended learning model can enhance learning outcomes by incorporating digital tools that provide interactive and immersive experiences [55,58]. However, successful implementation requires teacher training and equitable access to digital resources.

Despite the benefits of digital learning, challenges such as the digital divide, technological limitations, and educator readiness remain critical concerns. Kwon and Lee [53] pointed out that pupils from lower-income households faced difficulties in accessing online education, while Urankar and Jamšek [66] noted that technical subjects like engineering require hands-on learning that is difficult to replicate in virtual settings. To address these issues, post-pandemic education must integrate flexible learning policies that support pupil autonomy while ensuring access to necessary technological infrastructure. Moving forward, the studies suggest that incorporating AR, blended learning, and digital literacy training will be key in shaping a more resilient and inclusive education system [53,55,58,66].

5. Discussion

5.1 Blended Learning and Language Acquisition

Blended learning has proven to be a transformative approach in language acquisition, particularly in enhancing reading comprehension and literacy skills. The studies demonstrate its effectiveness in improving reading proficiency among elementary pupils. The integration of digital tools and traditional instruction allows learners to engage more actively with reading materials, leading to better comprehension and retention. Additionally, programs like Core5 and Lexia® Core5have shown significant benefits for low-performing pupils, particularly those from disadvantaged backgrounds, by providing personalized learning experiences. Furthermore, adaptive e-learning platforms like TACIT enhance comprehension by tailoring content to individual learners' needs, benefiting

struggling pupils, especially girls and older learners. These findings underscore the potential of blended learning to bridge literacy gaps and create more inclusive learning environments.

Beyond reading comprehension, blended learning also fosters motivation, engagement, and self-directed learning. Studies also highlight how gamified assessments significantly enhance pupils' motivation and language proficiency by reducing learner dissatisfaction. It is also demonstrate that blended learning improves vocabulary acquisition while increasing pupils' intrinsic motivation through autonomy and competence-driven learning experiences. Moreover, the use of ICT in collaborative and self-directed learning enables pupils to develop essential language skills while engaging in interactive digital activities. However, challenges such as seasonal learning loss suggest that continuous exposure to blended learning is necessary to sustain long-term language development. Overall, the integration of technology within language instruction offers promising outcomes, making language learning more engaging, effective, and adaptable to diverse pupil needs.

5.2 Blended Learning in STEM and Science Education

Blended learning has revolutionized STEM and science education by integrating traditional instruction with digital and interactive elements, fostering a more engaging and flexible learning experience. One significant advancement is the Activity System-Based Process Model (ASPM), which integrates Augmented Reality-Based Learning (ARBL) to improve spatial understanding in science subjects. This model enhances pupils' ability to grasp abstract concepts, such as 3D structures, through immersive learning experiences, leading to improved comprehension and engagement. Additionally, Hybrid Learning-Based Adaptive Media caters to various learning styles—visual, auditory, reading/writing, and kinesthetic—helping pupils develop critical thinking skills. In mathematics education, the combined use of concrete and virtual manipulatives in blended learning environments has been particularly effective. Studies show that using both physical and digital tools allows pupils to interact with abstract mathematical concepts in a more concrete manner, significantly improving problem-solving skills and overall mathematical achievement.

Blended learning has also shown great potential in addressing educational disparities, particularly in underprivileged settings. A study on STEM education for pupils from low socioeconomic backgrounds found that blended learning improved academic performance by offering experiential, hands-on learning opportunities. The Experiential Learning Theory (ELT) supports this approach, emphasizing that pupils learn best when actively engaged in problem-solving and real-world applications. Furthermore, blended learning models enhance pupil motivation and engagement, as demonstrated in an Indian elementary classroom study where digital and face-to-face instruction significantly increased classroom participation. However, challenges remain, such as the need for self-regulation skills among pupils and adequate teacher training to maximize the benefits of technology integration. Despite these challenges, blended learning continues to be a transformative force in STEM and science education, providing pupils with the necessary skills and adaptability for future academic and professional success.

5.3 Pupil Engagement, Motivation, and Inclusivity

Blended learning plays a crucial role in enhancing pupil engagement, motivation, and inclusivity by integrating traditional face-to-face instruction with digital technologies. One significant aspect of blended learning is its ability to create interactive and personalized learning experiences. The Station Rotation Model, for example, allows pupils to transition between different learning stations, combining teacher-led instruction with self-paced digital resources and collaborative group work. This model fosters engagement by allowing pupils to interact with content in various ways, making

learning more dynamic and accessible. Additionally, the integration of multimedia tools, such as videos and gamified learning elements, enhances motivation by catering to different learning styles and providing immediate feedback. Research highlights that pupils in blended learning environments exhibit higher levels of motivation due to the increased autonomy and flexibility they experience. The ability to access course materials asynchronously further supports self-regulated learning, allowing pupils to manage their time and workload effectively.

In terms of inclusivity, blended learning offers an adaptable framework that accommodates diverse learning needs, including those of pupils with disabilities and those from underprivileged backgrounds. Hybrid learning strategies, such as the use of clear instructions, adaptive media, and special assistance, ensure that pupils with learning disabilities can actively participate in lessons. The integration of synchronous and asynchronous learning modes also benefits pupils in rural or resource-limited settings by providing access to high-quality educational content and expert instructors through digital platforms. Additionally, multicultural learning approaches within blended learning frameworks help pupils develop cultural literacy and foster an inclusive classroom environment, promoting respect for diversity and encouraging collaborative learning among peers. Studies demonstrate that these methods contribute to improved academic performance and a greater sense of belonging among pupils, reinforcing the effectiveness of blended learning in creating an inclusive and engaging educational experience.

5.4 COVID-19 and Post-Pandemic Education

Blended learning has emerged as a critical educational model in the post-COVID-19 era, addressing both the limitations and opportunities that surfaced during the pandemic. The shift to online learning during the pandemic exposed challenges related to pupil engagement, digital access, and instructional quality. However, blended learning—combining face-to-face instruction with digital tools—has proven to be an effective solution. Research highlights that blended learning fosters pupil creativity and activeness, particularly when integrating interactive digital platforms with traditional classroom experiences. The combination of synchronous and asynchronous learning allows pupils to learn at their own pace while still benefiting from direct teacher guidance. This approach has been particularly beneficial for fostering 21st-century skills, including problem-solving, critical thinking, and collaboration, which are vital in an increasingly digital world.

Post-pandemic education continues to evolve, with blended learning becoming a standard approach in many institutions. One key advantage is its adaptability to different learning styles, ensuring that pupils who thrive in digital environments can still engage meaningfully in traditional classroom discussions. However, challenges remain, particularly in ensuring equitable access to digital resources and training educators to effectively implement technology-driven learning models. Research suggests that successful post-pandemic blended learning requires strategic implementation, including clear guidelines for educators, well-developed digital content, and continuous assessment of pupil engagement. Additionally, blended learning supports resilience in education systems, ensuring continuity of learning during disruptions, such as future pandemics or other emergencies. Ultimately, blended learning is not just a temporary response to the pandemic but a transformative model that enhances education by making learning more flexible, inclusive, and dynamic.

4. Conclusions and Future Research

Blended learning plays a transformative role in primary education by integrating traditional face-to-face instruction with digital tools, fostering improved learning outcomes, engagement, and retention. The studies analyzed demonstrate the broad applications and effectiveness of blended learning across different subject areas, pupil demographics, and instructional strategies. Blended learning significantly enhances reading comprehension and language proficiency, particularly when incorporating adaptive gamification and ICT-enhanced strategies. Furthermore, the integration of augmented reality (AR) tools has proven effective in improving English pronunciation and science education. The studies also suggest that STEM achievement benefits from blended instruction, particularly for pupils from low socioeconomic backgrounds. Additionally, blended learning models improve pupil engagement and foster self-directed and collaborative learning. Despite these benefits, challenges remain, particularly in teacher preparedness, technological accessibility, and pupil motivation in online settings.

While existing research underscores the efficacy of blended learning, further exploration is required in key areas. Future research should investigate the long-term effects of blended learning on academic performance and retention, particularly addressing issues like the summer slide observed in reading performance. Additionally, studies should focus on teacher training programs that enhance the effective implementation of blended learning models such as Station Rotation Models or Flipped Classroom. Further research should explore adaptive learning technologies that cater to diverse pupil needs, particularly in low-resource settings such as Google Tools. More studies should investigate motivational factors influencing pupil participation in blended environments, particularly with gamification and AR tools. Finally, research should assess digital equity in underprivileged communities and the effectiveness of hybrid learning in diverse socioeconomic contexts. By addressing these research gaps, future studies can refine blended learning methodologies, ensuring they remain inclusive, effective, and adaptable for primary education.

Acknowledgement

This research was supported by Ministry of Education, Malaysia under Hadiah Latihan Persekutuan (HLP) scheme.

Conflicts of Interest

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

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