Optimizing Hybrid Learning in Primary Education: A Systematic Review on AI Integration and Pedagogical Transformation in Society 5.0

Optimalisasi Hybrid Learning dalam Pendidikan Dasar: Literatur review tentang Integrasi AI dan Transformasi Pedagogis dalam Masyarakat 5.0

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Abstract
Hybrid learning has emerged as the primary technique in the reform of basic education within the Society 5.0 period, particularly in enhancing learning flexibility, digital literacy, and 21st-century skills for children aged 5 to 13 years. Nonetheless, its implementation in elementary school continues to encounter pedagogical and structural obstacles, such as deficiencies in digital infrastructure, instructor preparedness, and constraints in technology-driven assessment. This research used a PRISMA-based systematic literature review (SLR), analyzing Scopus Q1-Q4 and Sinta 2-5 journals that address the incorporation of Hybrid Learning in primary school and digital education policies. The study's findings indicate that Hybrid Learning, incorporating flipped classrooms, gamification, and AI-driven Learning Management Systems (LMS), enhances student engagement and conceptual comprehension. The efficacy of this paradigm relies on equitable digital access, TPACK-based training for educators, and education policies informed by AI and IoT. This research strategically enhances the design of adaptive, data-driven, and inclusive learning to facilitate the sustainable, technology-driven transformation of elementary education.

Keywords
Hybrid Learning; Society 5.0; Elementary Education; AI in Learning; Digital Education Policy

Abstrak
Hybrid learning telah menjadi strategi utama dalam reformasi pendidikan dasar di era Society 5.0, khususnya dalam meningkatkan fleksibilitas pembelajaran, literasi digital, dan keterampilan abad ke-21 bagi anak usia 5 hingga 13 tahun. Namun, penerapannya di sekolah dasar masih menghadapi berbagai tantangan pedagogis dan struktural, seperti keterbatasan infrastruktur digital, kesiapan tenaga pendidik, serta keterbatasan dalam asesmen berbasis teknologi. Penelitian ini menggunakan systematic literature review (SLR) berbasis PRISMA, dengan menganalisis jurnal Scopus Q1-Q4 dan Sinta 2 yang membahas integrasi hybrid learning dalam pendidikan dasar serta kebijakan pendidikan digital. Hasil penelitian menunjukkan bahwa hybrid learning yang mengadopsi flipped classroom, gamifikasi, dan Learning Management Systems (LMS) berbasis AI mampu meningkatkan keterlibatan siswa dan pemahaman konseptual mereka. Keberhasilan model ini sangat bergantung pada akses digital yang merata, pelatihan berbasis Technological Pedagogical Content Knowledge (TPACK) bagi pendidik, serta kebijakan pendidikan yang didukung oleh AI dan IoT. Penelitian ini secara strategis memperkuat desain pembelajaran yang adaptif, berbasis data, dan inklusif, guna mendukung transformasi pendidikan dasar yang berkelanjutan dan berbasis teknologi.

Kata Kunci
Hybrid Learning; Society 5.0; Pendidikan Dasar; AI dalam Pembelajaran; Kebijakan Pendidikan Digital

1. Introduction

Hybrid learning has emerged as a significant educational innovation, evolving alongside digitalization across numerous sectors, including education. Accelerated technical advancements over the past decade have facilitated the evolution of educational systems towards a more adaptable and technology-driven model. The COVID-19 pandemic has expedited this transformation, compelling numerous educational institutions globally, including those in Indonesia, to transition to online and hybrid learning modalities to maintain educational continuity amidst limitations on physical connection.

In the age of Society 5.0, education is being redefined not merely as a conduit for knowledge transfer, but also as a fundamental mechanism for cultivating digital and adaptable competences in students. The Society 5.0 idea underscores the incorporation of sophisticated technologies, including Artificial Intelligence (AI), Internet of Things (IoT), Big Data, and Learning Analytics, into daily life, particularly in education (Halverson et al., 2017). In this context, Hybrid Learning aims to deliver innovative solutions by integrating in-person instruction with digital technology, thereby fostering a more personalized and adaptable educational experience tailored to the unique needs of students.

Despite the shown efficacy of Hybrid Learning in enhancing educational outcomes, its application in primary school continues to encounter numerous intricate hurdles. A primary concern is the disparity in access to technology, particularly in regions with inadequate digital infrastructure. Rane (2024) disclosed that numerous primary schools in developing nations, including Indonesia, continue to struggle with establishing sufficient digital infrastructure, encompassing reliable internet connectivity, access to digital devices, and an educational environment conducive to both synchronous and asynchronous interactions. This results in disparities in access to digital education, with urban pupils having greater opportunity to engage with technology compared to their rural counterparts.

Alongside infrastructure constraints, the preparedness of educators to integrate digital technology into pedagogical practices constitutes a substantial impediment. Sefriani et al. (2021) discovered that most primary school educators continue to encounter a digital competency deficit, obstructing their ability to develop and execute successful Hybrid Learning. Many educators continue to employ technology just as an auxiliary instrument in traditional education, failing to fully harness its capacity for fostering more interactive and flexible learning experiences. Bennett et al. (2020) study emphasizes that in the absence of sufficient training, Hybrid Learning in elementary school often serves as an ancillary method rather than a genuine innovation that significantly transforms student learning.

While numerous studies have examined Hybrid Learning, the majority concentrate on higher education or technical assessments pertaining to digital learning infrastructure (Martins et al., 2025; Raes, 2022). Currently, research specifically examining the efficacy of Hybrid Learning in primary education remains scarce, particularly regarding its influence on learning outcomes and 21st-century skills among elementary school pupils.

Current research has predominantly concentrated on the policy dimensions of digital education or the execution of blended learning in higher education, neglecting the cognitive and social development setting of primary school pupils (Halverson et al., 2017). Elementary school students possess distinct learning qualities that necessitate an interactive, hands-on approach, along with opportunities for robust social involvement. Regrettably, Hybrid Learning at the primary level is frequently merely a replication of the model employed in higher education, without modifications to align with the developmental requirements of the child (Sari & Purwanta, 2021).

This study introduces originality by addressing the research gap concerning the efficacy of Hybrid Learning in primary school. This study primarily investigates the optimal application of Hybrid Learning in elementary schools, serving not merely as an online learning solution but as a strategy to enhance students' learning experiences, digital competencies, and social interactions within a technology-driven educational context (Raes, 2022). This study will evaluate educators' preparedness to implement a hybrid learning model tailored to elementary school students' characteristics and assess the extent to which Indonesia's digital education policies

facilitate the effective execution of this model (Martins et al., 2025).

This study has made a significant contribution to improving the effectiveness of Hybrid Learning as a more relevant and contextual learning model for elementary schools. In the context of elementary education, the application of Hybrid Learning cannot simply be adapted from the learning model in higher education, but must consider the characteristics of the cognitive, social, and emotional development of elementary school students (Fernandez-Rio & Menendez-Santurio, 2017).

Therefore, this study seeks to evaluate the effectiveness of Hybrid Learning in improving student learning outcomes, as well as identifying the best strategies for optimizing the integration of technology in primary education. With an evidence-based approach, this study is expected to provide recommendations that contribute significantly to digital education policies, especially in technology-based learning at the primary school level. More specifically, this study fills a research gap by presenting empirical evidence on the impact of Hybrid Learning on the learning outcomes of elementary school students, which until now has rarely been the main focus in previous research (Bennett et al., 2020).

Many studies on Hybrid Learning are more oriented towards higher and secondary education, while studies measuring its effectiveness in primary education are still limited. Thus, this study can provide a new perspective on how Hybrid Learning can improve the academic achievement and 21st-century skills of primary school students, including digital literacy, critical thinking, and problem solving (Rane, 2024). In addition, this study will also evaluate the readiness of educators to implement Hybrid Learning, given that the success of this model depends not only on digital infrastructure, but also on teachers' competence in designing and managing technology-based learning (Raes, 2022).

Teachers have a central role in determining the effectiveness of Hybrid Learning, from the selection of digital learning platforms, online and offline-based classroom management strategies, to the ability to conduct technology-based assessments. Therefore, this study will also identify the challenges faced by teachers in designing technology-based learning, as well as offering strategies to improve teachers' competence in adopting Hybrid Learning effectively in primary school environments (Kurniawati et al., 2021).

In addition to the readiness of educators, this study will also discuss the application of Hybrid Learning that is appropriate to the needs of elementary school students, taking into account the characteristics of their cognitive and social development (Priess-Buchheit, 2020). The Hybrid Learning-based learning model must ensure that the method used is interactive, contextual, and in accordance with the principles of pedagogy for elementary school children.

This study will explore how Hybrid Learning can accommodate students' needs in a more personal and adaptive way, so that they continue to have an interesting, meaningful, and relevant learning experience (Raes, 2022). Along with the development of digitalization in education, this study is very relevant in providing concrete solutions for elementary schools in Indonesia to overcome the challenges of implementing Hybrid Learning. Through this study, it is hoped that strategies will be found that can optimize Hybrid Learning as a future educational approach, not only in improving the quality of learning, but also in creating a more inclusive, interactive, and technology-based learning experience, in accordance with the demands of education in the Society 5.0 era (Martins et al., 2025).

As a broader implication, this study will provide policy recommendations regarding the integration of Hybrid Learning in primary education, taking into account various aspects, including infrastructure, pedagogy, and the development of a digital-based curriculum in Indonesia. Digital education policies must be able to answer the challenges of implementing Hybrid Learning by ensuring equitable access to technology, continuous teacher training, and curriculum integration in line with Society 5.0 (Rorimpandey & Midun, 2021). Therefore, the results of this study are expected to be a basis for developing digital education policies that are more inclusive and sustainable, so that Hybrid Learning can truly be part of the transformation of basic education that is innovative and adaptive to technological developments (Bali & Hasanah, 2022).

2. Methods

This study employs a systematic review methodology to examine the efficacy of Hybrid Learning in primary school within the context of Society 5.0. This methodology involves the collection, categorization, and analysis of 30 publications from esteemed journals to attain a more thorough comprehension of the trends, problems, and possibilities associated with the adoption of Hybrid Learning in elementary education. This systematic approach adheres to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines to guarantee that article selection is organized, transparent, and reproducible (Halverson et al., 2017).

This study utilizes data from esteemed international journals, including Scopus Q1-Q4 and nationally indexed Sinta 2-5 journals, as detailed in Tables 1 and Table 2, along with policy reports from the Ministry of Education, UNESCO, and the OECD regarding digital transformation in primary education. This study employs case studies from other nations to offer a worldwide perspective on the implementation of Hybrid Learning and its adaptation within the context of primary education in Indonesia (Martins et al., 2025). This study aims to deliver a comprehensive and practical examination of the optimisation of Hybrid Learning in elementary schools by integrating academic sources and educational policies.

The analysis involved categorising articles according to the primary themes: the efficacy of Hybrid Learning in enhancing elementary students' academic performance, the role of technology in education, the challenges associated with implementing Hybrid Learning, digital education policies, and educators' preparedness. This classification enables study to delineate significant factors that affect the adoption of Hybrid Learning from pedagogical, technological, and educational policy viewpoints (Raes, 2022).

This study employs bibliometric analysis, alongside theme classification, to discern research trends in Hybrid Learning during the previous decade. This analysis encompasses the evolution of publication volume, research trends, and frequently occurring keywords in pertinent studies, thereby offering a comprehensive insight into the trajectory of future research and

developmental opportunities within the realm of primary education in Indonesia (Devra Raihan, et al., 2023). This method enables research to elucidate the evolution of Hybrid Learning in conjunction with technological integration in Society 5.0, and to examine how elements such as Artificial Intelligence (AI) and Learning Analytics facilitate the development of adaptive and personalized learning models for elementary school students (Sarwendah et al., 2023).

This research upholds the study's validity through source verification and data triangulation by contrasting results from other empirical studies and pertinent educational strategies. This research employs a systematic and evidence-based methodology to delineate the trends and challenges associated with Hybrid Learning, while also providing specific recommendations to enhance the implementation of this educational model in Indonesian elementary schools (Yaqin et al., 2025).

3. Results

The *Results* section of this study presents the main findings derived from a systematic literature review using PRISMA guidelines, which involved the identification, screening, and selection of 30 articles based on predefined inclusion and exclusion criteria. The selected studies were analysed thematically and grouped into four core dimensions: Hybrid Learning in basic education, Society 5.0 and digital transformation, the efficacy of Hybrid Learning, and the challenges and recommendations for its implementation. The articles were categorised based on recurring concepts, and bibliometric analysis was conducted to trace keyword trends and publication patterns over the past decade.

This study examines how Hybrid Learning is applied in primary schools by considering students' cognitive and social development, and how this model enhances flexibility and learning effectiveness through approaches such as flipped classrooms, gamification, and AI-based Learning Management Systems (LMS). It also explores the influence of Society 5.0 on digital education through the integration of AI, IoT, and Learning Analytics, which contribute to personalised and adaptive learning.

The efficacy of Hybrid Learning is evaluated in terms of its impact on student engagement, academic

Table 1. Synthesis of the Literature Review

No	Article Title	Research Focus	Contribution to Article
1	Scenarios of Secondary School Management During the Digital Era in the Next Decade (2022-2031)	Education management in the digital era in secondary schools (Thasai et al., 2023)	Supports the analysis of digital education policy
2	Teachers and Students Perceptions of a Hybrid Sport Education and Teaching for Personal and Social Responsibility Learning Unit	Teachers' and students' perceptions of hybrid learning in sports education (Fernandez-Rio & Menendez-Santurio, 2017)	Explains the impact of hybrid learning on student social interaction
3	Tinjauan Model Pembelajaran Blended Learning pada Perguruan Tinggi di Era New Normal Covid-19: Kebijakan dan Implementasi	Blended learning model in higher education (Zainuddin, 2021)	Provides a theoretical basis for blended learning in higher education
4	Aksentuasi Disiplin Belajar Mahasiswa dalam Moda Hybrid Learning di Era Pandemi Covid-19: Persepsi Pendidik	Educators' perceptions of learning discipline in hybrid learning (Bali & Hasanah, 2022)	Demonstrates how hybrid learning affects student discipline
5	Defining 'Distance Education' in Policy: Differences Among Federal, State, and Accreditation Agencies	Differences in distance education policies in various regulations (Karensky et al., 2023)	Assists in the analysis of digital education policy
6	Implementasi Rancangan Pembelajaran Berbasis TPACK sebagai Integrasi Pembelajaran di Era Society 5.0 untuk Meningkatkan Hasil Belajar	TPACK integration in Society 5.0-based learning (Khaira et al., 2021)	Supports the discussion of technology integration in Society 5.0
7	Implementation of Education Management in the Era of Society 5.0	Education management in the Society 5.0 era (Paramansyah & Rostandi, 2022)	Explains the implementation of Society 5.0 in education
8	The Implementation of Artificial Intelligence in STEM-Based Creative Learning in the Society 5.0 Era	Application of AI in creativity-based STEM learning (Sari & Purwanta, 2021)	Demonstrates the role of AI in hybrid learning
9	Effect of Hybrid Learning Strategy and Self-Efficacy on Learning Outcomes	Hybrid learning strategies and their effect on student self-efficacy (Rorimpandey & Midun, 2021)	Analyzes the effectiveness of hybrid learning on student learning outcomes
10	Policy Solutions That Foster Competency-Based Learning	Policy solutions for competency-based learning (Jenkins, 2020)	Provide a study of digital education policy
11	The Use of Technology in Hybrid Learning for Students with Special Needs	Use of technology in hybrid learning for students with special needs (Sarwendah et al., 2023)	Demonstrate how hybrid learning supports inclusivity
12	The Role of Hybrid Learning Spaces in Enhancing Higher Education Students' Employability	The influence of hybrid learning spaces on student employability (Bennett et al., 2020)	Highlight employability skills supported by hybrid learning
13	Hybrid Learning Integrated Remote Laboratory: A Pedagogical Strategy for Future Practicum Learning	Pedagogical strategy of hybrid learning in laboratory practicum (Masril et al., 2024)	Explain how remote laboratories can be integrated into hybrid learning
14	Bibliometric Analysis of Hybrid Learning Research Trends in Schools	Bibliometric analysis of hybrid learning research trends (Emiliyanti, 2024)	Provide global trends in hybrid learning research
15	AI-Powered Arabic Language Education in the Era of Society 5.0	AI-based Arabic language learning in the Society 5.0 era (Anwar & Ahyarudin, 2022)	Relate language learning to AI in Society 5.0
16	The Role of Hybrid Learning Spaces in Enhancing Higher Education	Hybrid learning spaces in higher education (Martins et al., 2025)	Explain hybrid learning as an innovative model in higher education
17	A Retro Perspective on Blended/Hybrid Learning: Systematic Review	Mapping and Visualization of the Scholarly Landscape (Bozkurt, 2022)	Systematic review of hybrid/blended learning research, Provide a systematic review of the effectiveness of hybrid learning
18	Society 5.0: Effective Technology for a Smart Society	The role of technology in Society 5.0 (Calp & Bütüner, 2022)	Explain how technology affects Society 5.0
19	Theorising Hybrid Lifelong Learning	The concept of lifelong learning in hybrid learning (Nørgård, 2021)	Assist in understanding lifelong learning in hybrid learning
20	A Systematic Review of Hybrid Learning Research Trends	A systematic review of hybrid learning trends (Ashraf et al., 2021)	Explain hybrid learning research trends
21	A Framework for Institutional Adoption and Implementation of Blended Learning in Higher Education,	The framework for the adoption and implementation of blended learning in education policy (Graham et al., 2013)	Demonstrate hybrid learning implementation strategies in education policy
22	Hybrid Learning in Post-Pandemic Higher Education Systems: An Analysis Using SEM and DNN	A post-pandemic analysis of hybrid learning using SEM and DNN (Yaqin et al., 2025)	Provide AI data-driven hybrid learning analysis
23	Blended Learning Research in Higher Education and K-12 Settings	Research on blended learning in higher education and K-12 (Halverson et al., 2017)	Demonstrate the effectiveness of blended learning at various levels of education
24	The Role of Hybrid Learning in Achieving the Sustainable Development Goals (SDGs)	The role of hybrid learning in achieving the Sustainable Development Goals (SDGs) (Martins et al., 2025)	Highlight the impact of hybrid learning on sustainable development

25	Education 4.0 and 5.0: Integrating Artificial Intelligence (AI) for Personalized and Adaptive Learning	Integration of AI in adaptive learning and personalization (Rane, 2024)	Explain how AI can strengthen hybrid learning
26	Exploring Student and Teacher Experiences in Hybrid Learning Environments: Does Presence Matter,	Student and teacher experiences in hybrid learning (Raes, 2022)	Provide an empirical study of student and teacher experiences in hybrid learning
27	A Hybrid Learning Pedagogy for Surmounting the Challenges of the COVID-19 Pandemic in Performing Arts Education,	Hybrid learning in performing arts education (Li et al., 2021)	Analyze the role of hybrid learning in art education
28	Blended Learning with Edmodo: The Effectiveness of Statistical Learning During the COVID-19 Pandemic,	The effectiveness of blended learning using Edmodo during the pandemic (Sefriani et al., 2021)	Provide empirical evidence of the effectiveness of hybrid learning
29	Effects of the Blended Learning Model on Preservice Teachers Academic Achievements and Twenty-First Century Skills,	The impact of the blended learning model on academic achievement and 21st century skills (Şentürk, 2021)	Analyze the impact of hybrid learning on 21st century competencies
30	Synchronous Hybrid Learning in Times of Social Distancing: A Report and Case Study on Benefits, Trainer Challenges, and Guidelines	Case studies of hybrid learning during social distancing (Priess-Buchheit, 2020)	Demonstrate the technical challenges and benefits of hybrid learning during the pandemic

Table 2. Article Selection Criteria

No	Inclusion Criteria	Exclusion Criteria
1	Articles that discuss Hybrid Learning, Society 5.0, Artificial Intelligence (AI) in education, and digital policy	Articles that only discuss higher education without relevance to basic education
2	Articles relevant to basic education, both in the context of digital learning, pedagogical effectiveness, and technology-based curriculum development	Articles that are not available in full-text access or do not include a clear research aspects of e-learning systems without any connection to Hybrid Learning pedagogy in primary schools
3	Articles that use an empirical approach (experimental, quasi-experimental, or survey studies) as well as systematic reviews and meta-analyses of the effectiveness of Hybrid Learning	
4	Articles published in Scopus Q1-Q4 journals, Sinta 2-5 journals, and the latest research with high academic credibility	
5	Case studies of education in various countries that can provide global insights into the implementation of Hybrid Learning in primary education	

performance, and 21st-century skills. Key challenges are also discussed, including unequal digital access, limited teacher preparedness, and gaps in educational policy. This study concludes with evidence-based recommendations focused on curriculum innovation, policy alignment, and teacher training to strengthen the implementation of Hybrid Learning in Indonesian primary school.

3.1. Hybrid Learning in Elementary Education

Hybrid Learning is an educational methodology that combines in-person instruction with digital technology, facilitating flexible access to materials and interactions between students and educators. This concept differs from blended learning, which prioritizes a seamless integration of online and offline education, and from online learning, which is entirely digital and lacks face-to-face interaction (Halverson et al., 2017). In primary schools, the adoption of Hybrid Learning must consider the cognitive, social, and emotional development of children, as experiential learning and social interaction remain essential at this stage of education (Şentürk, 2021).

Global case studies reveal that Hybrid Learning implementation varies significantly based on infrastructure, teacher readiness, and government policies. In Finland, Hybrid Learning is integrated into a student-centered model, emphasizing personalized learning pathways, where students engage in project-based activities with digital support while maintaining strong classroom interaction (Raes, 2022). Meanwhile, in Singapore, the government has actively supported Hybrid Learning through the National Digital Literacy Programme (NDLP), which equips primary students with digital devices and enhances their digital competency (Li et al., 2021). Conversely, India and Indonesia face challenges in ensuring equal access to digital resources, particularly in rural areas where

infrastructure gaps and teacher training deficiencies hinder the full-scale implementation of Hybrid Learning (Sefriani et al., 2021).

According to Raes (2022), the successful implementation of Hybrid Learning in primary schools necessitates a learning design that sustains student engagement, particularly through the use of flipped classrooms, gamification, and interactive Learning Management Systems (LMS). This paradigm must provide a balance between autonomous learning and social interaction, enabling students to become active participants in technology while cultivating essential communication, teamwork, and problem-solving skills, which are crucial in the 21st-century educational landscape (Martins et al., 2025).

Furthermore, research conducted by Sefriani et al. (2021) indicates that Hybrid Learning models remain predominantly adapted from higher education settings, requiring more contextual adaptation for primary school students. In South Korea, where digital pedagogy is highly advanced, primary students engage in AI-supported learning environments with adaptive learning platforms that adjust content based on individual progress (Calp & Bütüner, 2022). However, in countries like Brazil, where infrastructure inequalities persist, many schools use digital tools as supplementary resources rather than fully integrating them into the pedagogical framework (Rane, 2024).

The COVID-19 pandemic has significantly transformed the education sector, compelling primary schools to rapidly adopt digital learning methodologies. In Germany, the transition to Hybrid Learning was accelerated through the Digitalpakt initiative, which invested in improving school infrastructure and teacher digital competencies (Priess-Buchheit, 2020). In contrast, low-income countries such as Bangladesh and Nigeria struggled with unequal access to technology, making Hybrid Learning adoption fragmented and inconsistent (Şentürk, 2021). As schools move beyond the pandemic, Hybrid Learning is perceived not merely as an emergency measure, but as an integral component of long-term educational transformation, fostering a more flexible, personalized, and technology-driven learning system (Raes, 2022).

Post-pandemic, Hybrid Learning has evolved into a more structured methodology, characterized by an augmented use of digital platforms to enhance teacher-student interactions (Yaqin et al., 2025). For instance, in Japan, Learning Analytics has been leveraged to track student progress, integrating AI and IoT into the curriculum (Anwar & Ahyarudin, 2022). This approach allows students to access educational resources with greater flexibility, while still receiving direct teacher guidance, ensuring a balance between self-directed learning and social engagement (Calp & Bütüner, 2022).

Governments worldwide have taken initiatives to support the digitization of education. In Indonesia, the government has expanded internet access, provided digital devices, and enhanced teacher training in learning technology (Bennett et al., 2020). However, the primary challenge remains the disparity in technology access between urban and rural schools, as well as variations in schools' preparedness to integrate Hybrid Learning (Nørgård, 2021). In Sub-Saharan Africa, despite governmental efforts, resource constraints and digital illiteracy among teachers continue to limit Hybrid Learning implementation (Priess-Buchheit, 2020).

Moreover, educators' attitudes and institutional resistance remain significant obstacles. A study by Priess-Buchheit (2020) revealed that many teachers still perceive digital learning as a challenge rather than an opportunity to enhance educational effectiveness. Consequently, the successful evolution of Hybrid Learning in primary schools requires not only infrastructure and teacher training improvements, but also a shift in pedagogical paradigms, ensuring that technology is genuinely integrated into innovative, interactive, and developmentally appropriate learning approaches.

3.2. Society 5.0 and Digital Transformation in Education

Society 5.0 represents a novel paradigm that integrates technology as a fundamental component of human existence, encompassing the educational framework. Unlike the preceding era that emphasized the digital industrial revolution, Society 5.0 prioritizes the amalgamation of AI, IoT, and Big Data in education, aiming to establish a more personalized, adaptive, and technology-driven learning system (Calp & Bütüner,

2022). In elementary education, this transition signifies alterations in pedagogical approaches, wherein learning extends beyond direct classroom interaction and is augmented by data-driven technology that facilitate the customization of the educational experience (Masril et al., 2024).

The use of AI in elementary education facilitates the creation of a more adaptive learning system, allowing for the customization of teaching materials and tactics to meet the specific needs of pupils in real-time (Martins et al., 2025). The IoT contributes to the development of a more interactive and sensor-driven learning environment, exemplified by digital books, augmented reality teaching tools, and virtual laboratories that allow students to perform scientific experiments digitally (Thasai et al., 2023). The implementation of this technology necessitates curriculum modifications and the preparedness of educators to manage digital classrooms, ensuring that technology serves as an effective learning support tool rather than as an ancillary component of the education system (Sefriani et al., 2021).

Technology plays a vital role in enhancing student engagement and learning efficacy in the adoption of Hybrid Learning in primary schools. Research conducted by Priess-Buchheit (2020) indicates that the implementation of AI in elementary education has facilitated the development of a more individualized learning model, wherein the system may autonomously modify the pace and instructional strategies according to the unique capabilities of pupils. An illustration is the utilization of AI in STEM-oriented Creative Learning, which facilitates a more exploratory and problem-solving-centric educational experience for pupils (Calp & Bütüner, 2022).

Alongside AI, adaptive learning models are enhanced by data-driven technology in assessment systems and automated feedback, enabling educators to track student progress with more precision and formulate more effective learning strategies (Sefriani et al., 2021). Hybrid Learning under the framework of Society 5.0 transforms not just the delivery of content but also the manner in which students engage with knowledge and the assessment of learning outcomes. Optimal technology integration in Hybrid Learning fosters

student independence in learning while providing personalized advice (Bozkurt, 2022).

Despite the significant potential of technology to enhance the efficacy of Hybrid Learning in primary schools, its implementation encounters numerous hurdles, particularly regarding accessibility, infrastructure preparedness, and the readiness of both educators and children. A primary impediment is the disparity in internet connectivity between urban and rural schools, resulting in inequity in the implementation of digital technology in education. Moreover, the infrastructure preparedness in numerous elementary schools remains insufficient, as many educational institutions are devoid of essential support technologies, like laptops, tablets, or access to digital laboratories (Emiliyanti, 2024; Widodo et al., 2023).

Alongside infrastructural constraints, the disparity in technological proficiency between educators and learners constitutes a considerable obstacle to the execution of Hybrid Learning. Priess-Buchheit (2020) conducted a study revealing that numerous educators struggle to use digital teaching approaches, primarily due to insufficient training and expertise in utilizing technology as a pedagogical instrument. Conversely, despite the younger generation's greater familiarity with technology, a discrepancy in digital literacy persists among students from varying economic and geographical backgrounds, potentially impacting the efficacy of digital-based learning (Basri et al., 2023).

A comprehensive governmental strategy is required to address this challenge, encompassing enhanced internet connectivity for primary schools, investment in technology-driven educational infrastructure, and continuous training programs for teachers on the integration of technology into their pedagogical approaches (Raes, 2022). In the absence of a systematic strategy to address these challenges, the deployment of Hybrid Learning may exacerbate the digital education divide, rather than serve as an innovative solution for enhancing learning quality in the Society 5.0 era.

3.3. Effectiveness of Hybrid Learning in Primary Education

Hybrid learning has demonstrated a beneficial effect on student learning outcomes, particularly in fostering

learning autonomy, conceptual comprehension, and mastery of academic content (Halverson et al., 2017). A comparative study in Indonesia and Finland reveals that students in Hybrid Learning environments exhibit improved academic performance when digital learning tools are effectively integrated into traditional pedagogy. This aligns with findings from Martins et al. (2025), which emphasize that the integration of self-regulated learning strategies and educator guidance significantly enhances students' academic achievements, particularly in primary education settings. In Japan, AI-based adaptive learning systems embedded within Hybrid Learning frameworks have been shown to personalize student learning experiences, ensuring that each child progresses at their own pace while receiving real-time feedback through LMS (Andari, 2022).

Moreover, Hybrid Learning enhances students' learning discipline, particularly in time management, self-regulation, and accountability in technology-driven education (Şentürk, 2021). A study in South Korea highlights that students who engage in Hybrid Learning models demonstrate superior organizational skills, autonomously accessing educational materials and completing assignments with greater discipline compared to their peers in traditional classroom settings. However, the effectiveness of this model is contingent upon the digital preparedness of both educators and learners, as insufficient understanding of digital tools can hinder the effective implementation of Hybrid Learning (Sefriani et al., 2021).

The impact of Hybrid Learning is also observed in educator and student perceptions across various countries. Research in Singapore illustrates that teachers encounter difficulties in adjusting their pedagogical methods to digital integration, whereas students with higher technological proficiency report increased engagement in learning activities. Similarly, a study in Germany found that educators equipped with professional training in digital pedagogy were more successful in maintaining student engagement through gamified and interactive learning models. The efficacy of Hybrid Learning in enhancing educational outcomes is largely dependent on curriculum design, digital accessibility, and the ability of educators to effectively integrate technology into their teaching approaches (Şentürk, 2021).

Beyond academic performance, Hybrid Learning fosters 21st-century competencies, particularly in critical thinking, problem-solving, and digital literacy (Rorimpandey & Midun, 2021). In the Netherlands, students engaged in Hybrid Learning environments were found to develop stronger problem-solving abilities due to exposure to technology-enhanced project-based learning methodologies (Raes, 2022). Similarly, a study in India suggests that students in Hybrid Learning environments are better equipped to navigate digital platforms independently, improving their research and self-learning capabilities. Meanwhile, teachers in Brazil utilizing Hybrid Learning models have demonstrated improvements in their ability to use LMS, conduct online assessments, and facilitate blended content delivery, thereby enhancing digital literacy among both students and educators (Şentürk, 2021).

Despite its advantages, Hybrid Learning presents significant challenges, particularly regarding digital accessibility, social interaction, and teacher preparedness. Studies in rural Indonesia and Sub-Saharan Africa indicate that students in regions with limited technological infrastructure struggle to access Hybrid Learning resources, resulting in disparities in digital skill proficiency and academic outcomes. Research by Priess-Buchheit (2020) supports this finding, emphasizing that Hybrid Learning must be accompanied by comprehensive strategies to ensure equitable access to technology and training for educators. Furthermore, a study in Turkey highlights that students who predominantly engage in digital learning environments face challenges in developing interpersonal skills, affecting their ability to collaborate in group-based learning scenarios.

Governments worldwide are implementing initiatives to address these challenges. In Malaysia, national education policies have begun prioritizing teacher training programs to enhance digital competence, while Finland continues to refine its Hybrid Learning model through AI-assisted learning analytics that personalize student learning trajectories. In contrast, Brazil and Indonesia still struggle with policy gaps in educational technology, leading to inconsistencies in Hybrid

Learning implementation across different regions. Consequently, ensuring equitable access to technology, improving teacher training programs, and refining Hybrid Learning methodologies based on best practices from developed nations will be critical for maximizing its potential as a transformative educational model.

3.4. Challenges and Solutions for Hybrid Learning Implementation in Elementary Schools

The adoption of Hybrid Learning in elementary school encounters numerous technical challenges and infrastructure inadequacies, particularly in poor nations like Indonesia. Research conducted by Martins et al. (2025) indicates that numerous elementary schools continue to lack sufficient access to digital gadgets, reliable internet connectivity, and LMS that facilitate interactive learning. The preparedness of infrastructure is crucial for the efficacy of Hybrid Learning, since technological constraints may impede students' access to educational resources and diminish the quality of interaction between students and educators (Halverson et al., 2017).

Moreover, a digital divide exists between developed and poor countries, resulting in inequitable access to technology-based education. Raes (2022) found that metropolitan primary schools are more adept at transitioning to Hybrid Learning due to superior internet connectivity and enhanced digital resources, whilst pupils in rural regions continue to struggle with utilizing digital devices for educational purposes. This scenario results in disparities in learning quality, with students in regions of limited access experiencing more learning loss compared to those with superior technology support (Sefriani et al., 2021).

A further barrier lies in the complexity of evaluating hybrid learning, particularly in analyzing the efficacy of online and in-person instruction concurrently. Şentürk (2021) indicates that numerous educators encounter challenges in creating equitable and valid assessments for students in a hybrid learning environment, attributable to the disparity in learning experiences between students who engage more actively in online classes and those who prefer in-person interaction. Furthermore, technology-based assessment has not completely supplanted conventional assessment; thus, more novel evaluative

approaches are required to guarantee that all students have equitable opportunities to cultivate their abilities within the hybrid learning framework (Calp & Bütüner, 2022).

A strategy to enhance teachers' digital competencies is necessary to ensure they are adequately equipped to incorporate technology into their pedagogical approaches. A study by (Priess-Buchheit, 2020) demonstrates that the implementation of TPACK (Technological Pedagogical Content Knowledge) based learning aids educators in effectively integrating technology into their instruction. This approach enables teachers to employ technology not merely as a tool, but as a fundamental component of a more successful and dynamic learning strategy (Raes, 2022). Consequently, it is imperative to enhance teacher training in the use of digital learning platforms and technology-driven assessment methods to facilitate the design of more inclusive and personalized educational experiences for students.

A more effective blended learning paradigm is required, specifically the integration of hybrid learning with remote laboratories. Rane (2024) demonstrate that virtual laboratories and AI-driven simulations facilitate students' comprehension of abstract concepts through exploratory and practical engagement. This strategy enables students to engage actively with learning materials, despite the digital learning environment. Consequently, the adoption of Hybrid Learning utilizing digital experiments and simulation technology may serve as a viable solution to address the constraints of laboratory infrastructure in primary schools.

It is essential to promote inclusive digital education by guaranteeing equal access to digital learning technologies and resources for all students. Research conducted by Sefriani et al. (2021) indicates that digital education policies should encompass equitable access to digital infrastructure, which includes subsidizing learning devices for disadvantaged students, extending internet connectivity to remote regions, and establishing a universally accessible digital learning ecosystem. Moreover, educational policies should adopt greater flexibility in fostering the development of digital competencies by incorporating technological skills into the primary school curriculum, enabling students to not

only use technology but also leverage it to enhance their learning quality (Şentürk, 2021).

4. Discussion

Hybrid learning has become a crucial educational paradigm throughout the digital transition of the Society 5.0 age, particularly within the primary school system. The COVID-19 epidemic has expedited the shift to digital learning, compelling educational institutions to use technology-driven models to guarantee accessibility, flexibility, and efficacy in education. Hybrid Learning, the amalgamation of online and in-person education, has arisen as a flexible and innovative approach to maintain the continuation of fundamental education. Nevertheless, despite the extensive implementation of this paradigm in higher and secondary education, its integration into basic education continues to encounter substantial structural and pedagogical obstacles (Halverson et al., 2017; Raes, 2022).

Children aged 5-13 exhibit distinct cognitive, social, and emotional developmental traits compared to secondary and higher education students; thus, the application of Hybrid Learning cannot merely replicate the model utilized at advanced educational levels. According to Piaget's theory of cognitive development, children in this age group are in the concrete-operational stage until they transition to formal operational thinking, indicating that direct experience, social interaction, and multisensory stimulation remain the primary components of their learning (Priess-Buchheit, 2020; Şentürk, 2021). Consequently, digital learning that neglects kid development factors may impede their cognitive and social efficacy.

Hybrid learning in elementary school should encompass more than the digitization of instructional materials; it must provide an interactive, exploratory, and personalized learning experience. This model must guarantee that technology does not supplant the necessity of physical engagement vital for children's growth, but instead enhances their learning experience. Consequently, Hybrid Learning should be structured to integrate technology-driven activities with experiential pedagogical methods, including flipped classrooms, gamification, project-based learning, and interactive LMS (Rane, 2024; Sefriani et al., 2021).

The involvement of educators in hybrid learning, alongside adaptive learning design, is a crucial factor that influences the efficacy of this paradigm. In a hybrid learning environment, educators serve not just as instructors but also as facilitators of technology-enhanced learning. Regrettably, numerous primary school educators continue to encounter challenges in integrating technology into their teaching methodologies, attributable to insufficient digital training and inadequate supporting infrastructure. Yaqin et al. (2025) study indicates that educators lacking adequate digital competence are inclined to utilize technology passively, employing it merely as an auxiliary tool rather than as a fundamental component of an innovative learning method.

Consequently, to enhance the efficacy of Hybrid Learning in elementary education, training based on TPACK is essential. This method will assist educators in comprehending how to include technology within a pedagogical framework that aligns with children's developmental requirements, while ensuring that learning promotes students' cognitive, social, and emotional competencies (Bozkurt, 2022; Li et al., 2021; Nørgård, 2021).

In the Society 5.0 era, technology serves not merely as an educational instrument but has evolved into a fundamental component of a data-driven and personalized educational framework. Through the application of AI, IoT, and Big Data, Hybrid Learning may dynamically tailor educational resources to align with the student's comprehension level in real-time. In the realm of primary education, a more prudent strategy is essential for the integration of this technology, as children aged 5-13 are undergoing psychosocial development that necessitates direct interaction and emotional support from their educational environment (Calp & Bütüner, 2022; Martins et al., 2025; Masril et al., 2024).

The integration of AI in education facilitates a more personalized learning experience, enabling the system to modify the difficulty of the content according on each student's capabilities. Research indicates that instructors' inadequate digital literacy and infrastructural deficiencies are the primary barriers to the effective utilization of this technology (Paramansyah & Rostandi,

2022; Sari & Purwanta, 2021). Consequently, a strategy for equitable technology access, enhanced teacher training, and more inclusive educational policies is essential for Society 5.0 to positively influence primary-level learning.

Hybrid Learning enhances students' academic performance while simultaneously fostering 21st-century competencies, including critical thinking, problem-solving, and digital literacy. Access to diverse digital learning tools enables pupils to cultivate analytical skills and enhance collaboration abilities within a more interactive setting. Research indicates that digital-based learning may adversely affect students' social engagement, particularly when technology supplants direct interaction with educators and classmates (Halverson et al., 2017; Şentürk, 2021).

Consequently, Hybrid Learning in primary school must achieve a balance between digital and physical experiences, enabling students to be active participants in technology while simultaneously cultivating robust social skills. Governments and educational institutions must create digital assessment strategies that evaluate academic outcomes and examine the influence of Hybrid Learning on students' social and emotional competencies (Jenkins 2020; Karensky et al., 2023). This study demonstrates that Hybrid Learning possesses significant potential to enhance the efficacy of education in primary schools, particularly for students aged 5 to 13 years. The effective execution of this model is contingent upon the preparedness of the infrastructure, the proficiency of educators, and the equilibrium between digital engagement and social interaction in the learning process.

5. Conclusion

Hybrid learning has emerged as a more pertinent educational approach in primary education, particularly within the framework of digital transformation in the Society 5.0 age. This methodology facilitates learning flexibility and enhances 21st-century abilities, including digital literacy, critical thinking, and problem-solving. The implementation of Hybrid Learning for children aged 5-13 cannot be compared to the models utilised in secondary and higher education, as this age group relies significantly on direct interaction and experiential

learning. Consequently, the Hybrid Learning model must be pedagogically modified to sustain an equilibrium between digital technology and social contact in education. This study's findings affirm that successful Hybrid Learning in primary education requires the integration of technology-driven learning methodologies with a multisensory and participatory methodology. Flipped classrooms, gamification, and AI-driven LMS are strategies that can enhance active student involvement. This study reveals several significant hurdles in implementing Hybrid Learning, including infrastructural readiness, regional digital disparities, and insufficient teacher competence in utilizing learning technologies. To address these challenges, it is essential to implement TPACK-based training for educators, enhance inclusive digital education policy, and create AI-driven assessments that preserve students' emotional and social dimensions. This study affirms that Hybrid Learning possesses significant potential to enhance the efficacy of fundamental education; however, its execution must maintain a balance between technology and direct engagement. By adopting a more systematic approach, Hybrid Learning can enhance students' academic performance while fostering a personalized, adaptable, and inclusive educational environment, aligned with the requirements of digital-era education and Society 5.0.

Declaration of the use of AI

During the preparation of this work, the author(s) used ChatGPT (OpenAI), and QuillBot to improve the readability, coherence, and language clarity of the manuscript. All content generated with these tools was critically reviewed, revised, and edited by the author(s), who take full responsibility for the integrity, accuracy, and originality of the final published article.

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