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The Integration of Digital Literacy in Educational Policy: Addressing Global Challenges for Sustainable Education

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ABSTRACT

This study investigates the integration of technology and digital literacy into national education policies using a systematic literature review (SLR) guided by the PRISMA protocol. From an initial pool of 675 articles, 53 were selected through rigorous screening. The analysis identifies digital literacy as a central issue, with key challenges including disparities in technological access, inadequate teacher training, and obstacles to policy harmonization. While developed nations like Singapore and Finland have implemented structured approaches successfully, countries such as Indonesia encounter significant barriers, particularly in rural areas with limited infrastructure. The findings underscore the relevance of constructivist theory and pedagogical innovation, highlighting the critical role of teachers and the potential of technology to enhance educational quality. Practical recommendations include sustained professional development for educators, investment in digital infrastructure, and the integration of digital literacy within curricula to achieve inclusive and sustainable educational outcomes. This research provides essential insights for policymakers and educators to navigate the challenges of digital transformation in education effectively.

Keywords: digital literacy, technology integration, national educational policy, teacher professional, development, 21st-century skills, educational equity,

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INTRODUCTION

In an era marked by rapid technological advancements and an increasingly digitalized society, education systems worldwide face the urgent need to integrate technology and digital literacy into their frameworks[1]. Digital literacy is no longer merely a technical skill but a fundamental competency for active participation in a knowledge-based economy. Simultaneously, the integration of technology into education holds the potential to enhance accessibility, inclusivity, and the quality of learning experiences [2]. Despite these promising prospects, significant challenges remain, particularly in ensuring equitable access to technology, equipping educators with necessary skills, and harmonizing policies to support sustainable educational transformation[3].

Existing research highlights the successful implementation of digital literacy initiatives and technology integration in developed countries such as Singapore and Finland[4]. These nations demonstrate the effectiveness of structured and comprehensive approaches, including continuous teacher training and embedding digital literacy into the curriculum[5]. In contrast, developing nations like Indonesia face distinct obstacles, such as inadequate infrastructure, unequal technological access, and limited professional development opportunities for educators[6]. These disparities underscore the urgency of addressing systemic inequities to unlock the full potential of

technology in education. This study explores the integration of technology and digital literacy in national education policies through a systematic literature review (SLR)[7]. Utilizing the PRISMA protocol, the research identifies key trends, challenges, and opportunities in this domain. By analyzing 53 relevant articles published between 2019 and 2024, the study aims to provide actionable insights for policymakers and educators to navigate the complexities of digital transformation in education effectively.

The proposed approach offers a multidimensional perspective that not only identifies gaps in the current literature but also proposes practical recommendations to bridge these gaps. Specifically, this research emphasizes the importance of continuous teacher training, investment in digital infrastructure, and the incorporation of digital literacy within curricula. By addressing these critical areas, the study seeks to contribute to the development of inclusive and sustainable educatgies.ional policies that are responsive to the demands of the digital era. Through its innovative analysis and practical focus, this study provides valuable contributions to the field of educational policy and technology integration. It highlights the transformative potential of digital literacy and technology when supported by equitable and well-structured policies, thereby setting the stage for future research and implementation strategies.

METHOD

The review procedure in this study follows the PRISMA guidelines to ensure that the included studies meet strict methodological standards [8]. Literature searches were conducted through platforms such as ScienceDirect to obtain articles relevant to national educational policy, technology integration, and digital literacy. The process includes collection, analysis, and content analysis, with conclusions and SLR findings determined. The selection criteria include journal research articles discussing technology, digital literacy, and national educational policy. Articles that are not relevant, such as those discussing technology without a link to educational policy or digital literacy outside the context of formal education, were excluded.

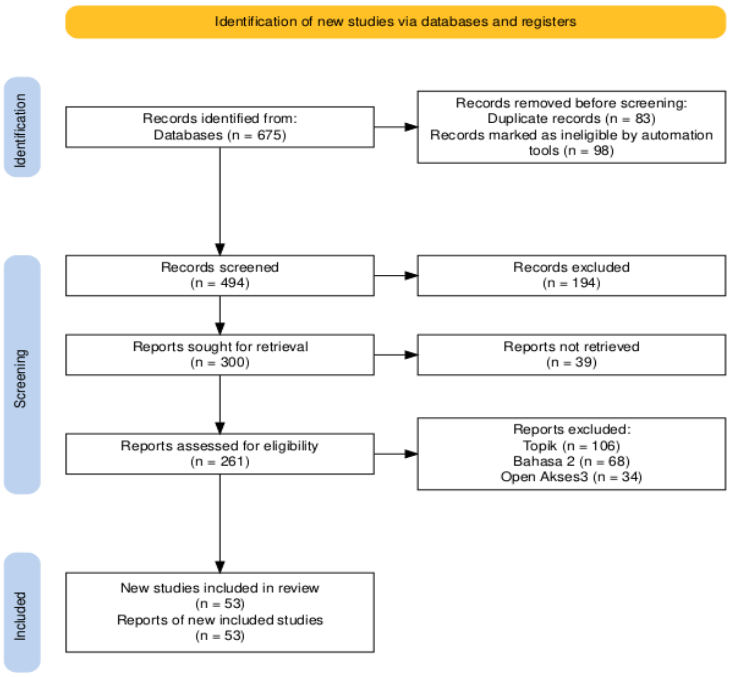
Table 1. Article include and exclude criteria

Type	Include	Exclude
Article Type	Research studies in the form of journal articles	Studies other than journal research articles
Scope of Discussion	Research discussing technology integration, digital literacy, and national educational policy	Research studies discussing technology without relation to educational policy, studies focusing on individual literacy skills without the context of formal education, studies in technical technology fields without an educational context, studies not covering national-level policy
Index	Q4-Q1	Not Q4-Q1
Year	2019-2024	Not 2019-2024
Research Variables	(X) National Educational Policy, Educational Technology, Digital Literacy	(Y) 21st-century skills, quality of learning, integration of technology and digital literacy
Language	English and Indonesian	English and Indonesian

The researcher then excluded 83 duplicated articles and 93 articles published before 2019, bringing the total to 494 articles for the screening stage. The next step involved excluding articles based on document type, as the researcher selected only research documents. Book reports and book chapters were excluded, totaling 194 articles, leaving 300 articles. Articles outside the subject

area of education were also excluded, totaling 39 articles, leaving 261. The researcher then excluded 68 articles that were not in English, and 34 articles were excluded based on relevance to the research topic and keywords. An additional 106 articles were excluded due to lack of open access, resulting in 53 articles for review. Below is the article selection process according to the criteria.

Figure 1. SLR Stage Flow Chart



Several types of analysis were conducted, such as citation analysis and bibliometric analysis using tools like VOSViewer to visualize relationships between documents and identify trends in the integration of technology and digital literacy in educational policy. The results of this analysis provide insights into how these topics are developing in academic literature and highlight areas that need further attention from policymakers and education practitioners.

FINDING AND DISCUSSION

Article Publiccation Year and According to Publisher

Figure2. Article Publication Year



Figure 3. According to Publisher

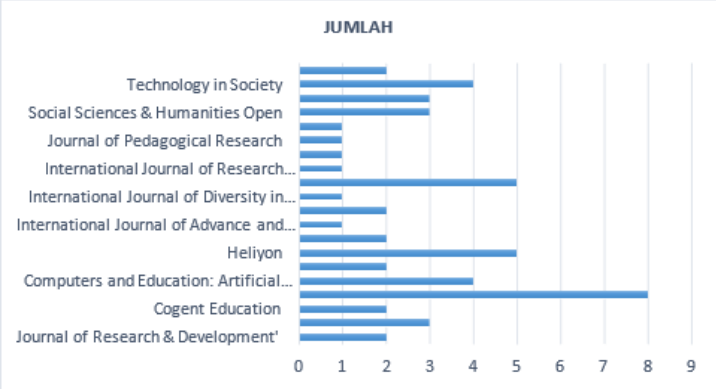


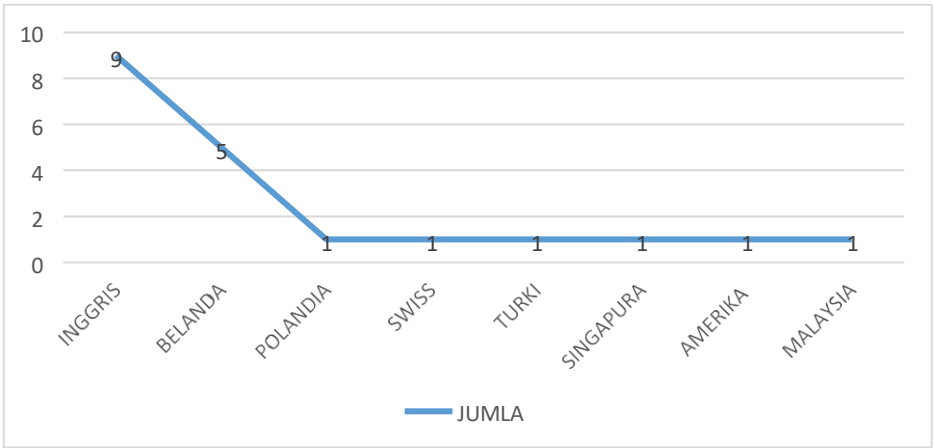
Figure 2. During the review process, the researcher found a total of 53 relevant journals. The distribution of articles in relation to the publication year is as follows: In 2019-2024, the researcher found 1 article each year, about 2% of the total journals considered. This indicates that in 2019, research interest in the topic began to emerge, although still limited. In 2020, the number of articles increased to 8%, with 4 articles, showing a rise in research interest in that year. In 2021-2022, there was a significant fluctuation, with 3 articles found in 2021 (about 6%) and 6 articles in 2022 (about 11%), indicating a decline in interest in 2021 followed by a recovery in 2022. The years 2023-2024 recorded the highest number of articles, with 25 articles in 2024 (about 47%) and 14 articles in 2023 (about 26%) of the total. This represents the peak of research interest in the topic, with a significant amount of research conducted in the related field during those years.

Figure 3. The distribution of journals with strong reputations and significant impact tends to be broader. Specific disciplines, such as computer science and artificial intelligence, often have more journals, and recent trends like open access and strong promotion from authors or publishers also influence journal data distribution. Journal distribution data shows variation in publication numbers. Some journals, such as Computer and Education: Artificial Intelligence with 8 distributions, and International Journal of Educational Development and Heliyon with 5 distributions each, indicate high interest in these publications. In contrast, some journals, like Journal of Open Innovation: Technology, Market, and Complexity, Teaching and Teacher Education, and Journal of Pedagogical Research, with only one distribution each, may reflect more specific research focus or lower interest.

Based on publishing country

Next, publication trends were analyzed based on the countries of publication, with the distribution of 53 journal articles. The analysis breaks down the contributions by country, highlighting challenges, obstacles, and opportunities, as shown in the image below.

Figure 4. Based on Publishing Country



In Malaysia, the U.S., Singapore, Turkey, Switzerland, and Poland each had one journal distribution. Despite the same number, this shows positive contributions from researchers in these countries. The Netherlands had five journal distributions, reflecting substantial contributions from institutions and researchers. The UK had nine, indicating a higher research focus or publication rate compared to the Netherlands. Overall, the UK and the Netherlands contributed more to journal data distribution, although factors like population size and research focus may influence this. A separate analysis of each publisher country based on a SWOT analysis of technology integration and digital literacy in national education policies is as follows:

UK: Strengths include excellent tech infrastructure supporting digital education policies. However, the digital divide between urban and rural areas poses a challenge. Opportunities include international collaboration with tech companies to update education technology, but rising device costs may worsen the digital gap[8]. Netherlands: Strong digital policies and continuous teacher training are strengths. However, some teachers lack training in effective tech use, limiting its classroom integration. Opportunities exist in international collaboration and platform development, but rural access and dependence on expensive technology are threats. Poland: Strong funding for educational technology is a strength, but teacher training and infrastructure need improvement [9]. Opportunities arise from decreasing tech costs, but urban-rural tech access disparities are a significant threat. Turkey: Strengths lie in technology education policies and platforms for schools, but rural areas suffer from limited access and inadequate teacher training. International cooperation could speed up tech adoption, but the urban-rural gap remains a threat[10]. Singapore: Exceptional tech access in schools and government support for digital education is a strength. However, reliance on expensive tech and integration challenges in remote areas pose weaknesses. Opportunities exist in further tech platform development, but tech dependency might worsen educational inequality[4]. Malaysia: Strengths include early integration of technology in education, but limited access in rural areas hampers digital education equality. Digital education programs offer opportunities, though reliance on external resources and limited device availability pose threats[10].

For RQ 1, to analyze the integration of technology and digital literacy in national education policies, the author used VOSviewer software to investigate research trends.

The first step was clustering the processed data to understand key trends in technology and digital literacy integration in global education policies.

Figure 5. Visualization Generated by VOSviewer



Figure 5. This network visualization shows the relationships between various key terms in the literature related to digital literacy, education, and policy. Large circles, such as "digital literacy" (orange color), indicate the central theme, while different colors represent research clusters: the red cluster discusses national education policy, such as "national education policy" and "curriculum," the yellow cluster highlights distance learning, such as "distance learning," and the green cluster includes general themes like "teacher" and "education." Connecting lines reflect close relationships, for example, between "digital literacy," "information literacy" (blue), and "distance learning" (yellow), which are frequently discussed together. This diagram identifies key trends, research gaps, and opportunities for policy development to enhance digital literacy in the digital era.

RQ 2. What are the research gaps related to the integration of technology and digital literacy in national education policies that need to be further explored?

To answer RQ2, the researcher extracted information about stakeholder involvement in the design process of technology and digital literacy integration policies. This involvement is categorized as active or passive, based on the definitions explained earlier. In Figure 5, the researcher also identified the level of involvement based on the roles of stakeholders, such as students, teachers, technology experts, and policymakers. Using the overlay generated from bibliometric analysis with VOSviewer, the researcher was able to observe the evolution of terms and topics emerging in the literature over time, as well as identify terms that received more or less attention in existing research. This overlay shows that terms like digital literacy and national education policy frequently appear and are the main focus in most studies. However, more specific terms like "sustainability teacher," "digital experts," or "attitude toward digital learning" show a more faded color intensity, indicating that these topics have received less attention in more recent literature.

Figure 6. Visualization Overlay by VOSviewer



Figure 6. This image shows the network visualization of terms related to digital literacy in the literature from 2020 to 2024. The color of the circles represents the dominant year of discussion, ranging from dark blue (2020) to yellow (2024). Terms such as "national education policy" (light green) dominate in the earlier years, while "distance learning" (yellow) becomes more relevant in the most recent years. The connecting lines represent relationships between terms, with thicker lines indicating stronger connections. The size of the circles reflects the frequency of the terms, with "digital literacy" at the center of the network, closely connected with other terms such as "information literacy," "education," and "distance learning," highlighting its role as a central concept in policy and education.

Table 1. Cluster Themes Related to the Integration of Technology and Digital Literacy in Global Education Policies

Cluster	Indicator
1. Dark green	Education, knowledge, policay preferences, quality, bureaucracy[11]
2. Dark blue	Digital technologies[12], earlt career teachers[13], ict literacy, internasional education, teacher self-efficacy[14]
3.Yellow	Teachers' digital literacy. Teacher, education tehnologiesm education quality, digital copetncy, blanded learning[15][16]
4.Purple	Education pdicay planning, education technology, pedagogy, public service dilevery, teachear performance, teacher training, technology Intregation[17]
5. Light blue	Information Literacy development, 21 st century abilities[18], infromasyion literacy, teaching learning strategi, post secondery education[19]
6.Orange	Digital Literacy, Digitalization, education model, south pasifi[20]

7. Chocolate	Teacher, qualitative, comparative[21]
8.Pink	Curriculum, Implementation, South Africa, environmental education[22]
9.Red	National education policy, policy, Indian, constitutional proxy, different[23]

RQ 3: What are the challenges and obstacles faced in the implementation of technology integration and digital literacy policies in national education?

To answer RQ 3, the researcher explores the challenges and obstacles faced in implementing technology integration and digital literacy policies in national education by analyzing existing literature through bibliometric analysis and data visualization using VOSviewer. The main obstacles in implementing these policies can be analyzed from the bibliometric visualization, which shows the connections between key themes. Digital literacy emerges as a central issue, with challenges such as the gap in digital literacy among students, teachers, and society. Another challenge is the connection between national education policy and curriculum, which highlights the difficulties in harmonizing policies with modern technology needs, as well as resistance to change [24]. Additionally, the themes of distance learning and the COVID-19 pandemic reveal problems with inadequate digital infrastructure and unequal access to technology in remote areas. The lack of teacher training is also a significant barrier, as indicated by the connection between teachers and education quality management [25], underscoring the need to enhance teachers' capacity to effectively use technology in the learning process. Sustainability challenges are evident due to the lack of long-term plans to support educational technology, as well as a shortage of relevant digital experts to support the effective implementation of policies [11].

From the year overlay in the bibliometric analysis, the evolution of challenges in implementing technology integration and digital literacy policies in national education from 2020 to 2024 can be observed. The theme of digital literacy remained a central focus throughout this period, reflecting its ongoing relevance [26]. However, themes such as distance learning and the COVID-19 pandemic dominated around 2020–2021, highlighting the significant impact of the pandemic on the need for remote learning and digital literacy [27]. Afterward, themes such as education quality management, teachers, and sustainability gained more attention in the following years, indicating a shift in focus towards sustainability challenges and the quality of education in technology implementation. Additionally, themes like national education policy and curriculum, which appeared more frequently in the early period (2020–2022), indicate initial efforts to integrate policies and curriculum to support technology [3]. On the other hand, themes like digital experts and sustainability, which became more prominent in 2023–2024, highlight newer gaps related to the need for digital experts and the sustainability of educational technology policies. Thus, the year overlay helps to understand how the focus of policies shifted from responding to the pandemic crisis to strengthening digital education infrastructure and long-term sustainability.

CONCLUSIONS

The integration of technology in education globally aims to enhance quality, expand access, and prepare students for the digital age [28]. It involves using technology as a tool to improve teaching and learning efficiency [29]. Research supports that policies integrating technology and digital literacy create adaptive learning environments that foster both academic and social skills in students. Teacher training in digital literacy plays a critical role in improving the effectiveness of technology-based learning, aligning with constructivist principles where students actively construct knowledge through technology. This study aligns with previous research, emphasizing that technology can improve learning, but its effectiveness depends on adequate teacher training and access to resources. It also highlights challenges in developing countries like Indonesia, where there is a digital divide and unequal access to technology, especially in rural areas [30]. The Indonesian government’s efforts, such as the Digital Literacy Movement, support the integration of digital

literacy, but addressing these gaps requires comprehensive teacher training and improved infrastructure.

Innovations like blended learning and the holistic integration of technology in curricula, seen in countries like Finland and Singapore, show that technology can improve learning and reduce dependency on teacher- centered methods [31]. However, developing countries still face challenges like unequal access to technology and training. Policies should focus on local needs, and there must be integrated solutions between government, private sector, and society to address the digital divide.

Policy Implications include prioritizing teacher training, ensuring technology access, adapting curricula to include technology, and funding infrastructure, especially in remote areas. This study supports constructivist and pedagogical innovation theories, which view teachers as facilitators of student-centered learning with the aid of technology, contributing to the development of education theories that link technology, pedagogy, and policy.

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