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Integration of Information Technology in Basic Education Curriculum: An Evaluation of ICT-Based Curriculum in Indonesia

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A B S T R A C T
Generation z, known as the digital literate generation, is a generation that is trendy and fluent in technology. The use of technology and communication has now become a basic need, as well as in the field of learning. The rise of learning using digital media requires teachers to be more innovative in choosing learning resources that students are interested in. The integration of Information and Communication Technology (ICT) in the basic education curriculum in Indonesia is a strategic step to improve the quality of learning in the digital era. This article aims to assess the implementation of ICT-based curriculum in Indonesia through relevant research and policies. The results show that despite great efforts in integrating ICT, challenges such as limited infrastructure, teacher competencies and the digital divide are still major obstacles. A comprehensive and collaborative strategy between the government, educational institutions and other stakeholders is needed to maximize the integration of Information & Communication Technology (ICT) in the basic education curriculum.

INTRODUCTION

Generation Z (Gen-Z), which has been expressed by experts as a generation that is technologically literate (Rachmawati, 2019), means that since birth individuals interact with technological advances (Nabila et al., 2023). This allows for the most significant changes in various fields caused by technological developments. The world of education is one of the main targets of the rampant development of information and communication technology. So that in the process of implementing learning always echoes the advancement of technology and communication.

In addition, this generation is also referred to as an innovative generation where students grow up and connect with strong communication networks and are adaptive to change (Çalışkan, 2021). The characteristics of Gen-Z who grew up in the digital and high-tech era are accustomed to using various communication platforms simultaneously and efficiently. The integration of ICT in the basic education curriculum is important to prepare the generation for the challenges of the 21st century. In Indonesia, there are various policies implemented to support this integration, but there are still obstacles in its implementation.

The industrial revolution 4.0 and the development of the digital era have driven a paradigm shift in the global education system, including in Indonesia (Cholily et al., 2019). Various strategic steps and policies have been taken by the government to support the grand design in facing the industrial revolution 4.0 (Santika, 2021). Education in the industrial era 4.0 requires students not only to master concepts but also other skills such as critical thinking skills, creativity, collaboration, teamwork skills, and communication skills as well as problem solving (Daeli et al., 2025; Daulay et al., 2021; Purwanto et al., 2023). Thus, the application of Information and Communication Technology (ICT) has become an urgent need in the learning process and curriculum. This of course will have an impact on various levels of education, especially at the basic education level (Rusniawan&Aprilliantoni, 2024). Where this level is the initial foundation for students' cognitive development and digital literacy.

Strategic efforts to support digital transformation in the education sector have been made by the Government of Indonesia (Fadhilah, 2024; Wang et al., 2013). One of them is by implementing the 2013 Curriculum and Merdeka Curriculum. This effort was made to provide space for the use of technology in the teaching and learning process (Ministry of Education and Culture, 2021). In this policy, ICT not only functions as a teaching aid, but also as a means to develop innovative learning models that support active, collaborative, and student-centered learning (Siwitomo et al., 2023; Syahrir et al., 2024; Insung Jung, 2015)

The reality of Information and Communication Technology (ICT) implementation still has significant gaps in the field. Various problems such as limited technological infrastructure, low teacher competence in using ICT, and access to digital services between regions are the main obstacles in optimizing ICT-based curriculum (Laila &Izzatul, 2025; Chafshah et al., 2023; Waruwu et al.,

2023). This has an impact on the integration of ICT in the curriculum that has not been fully planned systemically and sustainably.

This review aims to evaluate the implementation of an Information and Communication Technology (ICT)-based curriculum in Indonesian basic education through a literature review approach. By reviewing various research results and policies over the past decade, this article is expected to provide a comprehensive understanding of the effectiveness of ICT integration in the curriculum as well as challenges and development strategies. This evaluation is important as a basis for formulating educational policies and practices that are adaptive to technological developments and future learning needs.

METHODOLOGY

This study used a literature review approach to assess the implementation of Information and Communication Technology (ICT) in the primary education curriculum in Indonesia. The purpose of this literature review was to collect and analyze various theories as well as empirical results from previous research obtained in the last decade. The literature study enabled researchers to systematically and thoroughly analyze ICT integration policies, practices, challenges and strategies from different points of view.

Data collection was done by searching for scientific articles obtained from trusted databases such as Google Scholar, Scopus, and DOAJ. Inclusion criteria included: (1) articles published in indexed and reputable national and international journals; (2) focusing on basic education and ICT integration in the curriculum; (3) published in the period 2014-2024; and (4) available in Indonesian or English. Key words used included: "ICT integration in primary education". After conducting the review, several key articles were obtained that met the criteria and were analyzed qualitatively using a thematic analysis approach. This thematic analysis was conducted by grouping information based on the themes that became the focus of the research, namely: (1) ICT integration policy, (2) implementation and practice in primary schools, (3) obstacles that arise, and (4) efforts made by organizers to reflect this change. Analysis of existing research results, gaps between journals, and their relevance to the context of primary education in Indonesia

Results and Discussion "Indonesian curriculum and technology", "digital learning in primary schools", and "implementation of educational technology".

RESEARCH RESULT

ICT Integration Policies and Implementation

Various policies have been carried out by the Indonesian government to support the implementation of ICT in the field of education. Policies such as the 2013 Curriculum and the Merdeka Curriculum have integrated ICT in the learning process (DurrohNasihatul Ummah &Nadlir, 2023; Nisa, 2023). The integration of Information and Communication Technology (ICT) in implementing the Merdeka Curriculum is very important to improve the effectiveness of the learning process (Pakaya&Hakeu, 2023; Rejeki et al., 2023). Schools should maximize the use of digital technology and the internet as a means of presenting authentic, interesting, and innovative learning materials.

The integration of ICT can expand students' reach to various sources of knowledge, encourage new learning methods, and foster analytical thinking and inventiveness. Not only that, ICT also plays a role in realizing equitable and flexible learning, so that every student can develop their potential thoroughly and sustainably.

However, the reality in the field does not always run smoothly. There are a number of obstacles that hinder implementation, such as inadequate facilities and infrastructure, limited number of devices, unstable internet connection, and lack of provision for teachers (Haryuniati et al., 2024; Wahyudi and Jatun, 2024). The Indonesian government itself has actually been focusing on efforts to incorporate Information and Communication Technology (ICT) into the basic education system for about twenty years. This is emphasized through the 2013 Curriculum (K-13) and Merdeka Curriculum, both of which emphasize the importance of ICT capabilities as a key skill in this modern era. Especially in the Merdeka Curriculum, ICT is expected to play a major role in facilitating learning that is tailored to the needs of individual students, through diverse and project-based methods (Kemendikbudristek, 2022)

ICT implementation in primary and secondary education is a major focus of the Indonesian government, reflected in various strategy documents and official regulations. One example is Minister of Education and Culture Regulation 22/2016 on Process Standards for Primary and Secondary Education. This regulation straightforwardly advocates the use of ICT as an interactive learning tool, evidence that the government recognizes the important role of ICT in improving the quality of the teaching and learning process. Furthermore, the government's ideals on ICT in education are also reinforced in the Ministry of Education and Culture's Strategic Plan (RenstraKemdikbud) 2020-2024. The document clearly sets out two main focuses: improving digital education infrastructure and developing ICT-based teaching materials. These priorities emphasize the importance of having reliable digital facilities in all schools, while also highlighting the need to develop learning materials that are current, innovative and easily accessible through digital platforms. The emphasis on these two things signifies the government's planned efforts to create an educational environment that is adaptive to technological advances and capable of equipping students with the digital skills needed in the 21st century (Ministry of Education and Culture, 2020).

Assessments of the effectiveness of ICT integration strategies and their implementation in the field show that it is still difficult to achieve equitable performance. Observations show that primary schools, especially in the 3T areas (border areas, outermost areas, disadvantaged areas), face a number of formidable obstacles (TrenggonoHidayatullah et al., 2023; Warsihna, 2013). Chafshah et al. (2023) state that limited internet access, inadequate availability of technology tools, and teachers' rudimentary skills in using ICT pedagogically are these challenges. Most teachers also stated that the use of ICT in learning is usually technical even though they have received basic training. This indicates that the use of ICT has not reached the level needed to create meaningful and contextualized digital learning, which is critical to maximizing their ability to

improve the quality of teaching and learning. The study conducted by Syahrir et al. (2024) emphasizes that successful ICT integration depends not only on the availability of infrastructure, but also on the preparation of the entire educational environment, including curriculum, pedagogy, internal school policies, and a culture of digital literacy among teachers and students.

There is a clear discrepancy between the stated policy objectives and how they are implemented on the ground. This indicates the need for more in-depth assessment and review of these programs. These considerations are important because ICT unification is not just a symbol of educational progress, but must also truly trigger meaningful learning changes in primary schools.

Challenges in ICT Integration

Digital devices such as computers, tablets, and internet connections have made a significant impact in increasing interactivity, efficiency, and personalization of learning. This is realized through varied learning models such as blended learning, hybrid, and flipped classroom (Wahyudi&Jatun, 2024). However, the implementation of these technologies is not without obstacles; one of them is the difference in access and availability of technology facilities between urban and rural areas, public and private schools, and the disparity in teachers' ability to integrate technology into the learning process. Teacher readiness and competence is a major factor affecting the success of digital learning implementation; many teachers, especially senior ones, face obstacles due to lack of training and experience with digital tools. In addition, inadequate infrastructure, as well as socioeconomic factors and the role of government and the private sector, contribute to disparities in access and effectiveness of digital learning. Despite these challenges, technology offers great opportunities to improve the quality and engagement of student learning, so sustained efforts from all parties are needed to reduce disparities and optimize the benefits of technology in basic education.

Some of the main challenges in ICT integration include limited internet access, lack of technological devices in schools, and low digital competence of teachers (Chafshah et al., 2023). Hidayat (Hasna, 2023) further asserts that in the context of digitizing primary school management, the main challenge lies in the limitations of inadequate technological infrastructure. This includes lack of hardware (computers, tablets), unstable internet access, or inappropriate software systems. Without adequate technological support, schools will be left behind in the digitalization process, significantly hampering the implementation of digital systems. The digital divide between urban and rural areas affects the effectiveness of ICT implementation (Waruwu et al., 2023).

Although many efforts have been made by launching various policies and programs to incorporate information and communication technology (ICT) into basic education, there are still complex problems in the field that are systemic, structural, and also cultural. Thoroughly understanding these issues is key to a successful and sustainable ICT utilization strategy. That way, ICT is not just a patch, but really an important part of major changes in education whose results can be directly felt by students in learning. One of the main reasons why ICT utilization is still low is because there is a big difference in infrastructure between

schools, especially those in remote areas. Many primary schools in 3T areas still struggle to access the internet, lack digital learning tools such as computers and projectors, and the electricity network is often problematic (Magdalena and Maria Pawe, 2023; Sedatiwara et al., 2023). As a result, the use of ICT in teaching and learning activities is inconsistent and uneven (Waruwu et al., 2023). This difference in infrastructure is a major barrier to achieving the same quality of technology-based education across Indonesia.

Teachers' ability to integrate ICT in a pedagogically meaningful way remains a major challenge. Although various trainings and workshops have been implemented, these initiatives generally emphasize technical skills such as operating PowerPoint or video conferencing tools more than instructional design. As a result, teachers are often unprepared to create ICT-based learning environments that are interactive, collaborative and tailored to the developmental needs of primary school students (Syahrir et al., 2024). In line with this, Chafshah et al. (2023) found that many educators still consider ICT only as a tool to deliver content, not as a core component of a student-centered teaching strategy that encourages engagement.

School management systems can be another challenge. Support from school principals and internal policy positions can drive the success of ICT-based digital integration in the implementation of learning in educational units. However, limited infrastructure, minimal digital-based facilities, and lack of access to electricity in remote areas result in many primary schools not having a strategic plan to digitize learning (DheniPurnasari et al., 2024). ICT is more often used for administrative purposes than for meaningful learning activities. Without regular supervision and evaluation from school management, the utilization of Information and Communication Technology (ICT) is usually irregular and depends on the initiative of individual teachers (Sundari et al., 2024).

In addition, the role of parents and the surrounding environment is also a determining factor in the success of ICT integration, especially when students learn digitally at home. Unfortunately, many parents do not have adequate digital skills, and some of them do not even have access to devices or the internet. This leads to gaps in students' learning participation, especially from low-income families (Widodo and Mustaji, 2022). As a result, the potential of Information and Communication Technology (ICT) as a bridge for equitable learning has not been fully utilized.

Another important challenge is the digital divide, which is not only related to access and infrastructure, but also to the meaningful use of ICT. Zhang et al. (2020) point out that ICT integration without strengthening critical digital literacy can actually widen the education gap. Therefore, ICT integration policies must take intoaccount the social, cultural and economic aspects of students so that the utilization of technology truly improves the quality of learning and reduces the gap between students. Therefore, ICT integration in basic education in Indonesia faces multidimensional challenges that cannot be addressed by providing technical tools or training alone. A systematic and collaborative approach is needed, which includes inclusive policy planning, ongoing teacher capacity

building, school managerial support, and improved digital literacy at the family and community levels. Only in this way can ICT integration realize adaptive, equitable and transformative learning for all students in Indonesia.

Strategies for Strengthening ICT Integration

The rapid development of information and communication technology (ICT) provides a great opportunity to utilize digital tools in improving digital literacy. In the context of education, the use of ICT can help students to explore and understand the natural world in a more interactive and immersive way (Ludfiana et al., 2023). In addition, the rapid development of Information and Communication Technology provides a great opportunity to improve natural literacy through the use of digital devices (Choirunisa and Nauval, 2025). In the field of education, ICT can assist students in exploring and understanding the natural environment in a more interactive and immersive way. However, in its implementation, there are still many challenges and obstacles in integrating ICT in learning. A strategy is needed to overcome these challenges. This strategy does not only focus on providing hardware, but also includes strengthening the capacity of human resources, updating the curriculum, and increasing collaboration between education stakeholders.

To strengthen the integration of Information and Communication Technology (ICT) in basic education in Indonesia in a sustainable and equitable manner, a multidimensional strategy focusing on five main pillars is needed: First, strengthening teachers' digital literacy competencies must be a priority. It is not enough for teacher training programs to only provide technical skills, but they must be designed in a sustainable manner and based on real needs in the field. Training should target teachers' pedagogical abilities in designing ICT-based learning that is active, contextualized and encourages 21st century skills such as critical thinking, communication and collaboration (Syahrir et al., 2024). A blended learning approach can be an effective solution as it combines online and face-to-face learning flexibly (Banila et al., 2021; Darmawan, 2019).

Second, ICT integration needs to be strengthened through adaptive curriculum development. The national curriculum should provide opportunities for teachers to innovate in developing ICT-based materials that suit the local context and students' needs. A flexible curriculum allows teachers to combine technology with different learning approaches, so they can meet the needs of students with diverse backgrounds (Hermansyah and Rochintaniawati, 2023).

Third, cooperation between stakeholders is essential to support the sustainability of ICT integration. Central and local governments, schools, teaching communities, and the private sector need to create synergies in the provision of infrastructure, technical support, and digital learning content development. Collaboration with technology companies, for example through CSR programs, has been shown to help schools in remote areas gain access to devices and training (Sundari et al., 2024).

Fourth, strengthening school leadership is also very important. School principals should have a clear digital vision and be able to manage resources well to support ICT-based learning innovations. Research shows that schools led by technology-oriented principals tend to be more successful in integrating ICT

thoroughly in the learning process (Widodo and Mustaji, 2022). Therefore, technology-based leadership capacity building should be part of the principal training program.

Finally, monitoring and evaluation of ICT use should be conducted regularly and be based on data. Evaluation should not only pay attention to the number of devices or networks, but rather to their impact on student learning processes and outcomes. Indicators of the success of ICT integration should include learning quality, student engagement, and improved academic performance (Zhang et al., 2020). The results of this evaluation data can serve as a foundation for improving future policies and interventions. Using this strategy, the use of technology in education can be a tool for transformation towards more inclusive, effective, and age-appropriate learning, not just a symbol of modernization.

DISCUSSION

The era of revolution 4.0 is an era of disruption characterized by massive change, has many problems and challenges and is full of uncertainty. The curriculum is one of the means to answer the demands of the future. The question is what we should prepare in a very diverse world. One of the things we can think of is managing & designing learning so that children are involved adaptively in finding information. In addition, other supporting elements teach children how to obtain information and utilize technology. Ideally, teachers should be able to create a conducive, creative, fun learning environment and use various digital resources to improve the quality of student learning.

Learning in the era of the industrial revolution 4.0, which is full of technology, is a time when learning can be directed by students themselves. Education is no longer sourced from books but also from other learning resources such as digital and electronic media. ICT integration is instrumental in helping teachers to design and implement digital-based learning. Some of the advantages possessed by students who have digital literacy skills include students being able to produce and communicate information, construct knowledge, filter and manage information, have awareness in building relationships and can think critically in taking information (Effrisanti, 2023).

However, in its implementation, there are still challenges and obstacles in applying ICT in learning. These challenges stem not only from teachers who are still clueless in the use of ICT but also inadequate facilities and infrastructure so that digital media provided by educational institutions can only be used by certain people. In addition, the gap between rural and urban schools is a very significant gap in integrating digital resources. Limited internet access and inadequate electricity sources in 3T areas add a strong gap to ICT integration.

CONCLUSIONS AND RECOMMENDATIONS

The integration of Information and Communication Technology (ICT) in the basic education curriculum in Indonesia is a strategic need to respond to the digital era and equip students with 21st century competencies. Although the ICT integration policy has been initiated through various national programs such as

the 2013 Curriculum and Merdeka Belajar, its implementation in the field still faces considerable challenges. These include infrastructure inequality, low teacher competence, limited managerial support, and the digital divide among students.

To overcome these challenges, a comprehensive and contextualized reinforcement strategy is needed. Factors that support the success of effective and sustainable IT integration include improving teachers' digital skills, developing adaptive curricula, cross-sectoral collaboration, digital leadership in schools and conducting continuous evaluation based on data. In addition, family and community involvement in supporting technology-based learning should also be strengthened to create an inclusive digital education ecosystem.

In general, successful ICT integration is not just about adopting technology, but also about pedagogical transformation and paradigm shifts in teaching and learning. With a systematic and evidence-based approach, ICT integration at the basic education level can accelerate the equitable distribution of education quality in Indonesia and prepare the younger generation with appropriate skills for the future.

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