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Implementation of Education 5.0 in Improving the Quality of Technology-Based Learning in Secondary Schools in Indonesia

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ABSTRACT

This study investigates the implementation of Education 5.0 in enhancing the quality of technology-based learning in secondary schools in Indonesia. Utilizing a quantitative research approach, data were collected from 150 respondents, including educators and students, through a structured questionnaire employing a Likert scale (1–5). Data analysis was conducted using SPSS version 25, incorporating descriptive statistics, correlation, and multiple regression analyses. The findings reveal a positive and significant relationship between Education 5.0 components—technology integration, personalized learning, teacher effectiveness, and student engagement—and the quality of learning. Among these, technology integration was identified as the most influential factor. The results underscore the transformative potential of Education 5.0 in creating interactive, learner-centered environments. However, challenges such as digital infrastructure disparities and teacher readiness must be addressed to maximize its benefits. This study provides valuable insights for policymakers, educators, and stakeholders in advancing educational innovation in Indonesia.

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1. INTRODUCTION

Education 5.0 represents a shift in educational paradigms through the integration of advanced technologies and a learner-centered approach to prepare students for the Fourth Industrial Revolution. By leveraging AI, virtual reality, and big data analytics, it creates interactive and personalized learning environments [1]. AI-powered tools like ChatGPT enable customized education but pose challenges in equitable access (Nguyen, 2025). This model prioritizes student engagement, fostering critical thinking, adaptability, and collaboration over traditional academic achievements [2]. Furthermore, it enhances social and emotional skills, equipping students for a dynamic and interconnected world [3].

The adoption of Education 5.0 in Indonesian secondary schools is crucial for improving educational quality despite challenges such as uneven technology access and varying teacher competencies. This model emphasizes technology integration to create engaging and inclusive learning environments, with ICT and AI playing key

roles in transforming education. ICT in mathematics enhances interactivity and digital literacy but requires supportive policies for infrastructure and teacher training [4]. AI enables adaptive learning and personalized experiences, though infrastructure limitations and data privacy concerns must be addressed [5]. Challenges include limited technology access, low digital competence, and financial constraints, while opportunities arise from flexible learning, global collaboration, and innovative teaching methods [6]. The Smart School program in South Sulawesi exemplifies successful technology integration, emphasizing compatibility, trialability, and observability in policy adoption (Mardin et al., 2024). Policies such as the Directorate General of Teachers and Education Personnel Regulation aim to enhance learning through technology-based management but face infrastructure gaps in rural areas [7]. Sustainable improvements require continuous investment in infrastructure, teacher training, and stakeholder engagement to strengthen technology-based education (Mardin et al., 2024).

This study investigates the implementation of Education 5.0 in secondary schools in Indonesia, focusing on its role in improving the quality of technology-based learning. The research adopts a quantitative approach to analyze the perceptions of educators and students regarding the effectiveness of Education 5.0 practices. By utilizing a sample of 150 respondents and employing statistical analysis with SPSS version 25, the study aims to identify key factors contributing to the success of technology-enhanced learning and provide evidence-based recommendations for policymakers and educators.

2. LITERATURE REVIEW

2.1 Education 5.0: Theoretical Foundations

Education 5.0 represents an evolution from Education 4.0, emphasizing personalization, collaboration, and ethical considerations in learning environments. Rooted in constructivism and connectivism, it advocates for learner-centered and networked learning approaches that enhance human, social, and emotional growth rather than merely providing digital tools [3], [8]. This model leverages AI, VR, and AR to create flexible and accessible learning environments, benefiting students with disabilities and fostering collaboration between humans and machines, particularly in complex problem-solving and innovation within engineering education [9], [10]. Ethical considerations are crucial in ensuring that technology-based education remains humanistic, requiring the integration of professional ethics and continuous moral training [8]. Connectivism, as proposed by Siemens, supports Education 5.0 by emphasizing the role of digital connections in facilitating learning, while constructivism reinforces learner-centered approaches, encouraging active engagement and self-reflection [3], [10].

2.2 Technology-Based Learning in Secondary Education

Technology-based learning has significantly transformed secondary education by enhancing student engagement, motivation, and learning outcomes through innovative tools and platforms. The integration of digital tools, online platforms, and AI has improved academic performance when effectively implemented, though it requires thoughtful instructional design and support for educators and students [11]. In virtual learning environments, technology fosters increased student participation, yet challenges such as the digital divide and lack of institutional support persist, particularly in developing countries like Indonesia, where limited digital infrastructure and socio-economic disparities exacerbate these issues [12]. Digital tools and platforms enhance engagement, motivation, and the development of critical skills like problem-solving, collaboration, and digital literacy, while virtual classrooms offer flexibility and accessibility for personalized learning

[11], [13], [14]. However, barriers such as limited technology access, inadequate teacher training, and socio-economic disparities hinder equitable educational outcomes [12], [13]. To address these challenges, professional development programs, such as Technology-Enhanced Cooperative Problem-Based Learning workshops, can improve educators' teaching strategies and confidence in using digital tools [13]. Additionally, ensuring equitable access to resources and implementing supportive policies are essential for bridging the digital divide and enhancing the effectiveness of technology-based learning [12].

2.3 The Role of Education 5.0 in Enhancing Learning Quality

Education 5.0, characterized by personalized and adaptive learning, leverages AI-driven technologies to enhance educational outcomes and align with Indonesia's goals of innovation and inclusivity, though studies on its effectiveness in secondary schools remain limited. AI technologies, such as intelligent tutoring systems and adaptive learning platforms, provide tailored instruction, real-time feedback, and customized content to improve engagement and knowledge retention [15], [16]. Acting as a co-teacher, AI adapts to individual learning styles, boosting academic performance and student participation [17]. Beyond personalization, Education 5.0 integrates STEM with creativity and ethics, promoting interdisciplinary and inclusive education while improving digital literacy, a crucial skill for future workforces [17], [18]. However, challenges such as technology complexity, limited curriculum adaptability, infrastructure gaps, data privacy, and algorithmic bias remain obstacles [15], [19]. Despite these, AI presents significant opportunities to enhance education accessibility and effectiveness, making it a transformative force in modern learning [19].

2.4 Gaps in the Literature

While the theoretical and empirical foundations of Education 5.0 are well-established, several gaps in the literature persist. First, there is a lack of context-specific studies examining the implementation of Education 5.0 in developing countries, particularly in Indonesia. Second, existing research often focuses on higher education, with limited attention to secondary schools, where the impact of technology-based learning is equally critical. Lastly, the relationship between teacher readiness, infrastructural support, and the effectiveness of Education 5.0 practices warrants further investigation.

This study seeks to address these gaps by investigating the implementation of Education 5.0 in secondary schools in Indonesia. By analyzing the perceptions of educators and students, the research aims to provide a comprehensive understanding of the factors influencing the quality of technology-based learning. The findings are expected to inform policymakers and educators, offering actionable recommendations for optimizing the implementation of Education 5.0 in diverse educational settings.

3. RESEARCH METHODS

3.1 Research Approach

The quantitative approach was chosen for its ability to objectively measure relationships between variables and provide statistical evidence to support findings. This method is particularly suitable for analyzing the perceptions of educators and students regarding the implementation of Education 5.0 and its impact on the quality of learning. The study utilized a survey design to gather data systematically from a sample of secondary school stakeholders.

3.2 Population and Sample

The population for this study comprises educators and students from secondary schools in Indonesia where

technology-based learning initiatives have been introduced. A sample size of 150 respondents was determined, aligning with guidelines for sufficient statistical power in quantitative studies. Stratified random sampling was employed to ensure representation from different regions, school types, and demographics, enhancing the generalizability of the findings.

3.3 Data Collection Instruments

Data were collected using a structured questionnaire designed to measure variables related to the implementation of Education 5.0 and the quality of technology-based learning. The questionnaire comprised two main sections: Demographic Information, which captured respondents' background details such as age, gender, role (educator or student), and familiarity with technology-based learning; and Education 5.0 and Learning Quality Variables, which measured perceptions of technology integration, personalized learning, teacher effectiveness, student engagement, and overall learning quality. A 5-point Likert scale (ranging from 1 = strongly disagree to 5 = strongly agree) was used to gauge respondents' levels of agreement with specific statements.

To accommodate respondents with varying access to technology, the survey was administered both online and offline. Participants received clear instructions and assurances of confidentiality to promote honest and accurate responses. The data collection period lasted four weeks to ensure sufficient participation and representation.

3.4 Data Analysis

The collected data were analyzed using SPSS version 25, with descriptive statistics summarizing demographic information and respondents' perceptions. Inferential statistical techniques, including correlation and regression analyses, were used to examine the relationships between Education 5.0 implementation and the quality of technology-based learning. The data analysis process involved several key steps: data cleaning to address missing or inconsistent responses, descriptive analysis to calculate means, standard deviations, and frequencies for each variable, and inferential analysis using Pearson correlation to identify relationships between variables and multiple regression analysis to determine the extent to which Education 5.0 predicts learning quality.

4. RESULTS AND DISCUSSION

4.1 Results

a. Demographic Sample

The demographic analysis of 150 respondents, including educators and students from Indonesian secondary schools, showed a higher male participation (60%) than female (40%). Most respondents were students aged 15–18 (55%), while educators were in the 25–40 age range (45%). Among educators, 75% held a Bachelor's degree and 25% a Master's degree. Familiarity with technology-based learning was generally high, with 48% highly familiar, 38% moderately familiar, and 14% having low familiarity. The majority of respondents were from urban schools (65%), reflecting better access to technology-based learning. Students comprised 60% of the sample, aligning with the study's focus on engagement and learning experiences in Education 5.0.

b. Descriptive Statistics

The demographic analysis of 150 respondents showed that 40% were educators and 60% were students, with most having moderate to high familiarity with technology-based learning tools. The mean scores for key variables reflected a generally positive perception of Education 5.0 implementation: technology integration (M = 4.21, SD = 0.65), personalized learning (M = 4.15, SD = 0.72), teacher effectiveness (M = 4.18,

SD = 0.68), student engagement (M = 4.10, SD = 0.70), and overall learning quality (M = 4.25, SD = 0.62). These findings suggest that Education 5.0 is perceived as contributing positively to learning quality.

c. Correlation Analysis

Pearson correlation analysis revealed significant positive relationships between all variables, indicating that technology integration ($r = 0.681$, $p < 0.01$), personalized learning ($r = 0.647$, $p < 0.01$), teacher effectiveness ($r = 0.702$, $p < 0.01$), and student engagement ($r = 0.626$, $p < 0.01$) were all strongly associated with improved learning quality. These findings suggest that each component of Education 5.0 contributes positively to enhancing learning outcomes in technology-based educational settings.

d. Regression Analysis

Multiple regression analysis was conducted to assess the predictive power of key variables on learning quality, revealing a significant model ($F(4,145) = 42.35$, $p < 0.01$) with an adjusted $R^2 = 0.52$, indicating that the model explains 52% of the variance in learning quality. The standardized beta coefficients showed that Technology Integration ($\beta = 0.32$, $p < 0.01$) had the strongest impact, followed by Teacher Effectiveness ($\beta = 0.28$, $p < 0.01$), Personalized Learning ($\beta = 0.25$, $p < 0.01$), and Student Engagement ($\beta = 0.20$, $p < 0.05$). These findings suggest that all four components of Education 5.0 significantly contribute to enhancing learning quality, with technology integration playing the most influential role.

4.2 Discussion

The findings provide empirical evidence that Education 5.0 significantly enhances the quality of technology-based learning in secondary schools in Indonesia. The results align with existing literature emphasizing the transformative potential of integrating advanced technologies into education [20].

The high beta coefficient for Technology Integration underscores its pivotal role in creating dynamic and interactive learning environments. Technologies such as AI-driven platforms and virtual reality tools enable personalized and immersive learning experiences, as highlighted by Garrison and Vaughan (2008). In Indonesia, schools adopting such technologies can bridge traditional educational gaps, particularly in remote and underserved areas.

The significant impact of Personalized Learning on learning quality reflects the shift towards learner-centric education in the 21st century. By tailoring instruction to individual needs, Education 5.0 fosters deeper engagement and improved outcomes. However, the effective implementation of personalized learning requires sufficient digital infrastructure and teacher training, areas that need further investment in Indonesia.

Teacher Effectiveness emerged as a crucial factor, highlighting the importance of educators' ability to adapt to and leverage technology. Professional development programs focused on digital pedagogy are essential to equip teachers with the skills needed to implement Education 5.0 successfully [21]–[23]. The findings suggest that teacher readiness significantly influences the success of technology-based learning initiatives.

The role of Student Engagement in learning quality underscores the importance of fostering active participation in the learning process. Gamification, collaborative projects, and real-world applications are effective strategies for maintaining high levels of engagement. Indonesian schools can benefit from adopting these approaches to complement the technological advancements introduced by Education 5.0.

4.3 Practical Implications

The results have several practical implications for policymakers and

educators in Indonesia. First, investments in digital infrastructure and tools should be prioritized to support the widespread adoption of Education 5.0. Second, capacity-building programs for teachers should focus on integrating technology into pedagogy. Third, schools should adopt holistic strategies that combine technology, personalized instruction, and student-centered learning practices to maximize the benefits of Education 5.0.

4.4 Challenges and Future Research

Despite the positive findings, challenges such as unequal access to technology, varying teacher competencies, and socio-economic disparities remain. Future research should explore strategies to address these barriers and investigate the long-term impact of Education 5.0 on learning outcomes. Additionally, qualitative studies could provide deeper insights into the experiences of educators and students in implementing technology-based learning.

5. CONCLUSION

The implementation of Education 5.0 significantly enhances the quality of technology-based learning in secondary schools in Indonesia, as evidenced by the study's findings. Technology integration, personalized learning, teacher effectiveness, and student engagement are crucial factors contributing to improved learning quality, with technology integration playing the most pivotal role. These findings align with global trends advocating for advanced educational technologies to create dynamic, personalized, and learner-focused environments.

Despite the positive outcomes, the study highlights challenges such as unequal access to digital infrastructure, varying teacher competencies, and socio-economic disparities. Addressing these issues requires concerted efforts from policymakers, educators, and stakeholders, including investments in technology, teacher training programs, and inclusive educational policies.

This research emphasizes the transformative potential of Education 5.0 in Indonesia's educational landscape and offers practical recommendations for its successful implementation. Future studies should explore strategies to mitigate the identified challenges and examine the long-term impacts of Education 5.0 on student outcomes and broader educational goals.

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