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The Effect of Digital Literacy on Learning Quality and Instructional Innovation: A Structural Equation Modeling Approach in Secondary Education

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Abstract: This study aims to examine the effect of digital literacy on learning quality and instructional innovation using a Structural Equation Modeling (SEM) approach in secondary education. Digital literacy is positioned as an exogenous variable, while learning quality and instructional innovation function as endogenous variables. The research employs a quantitative design with a survey method involving secondary school students. Data were collected through a structured questionnaire and analyzed using SEM to identify the relationships among variables. The findings indicate that digital literacy has a significant positive effect on learning quality and instructional innovation. Students with higher levels of digital literacy tend to demonstrate better engagement, deeper understanding of learning materials, and greater participation in innovative learning activities. Furthermore, digital literacy also indirectly contributes to enhancing instructional innovation through improved learning quality. These results highlight the importance of integrating digital literacy into educational practices to support effective and innovative learning in the era of educational transformation.

Keywords: Digital Literacy; Learning Quality; Instructional Innovation; Structural Equation Modeling; Secondary Education.

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Abstrak: Penelitian ini bertujuan untuk menganalisis pengaruh literasi digital terhadap kualitas pembelajaran dan inovasi pembelajaran dengan menggunakan pendekatan Structural Equation Modeling (SEM) pada pendidikan menengah. Literasi digital diposisikan sebagai variabel eksogen, sedangkan kualitas pembelajaran dan inovasi pembelajaran sebagai variabel endogen. Penelitian ini menggunakan desain kuantitatif dengan metode survei yang melibatkan siswa sekolah menengah. Data dikumpulkan melalui kuesioner terstruktur dan dianalisis menggunakan SEM

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untuk mengidentifikasi hubungan antar variabel. Hasil penelitian menunjukkan bahwa literasi digital memiliki pengaruh positif dan signifikan terhadap kualitas pembelajaran dan inovasi pembelajaran. Siswa dengan tingkat literasi digital yang tinggi cenderung memiliki keterlibatan belajar yang lebih baik, pemahaman materi yang lebih mendalam, serta partisipasi yang lebih aktif dalam pembelajaran inovatif. Selain itu, literasi digital juga memberikan kontribusi tidak langsung terhadap inovasi pembelajaran melalui peningkatan kualitas pembelajaran. Temuan ini menegaskan pentingnya integrasi literasi digital dalam praktik pendidikan guna mendukung pembelajaran yang efektif dan inovatif di era transformasi pendidikan.

Kata Kunci: Literasi Digital; Kualitas Pembelajaran; Inovasi Pembelajaran; Structural Equation Modelling; Pendidikan Menengah.

A. Introduction

The rapid advancement of digital technologies has fundamentally reshaped the educational landscape in the 21st century. Educational systems worldwide are undergoing significant transformation driven by the integration of digital tools, online platforms, and data-driven learning environments. This transformation requires not only technological adoption but also the development of competencies that enable learners and educators to effectively navigate digital ecosystems (Selwyn, 2016).

Digital literacy has emerged as a critical competency in this transformation era. It encompasses the ability to access, evaluate, create, and communicate information using digital technologies. In contemporary education, digital literacy is no longer optional but essential for effective participation in learning processes and knowledge construction.

Recent studies emphasize that digital literacy plays a pivotal role in improving the quality of education. However, research on digital literacy remains fragmented, with varying conceptualizations and methodological approaches across different contexts . This fragmentation highlights the need for integrative and empirical studies that connect digital literacy with measurable learning outcomes.

In secondary education, students are increasingly exposed to digital technologies, making digital literacy particularly relevant. As digital natives, students in this level are

expected to possess the skills necessary to engage with digital content critically and creatively. However, exposure alone does not guarantee competence, as structured learning and guidance are still required (Redecker, 2017).

Learning quality is a central concern in educational research, referring to the effectiveness of instructional processes in achieving intended learning outcomes. High-quality learning environments are characterized by student engagement, meaningful interaction, and the ability to apply knowledge in real-world contexts (Biggs & Tang, 2011). Digital literacy has been identified as a key factor influencing these aspects.

Empirical evidence suggests that digital literacy positively affects learning outcomes and engagement. For instance, quantitative research in Indonesia demonstrates a significant relationship between digital literacy levels and perceived learning quality among students and teachers. This finding reinforces the importance of integrating digital competencies into educational frameworks.

In addition to learning quality, instructional innovation has become a critical component of modern education. Instructional innovation refers to the implementation of new teaching strategies, technologies, and pedagogical approaches to enhance learning effectiveness. The integration of digital tools is a primary driver of such innovation.

Recent research highlights the interconnection between digital literacy and pedagogical innovation. Studies show that digital literacy supports the adoption of innovative teaching methods and curricular adaptations, particularly in technology-enhanced learning environments. This suggests that digital literacy not only affects student outcomes but also influences instructional practices.

Moreover, digital literacy contributes to the effective design of online and blended learning environments. Educators with higher digital literacy are better equipped to design engaging and interactive courses, which ultimately improve learning quality. This underscores the dual role of digital literacy in shaping both teaching and learning processes.

The increasing use of social media and e-learning platforms further emphasizes the importance of digital literacy. Studies indicate that digital competencies among

teachers and students significantly influence the quality of online learning experiences. Without adequate digital skills, the potential of these platforms cannot be fully realized.

Despite these benefits, challenges remain in the implementation of digital literacy in education. One major issue is the disparity in digital skills among students and educators, which can lead to unequal learning opportunities. This digital divide remains a significant barrier to achieving equitable education outcomes (Van Dijk, 2020).

Furthermore, the rapid evolution of technology requires continuous adaptation. Emerging technologies such as artificial intelligence and virtual reality are transforming educational practices, demanding new forms of literacy beyond basic digital skills. These developments highlight the dynamic nature of digital literacy in education.

Another critical issue is the lack of pedagogical readiness among educators. While many teachers recognize the benefits of digital technologies, they often face challenges in integrating these tools effectively into their teaching practices. This gap between technological availability and pedagogical implementation needs to be addressed.

In the context of secondary education, these challenges are particularly significant. Students at this level are at a critical stage of cognitive and social development, making it essential to provide structured and meaningful learning experiences. Digital literacy can serve as a bridge between technological tools and effective learning outcomes.

Previous research has predominantly focused on either digital literacy or learning outcomes independently. There is still limited research that simultaneously examines the relationships among digital literacy, learning quality, and instructional innovation using advanced analytical methods such as Structural Equation Modeling (SEM). This gap presents an opportunity for further investigation.

Structural Equation Modeling (SEM) is a robust statistical technique that allows researchers to examine complex relationships among multiple variables simultaneously. It is particularly suitable for analyzing the direct and indirect effects of digital literacy on learning quality and instructional innovation. This methodological approach enhances the rigor and validity of research findings (Hair et al., 2019).

This study is situated within the broader discourse of educational transformation, which emphasizes the integration of technology, pedagogy, and content knowledge. Digital literacy is positioned as a foundational element that supports this integration and enables effective learning in the digital age.

The significance of this research lies in its contribution to both theory and practice. Theoretically, it provides empirical evidence on the relationships among digital literacy, learning quality, and instructional innovation. Practically, it offers insights for educators and policymakers in designing effective digital learning strategies.

Furthermore, this study aligns with global educational goals, particularly the Sustainable Development Goal 4 (SDG 4), which aims to ensure inclusive and equitable quality education. Digital literacy is recognized as a key component in achieving this goal by enhancing access to and quality of education.

The specific objectives of this study are: (1) to examine the effect of digital literacy on learning quality; (2) to analyze its impact on instructional innovation; and (3) to investigate the relationship between learning quality and instructional innovation using SEM analysis.

In conclusion, digital literacy plays a crucial role in shaping the future of education. Understanding its impact on learning quality and instructional innovation is essential for developing effective educational strategies. Therefore, this study seeks to provide a comprehensive analysis of these relationships within the context of secondary education.

B. Research Methodology

This study employed a quantitative research approach to examine the effect of digital literacy on learning quality and instructional innovation in secondary education. A survey design was used to collect data from students, as it allows for the measurement of relationships among variables in a structured and generalizable manner (Creswell, 2014). The study positioned digital literacy as an exogenous variable, while learning quality and instructional innovation were treated as endogenous variables within the research model.

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The research design applied in this study was explanatory, aiming to test causal relationships between variables using empirical data. This design is appropriate for studies that seek to explain the influence of one construct on another and to validate theoretical models through statistical analysis (Hair et al., 2019). The use of Structural Equation Modeling (SEM) further strengthens the explanatory power of the research.

The population of this study consisted of secondary school students enrolled in formal education institutions. A sample was selected using a stratified random sampling technique to ensure representation across different grade levels. The sample size was determined based on SEM requirements, with a minimum of 200 respondents to achieve reliable and valid results (Kline, 2016).

Data were collected through a structured questionnaire using a Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The instrument was developed based on established theoretical frameworks of digital literacy, learning quality, and instructional innovation. The questionnaire included indicators such as information literacy, digital communication skills, critical evaluation, student engagement, learning effectiveness, and innovative learning practices (Redecker, 2017).

Prior to data collection, the instrument underwent validity and reliability testing. Content validity was ensured through expert judgment, while construct validity was tested using Confirmatory Factor Analysis (CFA). Reliability was measured using Cronbach's alpha and composite reliability, with acceptable thresholds set at 0.70 or higher (Hair et al., 2019).

Data analysis was conducted using Structural Equation Modeling (SEM) with the Partial Least Squares (PLS) approach. SEM-PLS was chosen due to its suitability for complex models and its ability to handle non-normal data distributions (Hair et al., 2019). The analysis involved two main stages: evaluation of the measurement model (outer model) and evaluation of the structural model (inner model).

The measurement model assessment included convergent validity, discriminant validity, and reliability tests. Convergent validity was evaluated through factor loadings and Average Variance Extracted (AVE), while discriminant validity was assessed using

the Fornell-Larcker criterion and cross-loadings. These tests ensured that the constructs were measured accurately and consistently.

The structural model evaluation focused on testing the research hypotheses by analyzing path coefficients, coefficient of determination (R^2), effect size (f^2), and predictive relevance (Q^2). Bootstrapping techniques were applied to determine the significance of relationships among variables. This process enabled the identification of both direct and indirect effects of digital literacy on learning quality and instructional innovation (Hair et al., 2019).

Ethical considerations were observed throughout the research process. Participants were informed about the purpose of the study and provided consent before completing the questionnaire. Confidentiality and anonymity were maintained to protect respondents' identities. The study adhered to ethical research standards to ensure the integrity and credibility of the findings (Orb et al., 2001).

C. Results and Discussion

The analysis was conducted using Structural Equation Modeling with the Partial Least Squares (SEM-PLS) approach to examine the relationships among digital literacy, learning quality, and instructional innovation. The model evaluation followed a two-step procedure, including the assessment of the measurement model (outer model) and the structural model (inner model) (Hair et al., 2019).

The measurement model assessment began with evaluating indicator reliability. All factor loadings exceeded the recommended threshold of 0.70, indicating that the observed variables adequately represented their respective latent constructs. This suggests that the measurement items used in the questionnaire were valid indicators of digital literacy, learning quality, and instructional innovation.

Convergent validity was confirmed through the Average Variance Extracted (AVE) values, which were all above 0.50. This indicates that each construct explains more than half of the variance of its indicators, demonstrating adequate convergent validity (Fornell & Larcker, 1981). Therefore, the constructs in this study were considered sufficiently representative.

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Discriminant validity was assessed using the Fornell-Larcker criterion and cross-loading analysis. The results showed that the square root of AVE for each construct was higher than its correlations with other constructs. This confirms that each construct is distinct and measures a unique concept within the model (Hair et al., 2019).

Reliability testing was conducted using Cronbach's alpha and composite reliability. All constructs achieved values above 0.70, indicating high internal consistency. This finding suggests that the measurement instrument is reliable and produces stable and consistent results across items.

After confirming the adequacy of the measurement model, the structural model was evaluated. The coefficient of determination (R^2) for learning quality was found to be 0.62, indicating that digital literacy explains 62% of the variance in learning quality. Meanwhile, the R^2 value for instructional innovation was 0.68, suggesting that digital literacy and learning quality together explain 68% of the variance in instructional innovation.

The path coefficient analysis revealed that digital literacy has a significant positive effect on learning quality ($\beta = 0.79$, $p < 0.001$). This result indicates that higher levels of digital literacy are associated with improved learning quality among secondary school students. This finding is consistent with previous studies highlighting the importance of digital competencies in enhancing educational outcomes (Redecker, 2017).

Furthermore, digital literacy was found to have a direct positive effect on instructional innovation ($\beta = 0.45$, $p < 0.01$). This suggests that students with strong digital skills are more likely to engage in innovative learning practices, such as utilizing digital tools and exploring creative problem-solving approaches.

Learning quality also demonstrated a significant positive effect on instructional innovation ($\beta = 0.42$, $p < 0.01$). This indicates that improved learning quality contributes to the development of innovative instructional practices. Students who experience meaningful and engaging learning environments are more likely to participate in innovative activities.

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The mediation analysis showed that learning quality partially mediates the relationship between digital literacy and instructional innovation. The indirect effect was significant ($\beta = 0.33$, $p < 0.01$), indicating that digital literacy enhances instructional innovation both directly and indirectly through improved learning quality.

Effect size analysis (f^2) revealed that digital literacy has a strong effect on learning quality and a moderate effect on instructional innovation. Learning quality, in turn, has a moderate effect on instructional innovation. These results highlight the central role of digital literacy in shaping both learning outcomes and innovative practices.

Predictive relevance (Q^2) values were greater than zero for both endogenous constructs, confirming that the model has strong predictive capability. This indicates that the model is not only explanatory but also capable of predicting future outcomes within similar contexts (Hair et al., 2019).

In discussing these findings, it is evident that digital literacy serves as a foundational competency in modern education. Students with higher digital literacy are better equipped to access, evaluate, and utilize digital information, leading to improved learning experiences and outcomes (Selwyn, 2016).

The strong relationship between digital literacy and learning quality suggests that integrating digital skills into the curriculum is essential. Educational institutions must prioritize digital literacy development to enhance student engagement, understanding, and academic performance.

The direct effect of digital literacy on instructional innovation highlights its role in fostering creativity and adaptability among students. Digital tools provide opportunities for innovative learning experiences, enabling students to explore new ways of acquiring knowledge.

The mediating role of learning quality underscores the importance of effective instructional design. While digital literacy provides the necessary skills, high-quality learning environments are required to translate these skills into innovative practices (Biggs & Tang, 2011).

These findings also have implications for teachers, who play a crucial role in facilitating digital learning. Educators must be equipped with digital competencies to design and implement innovative teaching strategies that align with students' needs.

From a policy perspective, the results emphasize the need for educational reforms that integrate digital literacy into national curricula. Policymakers should invest in digital infrastructure and training programs to support the effective implementation of technology in education.

However, the study also acknowledges certain limitations. The data were collected from a specific educational context, which may limit generalizability. Future research should consider diverse settings and incorporate longitudinal designs to examine long-term effects.

In conclusion, the SEM analysis provides strong empirical evidence that digital literacy significantly influences learning quality and instructional innovation. The findings highlight the importance of integrating digital competencies into educational practices to support effective and innovative learning in the era of educational transformation.

D. Conclusion

This study provides robust empirical evidence that digital literacy is a critical determinant of both learning quality and instructional innovation in secondary education. The SEM-PLS analysis confirms that digital literacy exerts a strong direct effect on learning quality and a significant direct as well as indirect effect on instructional innovation through the mediating role of learning quality. These findings reinforce the position of digital literacy as a foundational competency in the era of educational transformation, enabling students to engage more deeply with learning materials and participate in innovative learning processes.

From a theoretical perspective, this study contributes to the growing body of literature by integrating digital literacy, learning quality, and instructional innovation into a single structural model. It extends existing frameworks by demonstrating not only direct relationships but also mediation effects, thereby offering a more comprehensive

understanding of how digital competencies translate into pedagogical outcomes. The results support constructivist and technology-enhanced learning theories, emphasizing that meaningful learning occurs when digital skills are effectively aligned with high-quality instructional design.

Practically, the findings highlight the urgent need for educational stakeholders to prioritize digital literacy development within curricula and instructional practices. Schools and policymakers should invest in digital infrastructure, teacher training, and curriculum integration strategies that promote both technological proficiency and pedagogical innovation. Teachers, in particular, must adopt learner-centered approaches that leverage digital tools to enhance engagement and creativity. By systematically embedding digital literacy into educational systems, institutions can foster more effective, innovative, and future-ready learning environments.

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