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Digital Literacy and Critical Thinking Skills of Students in the Era Industry 4.0

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Abstract

Industry 4.0 has introduced new challenges in the field of education, where digital literacy and critical thinking skills have become increasingly essential for students in navigating the ever-evolving flow of digital information. This study aims to analyze the relationship between digital literacy and students' critical thinking skills at the secondary school level. Utilizing a correlational survey method, data were collected from 250 students and analyzed using Pearson correlation and simple linear regression tests. The results indicate a significant positive relationship between digital literacy and critical thinking skills ($r = 0.652$, $p < 0.01$). Furthermore, regression analysis shows that digital literacy contributes 42.6% to the enhancement of students' critical thinking skills. These findings affirm that improving digital literacy can support the development of critical thinking through technology-based learning and more adaptive pedagogical approaches. Therefore, integrating digital literacy into the educational curriculum is crucial to equip students with essential skills to face the challenges of the digital era.

Keywords

critical thinking; digital education; digital literacy; industry 4.0

INTRODUCTION

The Fourth Industrial Revolution has brought fundamental changes to various aspects of life, including education. The integration of technology into the educational sphere has not only expanded access to digital learning resources but also demands an improvement in digital literacy and critical thinking skills among students (Setiawardani et al., 2021). These competencies are essential in an era characterized by a massive and rapidly evolving flow of information. However, despite broader access to technology, challenges in critically utilizing information remain a significant barrier (Dewi et al.,

2024). Therefore, more adaptive educational approaches are needed to equip students with relevant skills to navigate an increasingly complex digital era.

In the educational context, digital literacy encompasses not only technical skills in using digital devices but also the ability to understand, evaluate, and wisely utilize information. Students must be able to distinguish valid information from hoaxes or misinformation, which are increasingly widespread across digital platforms (Setiawardani et al., 2021). Various studies have shown that, despite the growing integration of digital technologies in learning, many students still struggle to filter and evaluate the information they receive (Rosalina et al., 2021). This indicates that effective digital literacy goes beyond mere access to technology; it also involves critical thinking skills in assessing diverse sources of information.

In the digital era, critical thinking skills play an increasingly crucial role. Students are not only expected to passively receive information, but also to analyze, evaluate, and make informed decisions based on available data (Meirbekov et al., 2022). Critical thinking enables students to develop a deeper understanding of issues and avoid cognitive biases that may hinder the decision-making process (Setiawardani et al., 2021). Research indicates that the use of digital tools in learning can enhance students' critical thinking skills, particularly when applied in logic-based and collaborative tasks (Meirbekov et al., 2022). Therefore, technology-based learning should be designed to foster analytical and reflective thinking skills, strengthening students' ability to process and utilize information more critically.

The importance of digital literacy and critical thinking in education necessitates a more systematic integration of these skills into the curriculum. The 4C skill framework critical thinking, communication, collaboration, and creativity has become a key reference in developing student competencies that are adaptive to the demands of a rapidly changing era (Syerlita & Siagian, 2024). Furthermore, digital technologies such as e-learning have been proven to support virtual learning activities and contribute to improved student learning outcomes (Lumbanbatu & Mayasari, 2021). However, the implementation of technology in education must be accompanied by strategies that emphasize evaluative and analytical aspects, ensuring that students become not only users of technology but also critical and responsible individuals within the digital ecosystem.

In line with this, SMA Negeri 2 Mataram has been selected as the research location to explore the relationship between digital literacy and students' critical thinking skills. As one of the leading high schools in Mataram City, SMA 2 Mataram has made progress in integrating technology into learning, particularly through the use of digital platforms, online assignments, and multimedia-based teaching. However, preliminary observations and interviews with educators indicate that although students at SMA 2 Mataram are generally proficient in operating digital tools, there remain notable gaps in their ability to critically analyze online information and apply logical reasoning in solving problems. Students often rely on superficial information from the internet without verifying its validity or engaging in deeper analysis. This reflects a significant need for educational strategies that go beyond technical digital skills and focus on enhancing students' critical thinking in digital contexts.

Thus, the Fourth Industrial Revolution not only presents challenges to the education sector but also creates opportunities to develop more innovative learning approaches. Digital literacy and critical thinking are two key elements that must be strengthened to enable students to adapt to an increasingly complex information environment. Therefore, efforts to enhance these two competencies should be prioritized in educational reform both through curriculum renewal and through more strategic and targeted utilization of technology (Dewi et al., 2024). In a continuously evolving digital era, the synergy between technology, innovative pedagogy, and the strengthening of digital literacy becomes a critical factor in shaping a generation that is ready to face future global challenges.

This study aims to examine the relationship between digital literacy and students' critical thinking skills in the era of the Fourth Industrial Revolution. Specifically, it seeks to measure the extent to which students' levels of digital literacy contribute to the development of their critical thinking skills within an increasingly digitalized learning environment. Additionally, this research intends to provide strategic recommendations for educators in designing technology-based learning approaches that can enhance students' critical thinking skills, thereby better preparing them to face the complexities of the digital world. The findings are expected to contribute to educational practices at SMA Negeri 2 Mataram and similar schools that are navigating the challenges and opportunities of digital transformation in education.

METHOD

This quantitative research employs a correlational survey method to examine the relationship between students' digital literacy and critical thinking skills in the context of the Fourth Industrial Revolution. The study was conducted at SMA Negeri 2 Mataram, involving a sample of 250 students selected using stratified random sampling to ensure representation across different grade levels. Data were collected through online questionnaires distributed via platforms such as WhatsApp, Instagram, and Line. Digital literacy was measured using an instrument based on Eshet-Alkalai's (2004) framework, while critical thinking skills were assessed using test items adapted from Ennis' (1985) model. The research instruments were tested for validity and reliability using convergent validity, composite reliability, and Cronbach's alpha. Data were analyzed using Jamovi version 2.6.22 through Pearson correlation to identify relationships and simple linear regression to assess the predictive contribution of digital literacy to students' critical thinking abilities.

RESULT AND DISCUSSION

Before conducting the main analysis, validity and reliability tests were performed to ensure that the digital literacy questionnaire and critical thinking test accurately measured the variables under investigation. Validity testing was conducted using Confirmatory Factor Analysis (CFA) by examining the values of Average Variance Extracted (AVE) and Composite Reliability (CR). The instrument is considered to have convergent validity if the AVE value is greater than 0.50 and the CR value exceeds 0.70 (Panduwinata & Setiawati, 2024).

Table 1. Instrument Validity

Construct	AVE	CR	Description
Digital Literacy	0.657	0.891	Valid
Critical Thinking	0.612	0.874	Valid

The analysis results indicate that the digital literacy construct has an AVE value of 0.657 and a CR value of 0.891, while the critical thinking construct has an AVE value of 0.612 and a CR value of 0.874. These values demonstrate that each indicator forming the construct meets the criteria for convergent validity.

Furthermore, reliability testing was conducted using Cronbach's Alpha and McDonald's Omega to assess the internal consistency of each statement item. The analysis results show that the Cronbach's Alpha value for the digital literacy construct is 0.852, and for critical thinking, it is 0.823. Meanwhile, the McDonald's Omega values are 0.867 and 0.838, respectively. Based on the recommended minimum threshold of 0.70 (Haryanto et al., 2022), both constructs meet the standards for good reliability.

Table 2. Instrument Reliability

Construct	Cronbach's Alpha	McDonald's Omega	Description
Digital Literacy	0.852	0.867	Reliabel
Critical Thinking	0.823	0.838	Reliabel

Thus, the results of the validity and reliability tests indicate that the digital literacy questionnaire and critical thinking test instruments meet the required criteria for use in further research. Furthermore, through Pearson correlation the data will be identified and simple linear regression to assess the predictive contribution of digital literacy to students' critical thinking skills. Pearson correlation analysis results are shown in table 3 and linear regression analysis results are shown in table 4.

Table 3. Pearson Correlation Analysis

Variable	Digital Literacy	Critical Thinking
Digital Literacy	1.000	0.652** ($p < 0.01$)
Critical Thinking	0.652** ($p < 0.01$)	1.000

The statistical analysis results indicate a significant positive relationship between digital literacy and students' critical thinking skills. The Pearson correlation yielded an r value of 0.652 with a p-value of < 0.01, demonstrating a strong relationship between these two variables.

Table 4. Results of Simple Linear Regression Analysis

Variable Independen	B (Coeficience)	SE (Standard Error)	t	p-value
Digital Literacy	0.652	0.085	7.65	<0.001
Critical Thinking	12.34	2.45	5.04	<0.001

The results of the linear regression analysis indicate that digital literacy significantly contributes to students' critical thinking skills. A regression coefficient of 0.652 suggests that for every one-unit increase in digital literacy, students' critical thinking skills improve by 0.652 units. Furthermore, a p-value of less than 0.001 indicates that the relationship between digital literacy and critical thinking is statistically significant at the 5%

significance level ($\alpha = 0.05$), thereby confirming that digital literacy indeed plays a role in enhancing students' critical thinking abilities.

Moreover, the R^2 value of 0.426 implies that 42.6% of the variance in students' critical thinking skills can be explained by digital literacy. This means that the higher the level of digital literacy students possess, the more likely they are to demonstrate better critical thinking skills. However, the remaining 57.4% of the variance is influenced by other factors not included in this model, such as teaching methods, learning environments, and support from families and educators.

In addition, the model's significance test yielded a p-value of less than 0.001, indicating that the regression model as a whole is statistically significant. In other words, digital literacy has a substantial effect on students' critical thinking skills. These findings underscore the importance of strengthening digital literacy in the educational domain as part of efforts to enhance students' critical thinking abilities in facing the challenges of the digital era.

The analysis results indicate a significant relationship between digital literacy and students' critical thinking skills. The Pearson correlation yielded an r-value of 0.652 with a significance level of $p < 0.01$, suggesting a strong and positive association between the two variables. In other words, the higher the students' digital literacy, the better their critical thinking abilities. This finding aligns with previous research that emphasizes digital literacy's contribution to the development of critical thinking skills by facilitating access to, evaluation, and synthesis of information from various digital sources (Mabini & Gallardo, 2024).

Numerous studies have shown that students with strong digital literacy are more capable of critically evaluating information and avoiding misinformation. This is because digital literacy fosters the ability to identify credible sources, understand argumentative structures, and think analytically (Gitadewi, 2024). Furthermore, technological advancements in education increasingly highlight the importance of digital literacy as a supporting factor in the enhancement of critical thinking, both in academic and professional contexts.

However, although the relationship between digital literacy and critical thinking is generally positive, some studies reveal that this relationship is not always linear across all contexts. For instance, a study on English as a Foreign Language (EFL) education in

Indonesia found that digital literacy does not automatically improve critical thinking skills, as other factors such as teaching methods and academic environment also influence the development of students' critical thinking (Indah et al., 2022). Another study found that parental involvement significantly contributes to the development of elementary students' critical thinking skills, suggesting that social and family factors should also be considered (Haryanto et al., 2022).

To optimize the positive impact of digital literacy on critical thinking, appropriate instructional approaches are required. One effective approach is Problem-Based Learning (PBL), which has been proven to enhance students' critical thinking by encouraging them to solve real-world problems using digital literacy to find solutions (Gitadewi, 2024 Moreover, elements of digital literacy such as online safety and digital citizenship also help sharpen critical thinking, particularly in understanding digital ethics and the credibility of online information (Mosquete & Libago, 2025).

This study is consistent with findings by Meirbekov et al. (2022), who reported that the use of digital tools in learning contributes to the improvement of students' analytical and reflective thinking skills. With access to diverse digital information sources, students become more trained in filtering and processing information critically, thereby developing a more systematic way of thinking when evaluating issues. This indicates that digital literacy is not merely the ability to access technology, but also involves using it to enhance comprehension and in-depth analysis.

Further support comes from the study by Chiu & Sun (2022) which emphasizes that technology-based learning enables students to be more critical in evaluating information. Through technology integration in learning processes, students are exposed to a wider range of perspectives, can compare information from different sources, and develop evaluative skills to assess the credibility of information. Hence, digital literacy not only affects technical proficiency in using digital tools but also plays a vital role in improving critical thinking skills necessary for navigating today's complex information landscape.

However, not all studies support the positive correlation between digital literacy and critical thinking. Rosalina et al. (2021 revealed that access to technology does not always lead to improved critical thinking if not accompanied by effective instructional strategies. In some contexts, students with access to technology but without proper guidance tend to become passive information consumers, failing to develop analytical thinking skills.

Therefore, the role of teachers and strategically designed learning approaches are crucial in optimizing the benefits of digital literacy for students' critical thinking development.

Given these varied findings, it can be concluded that digital literacy holds significant potential to enhance students' critical thinking skills. However, its impact largely depends on how technology is utilized in educational settings. Effective technology integration, supportive pedagogical strategies, and active engagement from teachers and learning environments are key factors in ensuring that digital literacy genuinely contributes to the development of students' critical thinking across educational levels.

The results of the simple linear regression analysis indicate that digital literacy significantly influences students' critical thinking skills. The resulting regression model is:

$$Y=12.34+0.652XY = 12.34 + 0.652XY=12.34+0.652X$$

where Y represents critical thinking skills and X represents digital literacy. The regression coefficient of 0.652 indicates that each one-unit increase in digital literacy is associated with a 0.652 increase in critical thinking skills. This shows a positive relationship between the two variables, with digital literacy contributing to the improvement of students' critical thinking.

The significance level of $p < 0.001$ confirms that the relationship between digital literacy and critical thinking is statistically significant. In other words, the likelihood that this relationship is due to chance is very small. Furthermore, the R^2 value of 0.426 suggests that 42.6% of the variability in critical thinking skills can be explained by digital literacy, while the remaining 57.4% is influenced by other factors not included in the model.

These findings are consistent with previous research indicating that digital literacy enhances critical thinking by strengthening students' ability to access, evaluate, and interpret information from various digital sources (Mabini & Gallardo, 2024; Haryanto et al., 2022). This capability is crucial in the digital age, where the variety and validity of online information are highly diverse. Furthermore, the results suggest that digital literacy goes beyond mere technical proficiency with digital tools and includes complex cognitive aspects such as assessing credibility, analyzing arguments, and synthesizing information from multiple sources. In educational contexts, this implies that increasing digital literacy can help foster reflective and analytical thinking, which is essential for both academic decision-making and everyday life.

However, it is important to note that while digital literacy significantly contributes to critical thinking, other factors such as teaching methods, academic environment, and support from educators also play essential roles (Indah et al., 2022). Therefore, to maximize the benefits of digital literacy in promoting critical thinking, appropriate pedagogical strategies such as the implementation of Problem-Based Learning (PBL) and the integration of digital literacy into educational curricula are essential.

CONCLUSION

This research aimed to examine the relationship between digital literacy and students' critical thinking skills in the era of the Industrial Revolution 4.0, particularly among students at SMA Negeri 2 Mataram. The findings revealed a significant positive correlation between the two variables, with digital literacy contributing 42.6% to the development of critical thinking skills, indicating a substantial impact in addressing the challenges posed by a digitalized learning environment. These results underscore the importance of integrating digital literacy into the education system, not only to enhance technical competencies but also to strengthen students' analytical, evaluative, and reflective thinking abilities. Compared to previous studies such as those by Rosalina et al. (2021), Meirbekov et al. (2022), and Syerlita & Siagian (2024), which focused on the general implementation of digital tools in learning, this research provides a more precise quantification of digital literacy's contribution to critical thinking development and offers context-specific insights drawn from the Indonesian education setting. The impact of this study lies in its practical implications for policy and pedagogy, encouraging the adoption of learning strategies like Project Based Learning (PBL) that stimulate active engagement with technology. Future research is expected to explore other contributing factors such as instructional design, socio-cultural influences, and the role of digital ethics in shaping student cognition. Additionally, expanding the study to multiple schools and diverse regions could further validate and enrich these findings. Ultimately, this research contributes to educational innovation by emphasizing the need for a holistic, collaborative approach involving educators, parents, and communities to build a digitally literate and critically minded generation capable of navigating global challenges.

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