Jurnal Pemberdayaan Masyarakat
Volume 5 Issue 3 Year 2026 | Pages 841-853
ykgm.org

E-ISSN 2962-8091
DOI: https://doi.org/10.46843/jpm.v5i3.869

Analysis of Digital Literacy and HOTS in College Students as a Manifestation of Quality Education in Supporting the SDGs

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ABSTRACT

The rapid integration of digital technologies into higher education has increased the importance of equipping students with digital literacy and Higher-Order Thinking Skills (HOTS), both of which are regarded as essential competencies for advancing Sustainable Development Goal (SDG) 4 on quality education. Despite growing scholarly attention to these competencies, evidence of their influence on educational quality in Indonesian universities remains insufficient. Accordingly, this study aimed to evaluate levels of digital literacy, HOTS, and perceived educational quality, and to investigate the contributions of digital literacy and HOTS to educational quality among undergraduate students enrolled in the Faculty of Teacher Training and Education at Universitas Riau Kepulauan. A quantitative study employing a descriptive-correlational approach was conducted with a sample of 200 undergraduate students selected using simple random sampling. Data were obtained through structured questionnaires using a Likert scale and analyzed using descriptive statistics and simple linear regression. The findings indicated that students generally demonstrated moderate levels of digital literacy, HOTS, and perceived educational quality. Regression results revealed that digital literacy explained variance in educational quality, whereas HOTS indicated that higher-order thinking is a considerably stronger determinant of educational quality than digital literacy. These findings underscore the strategic importance of strengthening both digital literacy and HOTS within higher education learning environments to improve educational outcomes and support the achievement of SDG 4.

ARTICLE INFORMATION

Keywords:
digital literacy; higher education; HOTS; quality education; SDGs

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Article info: Submitted: 2026-06-01 | Revised: 2026-07-08 | Accepted: 2026-08-16 | Published: 2026-09-08
Recommended citation: Marpaung, J., Rofiqah, T., Yanizon, A., Fatin, N. F., Putri, N. G., Ningsih, D. G., & Damin, Z. A. B. (2026). Analysis of Digital Literacy and HOTS in College Students as a Manifestation of Quality Education in Supporting the SDGs. *Jurnal Pemberdayaan Masyarakat, 5*(3), 841-853.

INTRODUCTION

The Sustainable Development Agenda will depend on the development of high-quality human capital, as SDG 4 highlights the importance of providing inclusive, quality education and lifelong learning opportunities for all. The development of such a goal in higher education will depend significantly on how well universities contribute to this cause by offering competencies for the twenty-first century. Digital literacy and higher-order thinking skills (HOTS) have been recognized as important competencies. When both competencies are combined, students will be able to assess available information critically, develop innovative ideas, problem-solve, and adapt to rapid technological changes and the increasing demands of the labor market (Sarmini & Marpaung, 2023). The nation of Indonesia has been increasingly focusing on improving its literacy rate as an educational

strategy. Literacy is broadly defined as a person's ability to find, interpret, analyze, and apply information using skills such as reading, writing, mathematical computation, and problem-solving. In addition to being an individual skill, literacy is widely regarded as a key indicator of national educational progress, contributing to social development and enhancing a country's competitiveness in an increasingly knowledge-driven global society (Ginting, 2020). Despite the introduction of various national literacy programs, improving students' literacy outcomes remains a major challenge in Indonesia's education sector. According to the 2022 PISA test results, students in Indonesia scored an average of 359 points in science, which still lags far behind the OECD average, highlighting the persistent gap in learning achievement (OECD, 2023). The above findings indicate that some students from Indonesia face difficulties comprehending information, using logical reasoning, and solving problems. These weaknesses could hamper the development of a strong workforce and slow efforts to improve education to international standards.

Insufficient literacy among young people may have far-reaching educational and social consequences. Poor literacy skills can limit individuals' ability to compete in today's knowledge-based economy, limit access to employment opportunities, and hamper continuous learning. Low reading engagement may further limit access to greater knowledge and inhibit social skills. In addition, poor literacy skills could inhibit the realization of one's potential, while heavy reliance on technology, coupled with low literacy levels, could lead to ignorance of the social environment and self-centered behavior (Kusuma, 2022). Building human capital is an important prerequisite for achieving the Sustainable Development Goals (SDGs). The SDGs serve as a blueprint for sustainable development until 2030 and contain 17 interrelated goals that address sustainability across its economic, social, and environmental dimensions. The SDGs are an expression of the common global desire to improve people's lives through joint action on various fronts, including poverty eradication, quality education, health care, environmental sustainability, and inclusive development (Giovanni & Subianto, 2023). In Indonesia, sustainable development requires the efficient use of human resources through effective collaboration among stakeholders, including the government, the private sector, civil society, and international organizations. Apart from institution-based coordination, commitment from all these stakeholders is also crucial for realizing the long-term development goals. These collaborations help develop evidence-based policies, implement development programs, and build capacity and community participation towards sustainable development in the country (Firdaus, 2024).

The swift development of digital technology has made digital literacy an essential competence for successful learning in the 21st century. Digital literacy does not simply mean the skills needed to operate digital devices; it comprises several abilities, including locating, analyzing, organizing, producing, and communicating digital information ethically across various settings of learning and social interaction (Carretero et al., 2017; Dinata, 2021). Having an advanced level of digital literacy enables university students to apply digital technologies effectively for educational purposes, critically assess the reliability of the information provided, distinguish misleading information from truthful information, and create reliable, evidence-based knowledge. The above skills are becoming crucial in modern higher education.

The rapid expansion of the digital realm presents several problems, such as an increase in cybercrime, information overload, misinformation, and digital manipulation. This necessitates a set of skills for individuals, particularly university students, to cope with this increasingly complex realm. It goes beyond the technical skills required for using digital technology. In fact, it includes the capacity to retrieve, analyze, evaluate, manage, and utilize digital information. This will enable the student to think critically and creatively, make judicious decisions based on accurate information, and constantly gain more knowledge in an increasingly interconnected digital world (Sarmini & Marpaung, 2023). According to Hague & Payton (Dinata, 2021), Digital literacy is widely recognized as a

multidimensional construct consisting of eight interconnected competencies. These include (1) functional digital skills, which reflect the ability to use information and communication technologies (ICT) effectively; (2) creativity, referring to the use of digital technologies to support innovation and knowledge creation; (3) collaboration, involving the co-construction of knowledge through digital interaction, discussion, and mutual feedback; (4) communication, defined as the ability to convey, interpret, and understand ideas effectively in digital environments; (5) information searching and selection, which emphasizes the identification and retrieval of relevant information; (6) critical analysis and evaluation of digital content and information sources; (7) cultural and social awareness, highlighting responsible engagement within diverse digital communities; and (8) digital safety, which promotes the ethical, secure, and responsible use of digital technologies.

Alongside digital literacy, Higher-Order Thinking Skills (HOTS) are another important skill set needed for success in higher education. HOTS refers to a set of sophisticated mental processes that help students think critically about available information, evaluate it, and develop creative solutions to various challenges. Such skills are vital for learning, decision-making, and knowledge construction in contemporary academic environments (Anderson & Krathwohl, 2001). Although the importance of HOTS has been well established, past studies have persistently documented the poor development of students' Higher-order Thinking Skills (HOTS). The poor development of HOTS has been mainly due to the use of rote learning, limited involvement in reading, and the lack of implementation of a student-centered approach, such as problem-based learning, designed to foster higher-level cognitive development (Agustin et al., 2021b; Nurjanah et al., 2021). There is an association between digital literacy and HOTS because it involves the critical evaluation of digital information, which forms the foundation of higher-order skills such as analytical, critical, and creative thinking. By assessing the reliability and relevance of information, digital literacy supports the cognitive processes required for higher-order reasoning and effective problem-solving.

The Partnership for 21st Century Learning (P21) framework highlights four essential competencies, widely known as the 4Cs, as the foundation for effective learning and success in the twenty-first century. These competencies comprise critical thinking and problem-solving, which involve systematically examining issues and identifying appropriate solutions; creativity and innovation, which encourage the generation of novel ideas and the development of innovative outcomes; communication, referring to the effective exchange of ideas across diverse contexts and audiences; and collaboration, which emphasizes productive teamwork to accomplish shared objectives. Collectively, these competencies closely align with the principles of Higher-Order Thinking Skills (HOTS), fostering the advanced cognitive abilities needed for critical inquiry, complex problem-solving, and meaningful knowledge construction (Suryana, 2023). As a key competency for twenty-first-century learning, Higher-Order Thinking Skills (HOTS) empower students to engage in advanced cognitive processes that extend beyond memorization and factual recall. These skills encompass critical analysis, evidence-based evaluation, and the creation of innovative solutions to authentic and complex problems (Tulljanah & Amini, 2021).

From an educational theory perspective, cognitive skills are commonly organized into two hierarchical levels: Lower-Order Thinking Skills (LOTS) and Higher-Order Thinking Skills (HOTS). As fundamental dimensions of the cognitive domain, these categories differ in the complexity of the mental processes they require. LOTS primarily focuses on foundational abilities, including remembering, understanding, and applying acquired knowledge, whereas HOTS involves more sophisticated cognitive processes that enable learners to critically analyze information, evaluate evidence and arguments, and develop creative solutions to complex and authentic problems (Nurjanah et al., 2021). Higher-Order Thinking Skills (HOTS) have become a central theme in educational reform across many countries, including Indonesia, because of their pivotal role in

promoting meaningful learning and preparing students for increasingly complex academic and professional demands. Despite this growing emphasis, the development of Indonesian students' higher-order cognitive abilities continues to face significant challenges. One major contributing factor is the continued reliance on instructional practices that prioritize knowledge transmission over the cultivation of analytical, evaluative, and creative thinking. In addition, limited reading engagement remains an important barrier to the development of HOTS. A substantial body of research suggests that strong reading proficiency provides the cognitive foundation for higher-order thinking by enhancing comprehension, critical interpretation, and the ability to synthesize information from multiple sources (Agustin et al., 2021b).

The importance of the current research is further validated by the data gathered from the initial survey conducted among students in the Faculty of Teacher Training and Education at Universitas Riau Kepulauan. The initial survey involved classroom observation, interviews with lecturers, and student surveys to determine students' learning traits and digital skills. It was found that, despite the widespread application of digital technology in academic endeavors, students mainly use it for information search rather than for academic purposes. Many students struggled with critically assessing the validity of online information, synthesizing information from various scholarly sources, developing well-substantiated arguments, and solving difficult tasks that require analytical and creative thinking skills. The findings indicate that the extensive application of digital technologies alone does not develop high-level digital literacy skills and Higher-Order Thinking Skills (HOTS), highlighting the need for instructional approaches that intentionally cultivate both competencies within higher education.

While there have been considerable studies on digital literacy and Higher-Order Thinking Skills (HOTS) as separate entities or on how the two interrelate, there seem to be few empirical studies on how these constructs relate to educational quality, especially with regard to Sustainable Development Goal 4 (SDG 4). The lack of sufficient studies is especially apparent in studies conducted among pre-service teachers in peripheral areas of Indonesia, including the Province of Kepulauan Riau. There is therefore a need for further empirical studies to establish the contribution of both constructs to quality education. The current research bridges this gap by investigating the role of digital literacy alongside HOTS in quality education using SDG 4 as a framework. Moreover, the current research will make a significant contribution to the existing literature by considering pre-service teachers, a strategic group that can influence future education practices and become drivers of innovation and sustainable change.

Building on the identified research gap, this study aims to evaluate the levels of digital literacy, Higher-Order Thinking Skills (HOTS), and perceived educational quality among undergraduate students in the Faculty of Teacher Training and Education at Universitas Riau Kepulauan. It further examines the extent to which digital literacy and HOTS contribute to achieving quality education within the context of Sustainable Development Goal 4 (SDG 4). By providing empirical evidence on these relationships, the study is expected to inform curriculum design, support pedagogical innovation, and guide higher education policies that strengthen learning quality and promote sustainable educational development. To address these objectives, the present study examines the following research question: "Analysis of Digital Literacy and HOTS in College Students as a Manifestation of Quality Education in Supporting Sustainable Development Goals (SDGs)".

METHOD

To address this identified research gap, the present study employed a quantitative research design to examine the influence of digital literacy and HOTS on educational quality among undergraduate students enrolled in the Faculty of Teacher Training and Education at Universitas Riau

Kepulauan. The study methodology is presented in the subsequent sections. The study was conducted at the Faculty of Teacher Training and Education at Universitas Riau Kepulauan, situated in Batu Aji, Batam City, Indonesia. Sugiyono (2020) reported that the study population comprised all undergraduate students enrolled in the Faculty of Teacher Training and Education at Universitas Riau Kepulauan, Batam City, representing five academic programs: English Education, Mathematics Education, Biology Education, History Education, and Guidance Counseling, as shown in Table 1.

Table 1. Numbers of Research Population

Number	Department	Amount
1.	English Education	223
2.	Mathematics Education	69
3.	Biology Education	67
4.	History Education	53
5.	Guidance and Counseling	129
TOTAL		541

Source: PDDIKTI 2025, July

According to Sugiyono (2020), a sample represents a subset of the population. Participants were recruited through a probability sampling method, with simple random sampling applied to ensure that each member of the population had an equal chance of being included. The final sample size was determined using the Slovin formula. So n = 541/(1+(541(0.05)2) = 229.96 = 200 students from 5 study programs. By taking 36.97% of each study program's total student population, we obtain the results presented in Table 2.

Table 2. Numbers of Research Samples

Number	Departement	Amount
1.	English Education	85
2.	Mathematics Education	30
3.	Biology Education	18
4.	History Education	12
5.	Guidance and Counseling	55
TOTAL		200

This research was conducted in several stages, as follows: (1) The preparation stage, which involved developing a research proposal and research instruments; (2) The research implementation stage, which involved distributing the instruments to the research sample; (3) The final stage involved analyzing the data and preparing the final research report. Information regarding digital literacy was obtained through a structured questionnaire consisting of four indicators: basic literacy skills, background knowledge, ICT skills, and attitudes toward information use. Higher-order Thinking Skills (HOTS) were measured using a questionnaire comprising Analysis (Differentiating, Organizing, and Attributing), Evaluation (Checking and Critiquing), and Creation (Generating, Planning, and Producing). Educational quality was measured using a questionnaire comprising four indicators: educational infrastructure; teaching quality; equitable access to education; and the integration of twenty-first-century skills. Data were collected through a structured Likert-type questionnaire.

Preliminary item validity was assessed in IBM SPSS Statistics via the Corrected Item-Total Correlation Coefficient. Based on a sample of 200 participants (df=198) and a significance level of 0,05, items with a corrected item-total correlation exceeding the critical correlation (r=0.138) were

considered valid, whereas those falling below the cutoff were removed from subsequent analyses. This process resulted in the retention of 25 of 32 Digital Literacy items, 17 of 24 Quality Education items, and 25 of 34 HOTS items. These retained items demonstrated acceptable internal consistency, reflected in Cronbach's Alpha values of 0.875, 0.694, and 0.748, respectively.

Data were analyzed using univariate statistics and bivariate analysis via simple linear regression, with all analyses conducted in IBM SPSS Statistics. Based on the data analysis, descriptive findings were generated on overall levels of digital literacy and HOTS, along with comparisons across respondent characteristics, study programs, and gender. Furthermore, the statistical analysis evaluated the effects of digital literacy and HOTS on educational quality using a simple regression model.

RESULTS AND DISCUSSION

The present research investigates digital literacy and HOTS skills, as well as their effects on educational quality among students at Universitas Riau Kepulauan. In this study, researchers used an instrument distributed to students at the Faculty of Teacher Training and Education at Universitas Riau Kepulauan, Batam, Indonesia, as respondents, totaling 200 people. The results presented in Table 3 indicate that the highest digital literacy variable score was 122, whereas the minimum score was 69. The highest HOTS score was 121, and the lowest score was 80. The highest educational quality score was 98, while the lowest was 58. The questionnaire data were descriptively analyzed to examine levels of digital literacy, HOTS, and educational quality, with the results presented in Table 3.

Table 3. Statistical Description of Digital Literacy Skills, HOTS, and Educational Quality

	Digital Literacy	***HOTS***	***Quality Education***
Minimum	69	80	58
Maximum	122	121	98
Mean	95.92	100.97	71.94
Standard Deviation	8.858	8.153	6.171

Based on the data above, the digital literacy, HOTS, and educational quality of FKIP students at Universitas Riau Kepulauan Batam can be grouped into five levels: very high, high, moderate, low, and very low. To find out more clearly, see Table 4 and Table 5:

Table 4. Average Achievement Level Classification

Percentage Range	**Category**
90% - 100%	Very High
80% - 89%	High
65% - 79%	Moderate
55% - 65%	Low
0 - 54%	Very Low

Table 5. Classifications of Digital Literacy, HOTS, and Quality Education Skills

No	Category	Digital Literacy		HOTS		Quality Education	
		Frequency	%	Frequency	%	Frequency	%
1.	Very High	5	2,5%	7	3,5%	5	2,5%
2.	High	47	23,5%	57	28,5%	40	20%
3.	Moderate	85	42,5%	74	37%	95	47,5%
4.	Low	57	28,5%	52	26%	53	26,5%
5.	Very Low	6	3%	10	5%	7	3,5%
Amount		200	100%	200	100%	200	100%

Based on the categories above, the findings indicate that undergraduate students' digital literacy in the Faculty of Teacher Training and Education at Universitas Riau Kepulauan is at a moderate level with a percentage of 42.5%; HOTS is classified as being at a moderate level with a percentage of 37%; and educational quality is categorized as moderate with a percentage of 47.5%. The results suggest that digital literacy, HOTS, and quality education among undergraduate students at the Faculty of Teacher Training and Education at Universitas Riau Kepulauan are generally at a moderate level. This suggests that although students actively utilize digital technology in academic activities, their competencies in critically evaluating information, synthesizing knowledge, and solving complex problems remain insufficient. These findings align with previous research showing that digital technology use does not necessarily translate into advanced digital literacy or higher-order cognitive skills without appropriate pedagogical support (Okoye et al., 2023; Timotheou et al., 2023).

Regression analysis revealed that digital literacy significantly contributes 15,3% to quality education, whereas HOTS contributes 79%. These findings indicate that although digital literacy facilitates access to information and learning resources, Higher-Order Thinking Skills (HOTS) exert a substantially stronger influence in improving educational quality. This supports previous studies emphasizing that analytical, evaluative, and creative thinking are fundamental competencies for achieving meaningful learning outcomes in higher education (Alshammary & Alhalafawy, 2023; Mat et al., 2024). The simultaneous contribution of digital literacy and HOTS to quality education further confirms that achieving SDG 4 (Quality Education) depends not only on technological competence but equally on the ability to critically evaluate, synthesize, and apply knowledge.

Unlike previous studies that examined digital literacy and HOTS separately, this study integrates both competencies within the SDG 4 framework and demonstrates that HOTS is the stronger predictor of quality education among pre-service teachers. This finding extends current knowledge by highlighting the complementary contributions of digital literacy together with HOTS in strengthening educational quality. The findings contribute to the literature on twenty-first-century competencies and quality education. In practice, these findings provide empirical support for higher education institutions to strengthen curricula by integrating digital literacy, inquiry-driven learning, and pedagogical strategies that foster critical thinking, creativity, and advanced problem-solving competencies in support of Sustainable Development Goal 4 (Quality Education).

Assessment of Classical Assumptions (Linearity and Normality Tests). The linearity assessment in this study was performed to assess whether a linear association existed between the two variables. The IBM SPSS Statistics Software results indicated that, for the Linearity Test of Digital Literacy Ability towards quality education, the Deviation from Linearity significance value was 0.386. Thus, the significance value (0.386 > 0.05); therefore, the null hypothesis (H_0) was not rejected, indicating that there is no significant linear relationship between the digital literacy variable and quality education. Furthermore, the IBM SPSS Statistics output indicated that, in the linearity test for HOTS towards quality education, the Deviation from linearity significance value was 0.435. Thus, the significance

value (0.435 > 0.05); therefore, the null hypothesis (H_0) was not rejected, indicating a significant linear association between the HOTS variable and educational quality. The normality assessment was performed to assess whether the collected data obtained from the variables studied follow a normal distribution. The normality assessment results showed that, with the Kolmogorov-Smirnov (K-S) Test, the Asymp. Sig. (two-tailed) The value for Digital Literacy (X1) is 0.066, which exceeds 0.05. For Higher-order Thinking Skill (HOTS) (X2), it is 0.075, which exceeds 0.05. Then, the normality assessment results for Quality Education (Y) are 0.075, which exceeds the 0.05 threshold. So it can be inferred that, across all three variables, the observed data followed a normal distribution, and the regression model employed in this study met the normality assumption.

To evaluate the effects of digital literacy skills and HOTS on quality education among FKIP students at Universitas Riau Kepulauan, Batam, the researchers conducted a simple linear regression analysis. The results from IBM SPSS Statistics indicated the effect of digital literacy on quality education; the coefficient of determination (R2) was used to estimate the proportion of variance in the dependent construct explained by the predictor variable. According to the IBM SPSS Statistics output on the influence of digital literacy on quality education, the R^2 (R Square) was 0.153. Accordingly, the predictor variable accounted for 15.3%, whereas the remaining 84.7% was attributed to other factors not studied. Similarly, the IBM SPSS Statistics output indicated the influence of digital literacy on quality education; the findings of the coefficient of determination assessment indicate that the R^2 (R Square) statistic was used to estimate the proportion of the independent variable's influence on the dependent variable explained by the independent variable. Meanwhile, from the SPSS output on the influence of HOTS on quality education, it can be seen that R^2 (R-Square) is 0.790. Accordingly, the independent variable accounted for 79%, whereas the remaining 21% is attributable to other factors that were not studied.

To assess the combined effect of the predictor variables (X1 and X2) toward the outcome variable (Y), the researcher used the F-test in regression analysis. This F-test was performed to examine whether both predictor variables, digital literacy and HOTS abilities, simultaneously influence the quality of education among students of the Faculty of Teacher Training and Education at Universitas Riau Kepulauan, Batam. According to the ANOVA results for the test of digital literacy and HOTS abilities on students' educational quality, the p-value is 0.000 < 0.05; therefore, the null hypothesis (H_0) was rejected. That means that digital literacy abilities (X1) and HOTS (X2) simultaneously influence the quality of students' education (Y).

The present findings demonstrate that the combination of digital literacy and HOTS significantly improves student learning outcomes at the Faculty of Teacher Training and Education at Universitas Riau Kepulauan. This finding confirms that educational quality in higher education is not determined solely by structural factors such as curriculum, facilities, and teaching resources, but is also strongly influenced by students' cognitive capacity and literacy skills in responding to 21st-century challenges. Amid rapid technological advancement and the complexity of global problems, students are required not only to master conceptual knowledge but also to develop critical, adaptive, and innovative thinking skills. In this context, digital literacy and HOTS become two essential competencies that complement each other. According to Gilster (1997) and Firdaus (2024), digital literacy serves as the foundation of twenty-first-century skills that equip students to effectively access and manage information, while HOTS strengthens the higher-level thinking competencies needed to critically analyze, assess, and create relevant solutions. Thus, the incorporation of digital literacy and HOTS plays a pivotal role in enhancing the quality of higher education, especially in advancing the achievement of the Sustainable Development Goals (SDGs), with particular Sustainable Development Goal 4 (Quality Education).

According to the simple linear regression analysis, digital literacy was found to exert a positive, statistically significant influence on educational quality among undergraduate students in the Faculty of Teacher Training and Education at Universitas Riau Kepulauan. The estimated regression coefficient of 0.278 ($p < 0.001$) indicates that higher levels of students' digital literacy are associated with higher levels of perceived educational quality. These findings indicate that digital literacy represents more than a supplementary skill; it functions as an essential competency in contemporary educational contexts and constitutes a fundamental factor in shaping high-quality learning experiences (Shofi, 2025). Furthermore, the explained variance coefficient ($R^2 = 0.153$) indicates that digital literacy accounts for 15.3% of the variability in educational quality, whereas the unexplained variance is associated with other factors not included in the proposed analytical model. Although this contribution is moderate, the findings reaffirm the strategic role of digital literacy in improving educational quality within higher education. These findings are consistent with the DigComp Framework for digital competence proposed by Carretero et al. (2017), which defines digital literacy as a complex and multifaceted competence encompassing information and data management, digital communication and collaboration, content development, online safety, and digital problem-solving. Together, these dimensions equip students with the skills required to successfully navigate learning environments and professional contexts in the digital age.

Students with strong digital literacy skills tend to effectively employ technology not only as a means of consuming information, but also as a learning resource, a medium for academic collaboration, and a vehicle for knowledge development. This result aligns with earlier studies by Dinata (2021) and Sarmini & Marpaung (2023), which indicated that digital literacy positively contributes to effective learning processes and enhances educational quality, particularly in higher education institutions. In the higher education context, digital literacy carries broader implications because teacher candidates are expected to become future educators. Consequently, mastering digital literacy not only improves learners' learning experiences but also reinforces their capacity to design innovative and sustainable learning environments. From the perspective of Sustainable Development Goal 4 (SDG 4: Quality Education), digital literacy plays a pivotal role in improving the quality and relevance of higher education systems. Students with advanced digital literacy competencies are better able to address emerging workforce demands, actively engage with the digital society, and support sustainable socioeconomic advancement.

Beyond digital literacy, this research further demonstrates that HOTS competencies significantly affect educational quality among students of the Faculty of Teacher Training and Education at Universitas Riau Kepulauan. This is reflected in a regression coefficient of 0.687, a significance level of 0.000, and an explained variance (R^2) of 0.790, indicating that HOTS can account for 79% of the variance in educational quality. These findings confirm that HOTS represents the strongest predictor of educational quality in higher education. The substantial effect of HOTS is consistent with the revised Bloom's cognitive framework by Anderson and Krathwohl (2001), which positions this cognitive capacity to analyze, evaluate, and create at the highest level of the cognitive domain. These higher-order thinking skills equip learners with the adaptive competencies needed to address complex, dynamic problems in both academic and professional contexts.

The calculated t-value of 27.275, which substantially exceeded the critical t-value, further strengthens empirical support for the claim that HOTS makes a significant contribution to improving educational quality. Learners with well-developed HOTS are not only able to understand conceptual knowledge but also to relate it to real-world situations, engage in critical reflection, solve complex problems, and generate innovative ideas or products. These findings are consistent with earlier studies by Agustin et al. (2021a) and Nurjanah et al. (2021), indicating that HOTS contributes substantially to learning quality and graduates' preparedness to address twenty-first-century

challenges. Therefore, strengthening HOTS constitutes an essential strategy for enhancing educational quality in higher education. Overall, these findings indicate that digital literacy and HOTS are two core competencies that complement each other in achieving quality education. Digital literacy supports students' ability to manage information and technology effectively, while HOTS strengthens critical, analytical, and creative thinking skills. The synergy between the two is a crucial strategy for higher education institutions in producing adaptive, innovative, and competitive graduates. Achieving the "Very Good" category in both variables, with an average digital literacy score of 95.92 and an HOTS score of 100.97, demonstrates that FKIP UNRIKA students have a strong starting point in supporting quality education. This achievement is not only relevant to the SDG 4.4 indicator on mastering twenty-first-century skills, but also reflects a real contribution to the human resource development agenda as outlined in Asta Cita and the vision of Golden Indonesia 2045.

The characteristics of the respondents, who were predominantly female students, English Education students, and students in their mid- to final-semester, indicate that strengthening digital literacy and HOTS needs to be carried out continuously and integrated throughout the learning process. This aligns with the guidelines outlined in the DigCompEdu Framework, underscoring the importance of integrating digital competencies into pre-service teacher education curricula. Therefore, FKIP UNRIKA has a strategic opportunity to develop a curriculum that systematically integrates digital literacy and HOTS as core competencies. This effort is expected to produce graduates with strong academic competence and well-equipped to contribute to building an inclusive, high-quality, and globally competitive education ecosystem.

The academic implications of this study underscore the strategic value of digital literacy and HOTS as primary foci in higher education development, particularly in education study programs. In practice, these findings can serve as a basis for policymakers at the faculty and university levels in designing more contextually relevant, innovative, and twenty-first-century skills-oriented learning strategies. In this way, strengthening digital literacy and HOTS not only improves the quality of higher education systems within universities while simultaneously making a substantial contribution to advancing the framework of the Sustainable Development Goals (SDGs), especially SDG 4 (Quality Education) and the development of highly competent, adaptive, and globally competitive human resources.

CONCLUSION

This study demonstrates that digital literacy, HOTS, and educational quality among undergraduate learners in the Faculty of Teacher Training and Education, Universitas Riau Kepulauan, are generally at a moderate level. Digital literacy contributed 15,3% to educational quality, whereas HOTS contributed 79%, indicating that Higher-Order Thinking is the stronger predictor of educational quality. Furthermore, digital literacy and HOTS exerted a favorable, statistically significant influence on quality education. These findings emphasize that strengthening technological competencies alone is insufficient without developing students' critical, analytical, and creative thinking skills. The originality of this research lies in demonstrating the complementary contributions of digital literacy and HOTS in supporting SDG 4 (Quality Education) among pre-service teachers. The empirical evidence supports higher education institutions in integrating digital literacy with inquiry, problem, and project-based learning within the curriculum. Implementing these findings is expected to improve learning quality, enhance graduate competencies, and better prepare future teachers to address the challenges of the digital era. Consequently, this provides evidence-based recommendations for curriculum development and higher education policies that support the achievement of sustainable quality education.

DECLARATION OF GENERATIVE AI

The authors declare that no generative AI or AI-assisted technologies were used in the writing process of this manuscript.

CONFLICTING INTEREST STATEMENT

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

FUNDING INFORMATION STATEMENT

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

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