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STEM-5E Integration and Local Wisdom of *Geblek* Making in Physics E-Books: Its Impact on Students' Digital Literacy Profiles

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Abstract – *In modern physics education, digital literacy has shifted from a supplementary skill to an essential competency for meaningful scientific inquiry. However, despite widespread access to digital technology, many students still demonstrate limited academic digital literacy, especially in physics learning contexts. This study aims to examine the effects of an interactive physics e-book integrated with the STEM 5E learning cycle and the local wisdom of geblek-making on students' digital literacy profiles. A quasi-experimental pretest–posttest control group design was used, involving 108 grade X students divided into an experimental group (STEM-5E e-book), a contrast group using a 3E e-book, and a contrast group using traditional textbooks. Students' digital literacy, including information literacy, media literacy, and ICT literacy, was measured with a validated 14-item multiple-choice test and analyzed using Aiken's V and Rasch modeling. Results show that the experimental group achieved the greatest improvement, with a mean normalized gain of 67.33% (moderately effective), outperforming the 3E group (55%) and the traditional group (44.67%). Information literacy showed the most notable improvement, reaching an effective category with an 82% increase. Rasch-based profile analysis also revealed the complete removal of low levels of digital literacy in the experimental group. The novelty of this study lies in its integration of ethnoscience with the STEM-5E framework via an interactive digital medium, positioning digital literacy as a culturally rooted skill. In conclusion, the findings show that combining inquiry-based learning, interactive digital tools, and local wisdom offers an effective way to enhance students' digital literacy and provides a strong pedagogical model for developing 21st-century skills in physics education.*

Keywords: *digital literacy; ethnoscience-based learning; local wisdom; STEM-5E learning cycle; physics e-book*

I. INTRODUCTION

In the context of physics education, students' digital literacy profiles have evolved from supplementary skills into core cognitive requirements. Digital literacy in science education is widely conceptualized as a multidimensional construct encompassing the ability to navigate complex information environments, critically evaluate the credibility of digital scientific data, and synthesize knowledge through collaborative digital processes (Grotlüschen & Buddeberg, 2025; Messaoudi, 2024; Saripudin et al., 2022; Tinmaz et al., 2022). As physics learning increasingly relies on computational modeling, simulations, and data-driven inquiry, students must develop robust digital literacy to transition from passive recipients of information to active participants in constructing scientific knowledge (Falloon, 2020; Purnama et al., 2021). This transformation is further reinforced by the growing necessity for learners to critically manage the widespread infodemic of scientific misinformation circulating within digital ecosystems (Noskova et al., 2021; Park et al., 2021; Son & Ha, 2025).

Despite the pervasive access to digital devices among today's learners, a substantial gap persists between students' everyday digital practices and the academic digital literacy required for scientific inquiry. Although often labeled as digital natives, students frequently demonstrate limited competence in employing digital tools for structured problem-solving, such as identifying variables in virtual laboratories, interpreting simulation outputs, or verifying the credibility of online physics resources (Musengimana et al., 2025; Park et al., 2021; Ruggieri, 2020; Topal & Shargh, 2023). This discrepancy is exacerbated by conventional instructional practices that merely digitize static textbooks, thereby failing to provide pedagogical scaffolding for higher-order digital engagement (Guillén et al., 2022; Noskova et al., 2021). Consequently, students' digital literacy profiles often remain superficial, limiting their ability to meaningfully explore abstract physics concepts through digital media.

To address this pedagogical challenge, integrating Science, Technology, Engineering, and Mathematics (STEM) within the 5E learning cycle (Engage, Explore, Explain, Elaborate, and Evaluate) provides a comprehensive instructional framework that aligns inquiry-based learning with the development of digital competence (Elvina et al., 2025). The STEM-5E model immerses students in structured inquiry processes that inherently promote digital literacy by requiring them to explore phenomena, analyze data, and evaluate solutions using digital tools (Anggraeni & Suratno, 2021; Eroğlu & Bektaş et al., 2021; Kruatong et al., 2022). In particular, during the Explore and Elaborate phases, students are encouraged to utilize digital sensors, data analysis software, and engineering design tools to solve authentic problems, thereby integrating conceptual understanding with meaningful digital practices (Bancong & Song, 2018; Fang et al., 2025).

The effective implementation of this instructional approach requires a versatile and interactive learning medium, such as a physics e-book. Unlike conventional PDF-based digital resources, interactive e-books function as comprehensive digital learning ecosystems that integrate hypermedia, interactive simulations (e.g., PHeT or localized applets), and real-time feedback mechanisms (Khaeruddin & Bancong, 2022; Marisda et al., 2025; Qotrunnada & Prahani, 2023; Susilowibowo et al., 2024). These features enable students to navigate non-linear information structures and engage with multimodal representations of physics concepts, both of which are essential for fostering advanced digital literacy. However, technological sophistication alone is insufficient. To be pedagogically effective, digital learning resources must also incorporate principles of culturally responsive teaching (CRT), ensuring that learning experiences are meaningfully connected to students' lived realities (Aristyasari et al., 2023; Febrianti, 2025).

In this regard, integrating ethnoscience through the local wisdom of *geblek*-making in the *Kulon Progo* region provides a powerful contextual foundation, particularly for the physics topic of measurement and units. The traditional *geblek* production process serves as an authentic physics laboratory in which students engage in real-world measurement activities, such as determining the mass of cassava, the volume of water for starch extraction, and the temperature and duration of frying (Ratnaningsih et al., 2020). Embedding this local wisdom within a STEM-5E-based physics e-book allows students to apply rigorous scientific procedures by converting traditional measurement practices into standardized International System (SI) units through digital analysis (Andriani et al., 2023; Ardiansyah et al., 2024; Nurazmi & Bancong, 2021; Hastuti et al., 2023; Saripudin et al., 2022). This cultural–digital intersection encourages students to document, model, and analyze local practices using digital tools, fostering contextualized digital literacy that bridges cultural heritage and scientific precision (Kurniati et al., 2025; Manalu & Wilujeng, 2025; Rahayu et al., 2025; Rosa et al., 2025).

Based on these considerations, this study aims to address a gap in the literature by integrating the STEM-5E learning model with local ethnoscience to enhance students' digital literacy by developing a physics e-book grounded in the local wisdom of *geblek* making. The novelty of this research lies in its holistic perspective, positioning digital literacy as a culturally grounded competency cultivated at the intersection of modern educational technology and indigenous knowledge. Specifically, this study focuses on the measurement and units of learning for grade X students. The following research questions guide it: (1) Is there a significant improvement in students' digital literacy profiles after the implementation of a STEM-5E physics e-book integrated with the local wisdom of *geblek* making? and (2) How are students' digital literacy profiles characterized before and after the intervention?

II. METHODS

1. Research design and procedures

This study used a quasi-experimental design with a pretest–posttest control group setup. This approach was chosen to assess the effectiveness of the instructional intervention in real classroom environments, where random participant assignment was not possible (Campbell et al., 1963; Creswell, 2012). The research procedures were carried out through three carefully planned phases: preparation, implementation, and evaluation.

The preparation phase involved validating the physics content on measurement and units for Phase E, developing the STEM-5E-based physics e-book integrated with the local wisdom of *geblek* making, and conducting expert validation of the digital literacy assessment instruments. The implementation phase began with administering a pre-test to all participant groups to measure their initial digital literacy profiles. Subsequently, the experimental group received instruction using the complete STEM-5E learning cycle embedded within the physics e-book, while the comparison groups were taught using alternative instructional approaches. During the evaluation phase, a post-test was administered, and the collected data were analyzed using appropriate statistical techniques. The overall research procedure, from preparation to data analysis, is illustrated in Figure 1.

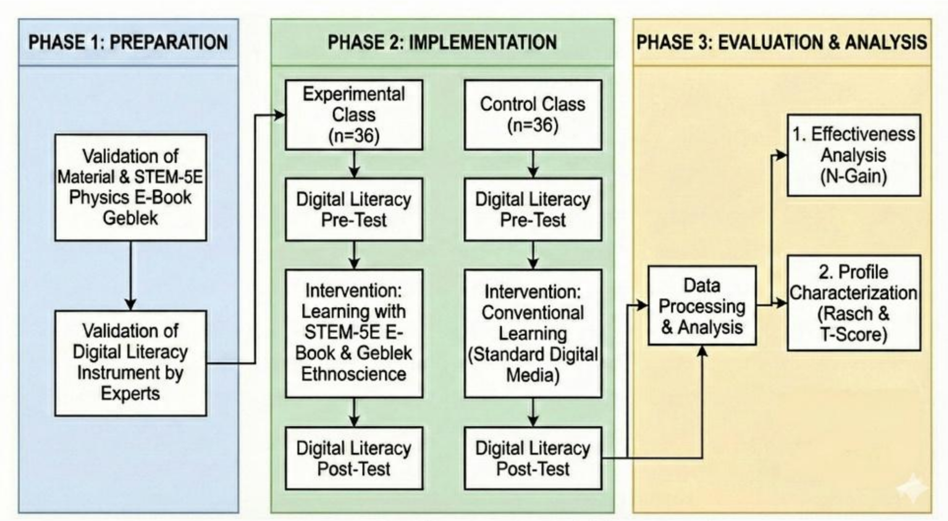

Figure 1. Systematic procedure of this research

The primary instrument used to assess students' digital literacy profiles was a 14-item multiple-choice test developed in accordance with the 21st-century skills framework proposed by Trilling and Fadel (2009). This framework conceptualizes digital literacy into three core dimensions: information literacy, media literacy, and information and communication technology

(ICT) literacy. The instrument was specifically designed to measure students’ digital literacy in relation to physics learning on measurement and units.

Before implementation, the instrument underwent rigorous quality testing to ensure its validity and reliability. Content validity was established through expert judgment, and the level of agreement among validators was analyzed using Aiken’s V index. Based on Aiken's (1985) categorization, the instrument was classified as highly feasible ($0.8 < V \leq 1.0$), feasible ($0.6 < V \leq 0.8$), unfeasible ($0.4 < V \leq 0.6$), or highly unfeasible ($0.2 < V \leq 0.4$). Construct validity was empirically examined using the Rasch Model analysis by evaluating item fit statistics, particularly the INFIT Mean Square (MNSQ) values. Items were considered valid if their INFIT MNSQ values fell within the acceptable range of 0.77–1.30 and their threshold values were between −2 and +2 logits (Adams & Khoo, 1993). In addition to construct validity, Rasch analysis was also used to estimate person and item reliability coefficients, with reliability levels classified as excellent ($R > 0.90$), good ($0.80 < R \leq 0.90$), and acceptable ($0.70 < R \leq 0.80$) (Gliem & Gliem, 2003). This series of tests ensured that the 14 digital literacy items were objective, linear, and consistent before they were used in the pre-test and post-test phases. The summary of content validity, construct validity, and reliability results is presented in Table 1.

Table 1. Psychometric characteristics of the digital literacy test instrument

Psychometric characteristics	Analysis	Result	Category
Content validity	Aiken’V	0.88 – 0.94	Valid
Construct validity	INFIT MNSQ	0.79 – 1.27	Valid
Threshold	Item measure	(-0.72) – 0.76	Moderate
Reliability	Person reliability	0.78	Acceptable
	Item reliability	0.82	Good

The quality of the STEM-5E E-book, which integrates the local wisdom of *geblek* making, was ensured through a content validity process involving media and material experts. To provide a more objective analysis, the qualitative data from the assessment instruments were transformed into interval data using the Method of Successive Interval (MSI) (Febriana & Setiawati, 2024; Nurazmi et al., 2025). Based on the transformation results, the media feasibility level was determined using the following criterion-referenced assessment categories: feasible ($Xi + 0{,}6\ SBi < X \leq Xi + 1{,}8\ SBi$). This validation phase confirms that the developed E-Book meets the educational and technical quality standards required for implementation in learning to enhance students' digital literacy profiles. The validity of the E-Book's content is shown in Table 2.

Table 2. Validity of the content of the physics e-book

Aspect	Mean value (X)	Score range	Category
Media	64.71	$63.70 < X \leq 69.94$	Feasible
Material	97.94	$95.07 < X \leq 104.76$	Feasible

2. Participants

The participants consisted of 108 grade X students from a public senior high school in the Special Region of Yogyakarta. A purposive cluster sampling technique was employed (Cohen et al., 2018). The school was intentionally selected due to its location within a central *geblek* production area, which provided an authentic socio-cultural context necessary for the ethnoscience-based learning approach. Cluster sampling was used with intact classes to preserve the natural classroom environment. To ensure internal validity and minimize potential confounding variables, several control measures were implemented. All groups were taught by the same physics teacher, followed the same curriculum content (measurement and units), received identical instructional time allocations, and were assessed using the same instruments. In addition, the three selected classes demonstrated equivalent initial academic abilities, as indicated by their previous semester report data.

The participants were divided into three groups: (1) the experimental group (n = 36), which utilized the STEM-5E physics e-book integrated with the local wisdom of *geblek* making; (2) contrast group 1 (n = 36), which used the same integrated E-Book but implemented through the 3E learning cycle (Explore, Explain, Elaborate). This group was designed to isolate the instructional contributions of the engage and evaluate phases, to examine whether the full 5E syntax is essential for digital literacy development, and (3) to contrast group 2 (n = 36), which employed conventional textbooks and traditional instructional methods. The inclusion criteria required that students have independent access to digital devices (smartphones or laptops) and had not previously received instruction on measurement and units through an ethnoscience-based approach.

3. Data Analysis

The quantitative data obtained in this study were analyzed using three complementary statistical techniques to comprehensively address the research questions.

a. The magnitude of the e-book's increase in improving digital literacy was analyzed using the normalized gain (N-Gain) score developed by Hake (1998). N-Gain measures the actual improvement relative to the maximum possible improvement that could be achieved, with the formula:

$$\text{Gain } (\%) = \frac{\text{Spost} - \text{Spre}}{\text{Smax} - \text{Spre}} \text{ x } 100\% \qquad (1)$$

The resulting N-Gain percentages were categorized based on the effectiveness interpretation table provided in the study guidelines, adapted from Hake (1998), as follows:

Table 3. Categorization of N-Gain interpretation

Percentage (%)	Effectiveness interpretation
< 40	Ineffective
40 – 55	Less effective
56 – 75	Moderately effective
> 76	Effective

b. Student profile characterization (Rasch Analysis & T-Score) to characterize students’ digital literacy profiles before and after the intervention, raw test scores were analyzed using the Rasch Model with the assistance of Winsteps software. Rasch analysis was employed to convert ordinal scores into interval-scale logit values (person measures), thereby satisfying the requirements for linear measurement (Bond et al., 2021). To facilitate interpretation, these logit values were converted into standard T-Scores using the formula:

$$T = 50 + 10\,(M) \qquad (2)$$

Where M, the use of T-Scores standardizes the score distribution with a mean of 50 and a standard deviation of 10 (Kurpius & Stafford, 2006). Based on these T-scores, students’ digital literacy profiles were classified into three categories: high ($T > 60$), moderate ($40 \leq T \leq 60$), and low ($T < 40$).

III. RESULTS

1. Improvement of digital literacy proficiency

The effectiveness of the instructional intervention in enhancing students’ digital literacy was evaluated using the Normalized Gain (N-Gain) analysis based on pre-test and post-test scores across three dimensions: information literacy, media literacy, and ICT literacy. A summary of the N-Gain results for each group is presented in Table 4.

Table 4. Estimation of digital literacy proficiency improvement

Aspect	Class		
	Experiment (%)	Contrast 1 (%)	Contrast 2 (%)
Information literacy	82	66	40
Media literacy	60	54	54
ICT literacy	60	45	40
Mean	67.3	55.0	44.7

The findings reveal a clear hierarchy of instructional approach effectiveness. The experimental group, which implemented the STEM-5E physics e-book integrated with local wisdom in *geblek* making, achieved the highest overall improvement, with a mean N-Gain of 67.3%, categorized as moderately effective. In comparison, contrast group 1, which applied the

3E learning cycle using the same e-book, obtained a mean N-Gain of 55.0%, classified as less effective. Meanwhile, contrast group 2, which relied on traditional textbooks and instruction, demonstrated the lowest improvement, with a mean N-Gain of 44.7%, placing it in the less effective category.

When evaluated through the literacy dimension, the experimental group showed the most significant improvement in information literacy, achieving an N-Gain of 82%, which falls into the effective category. This gain greatly surpassed that of contrast group 1 (66%) and contrast group 2 (40%). Media literacy gains in the experimental group reached 60%, categorized as moderately effective, while ICT literacy showed a similar improvement level at 60%. In contrast, both comparison groups experienced relatively modest gains across all three literacy dimensions, with ICT literacy consistently being the weakest area of progress. Overall, these findings suggest that the STEM-5E-based e-book combined with ethnoscience created a more effective learning environment for boosting students' digital literacy skills than either the reduced inquiry model (3E) or traditional textbook instruction.

2. Profile of digital literacy ability

To further characterize students' digital literacy profiles, a Rasch model classification was applied to map students into three ordered proficiency strata: high, medium, and low. The pretest–posttest distribution of these profiles across the experimental and comparison classes is presented in Figures 2–5, enabling both a global (overall digital literacy) and dimensional (information, media, and ICT literacy) interpretation of the intervention effects

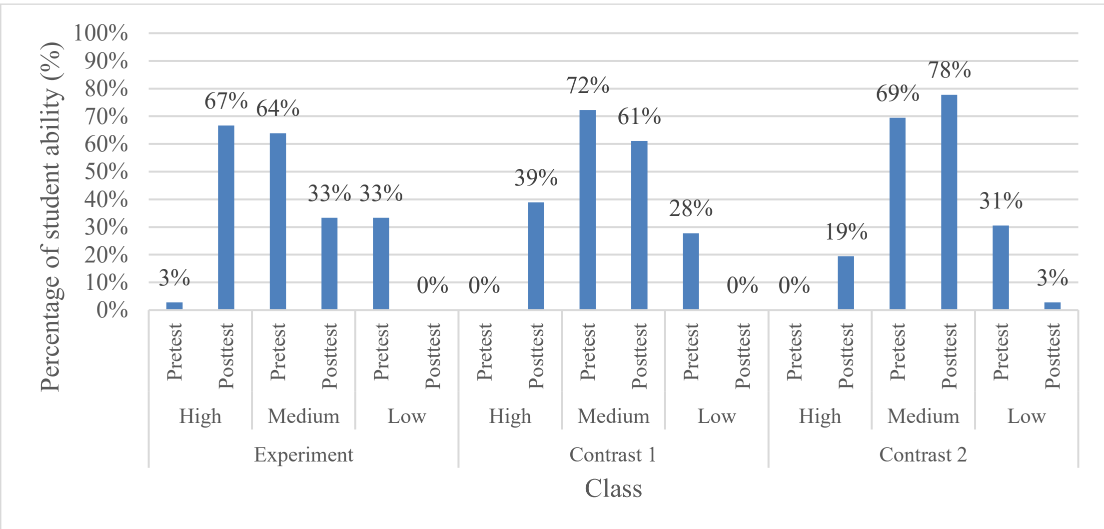

Figure 2. Achievement of digital literacy ability

Figure 2 shows a clear redistribution of proficiency levels in the experimental class after the intervention. At the start, the experimental group was mostly in the medium category (64%), with a significant low segment (33%), and only 3% classified as high. After the intervention, the distribution changed significantly: the low category was completely eliminated (0%), while the high category increased sharply to 67%, and the remaining students moved into the medium band (33%). This pattern indicates more than just small improvements; it shows a fundamental rise in overall digital literacy.

In contrast, the comparison classes showed smaller or limited changes. In Contrast 1, the posttest still had most students in the medium band (61%), with 39% reaching the high level and none remaining low (down from 28% low at pretest). Contrast 2 showed the least favorable shift: although the high category grew to 19%, most students remained at the medium level (78%), with a small low group (3%), indicating incomplete progress at the lowest proficiency level. Overall, these results suggest that the intervention caused the biggest upward shifts and the greatest reduction of low proficiency in the experimental group.

Figure 3 shows that the experimental class made the greatest gains in information literacy. Before the intervention, students were distributed as high 11%, medium 44%, and low 44%. Afterward, the distribution tightened towards the higher level, with high proficiency increasing to 92%, medium decreasing to 8%, and low eliminated entirely (0%). This progression reflects a strong improvement in students' ability to find, evaluate, and use information effectively within digital environments.

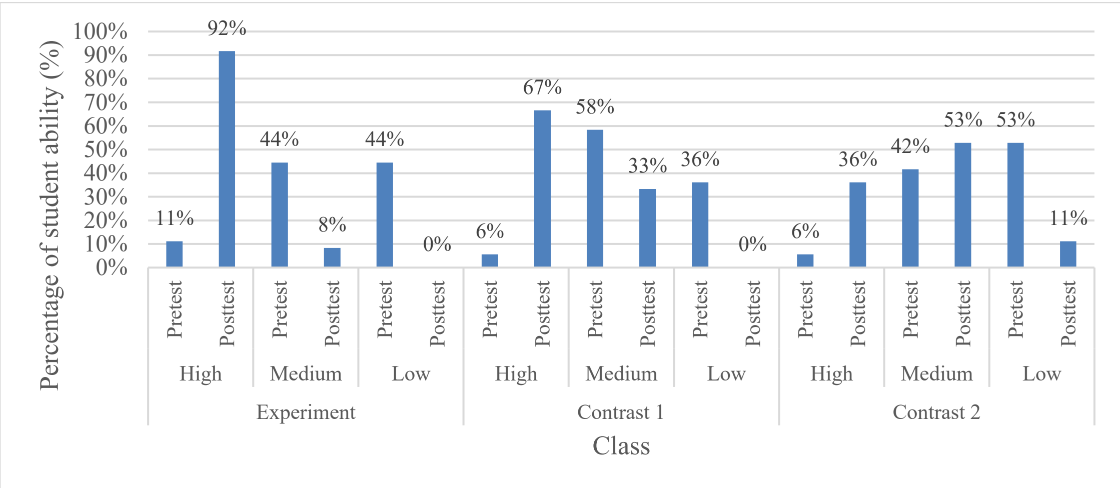

Figure 3. Achievement of information literacy aspects

The comparison classes improved, but less decisively. In Contrast 1, the high category increased from 6% to 67%, while medium declined from 58% to 33%, and low was eliminated (from 36% to 0%). In Contrast 2, improvements were relatively limited: high increased from 6% to 36%, medium rose from 42% to 53%, and low decreased from 53% to 11% but was not completely eliminated. Therefore, gains in information literacy were strongest and most widespread in the experimental class, indicating better progress into the high proficiency level.

Figure 4 shows consistent advantages for the experimental class in media literacy. Initially, the experimental group had a large low segment (56%), with medium at 28% and high at 17%. After the intervention, high proficiency rose to 75%, medium proficiency dropped to 19%, and low proficiency decreased sharply to 6%. This distribution suggests significant improvements in interpreting, analyzing, and responsibly engaging with digital media content.

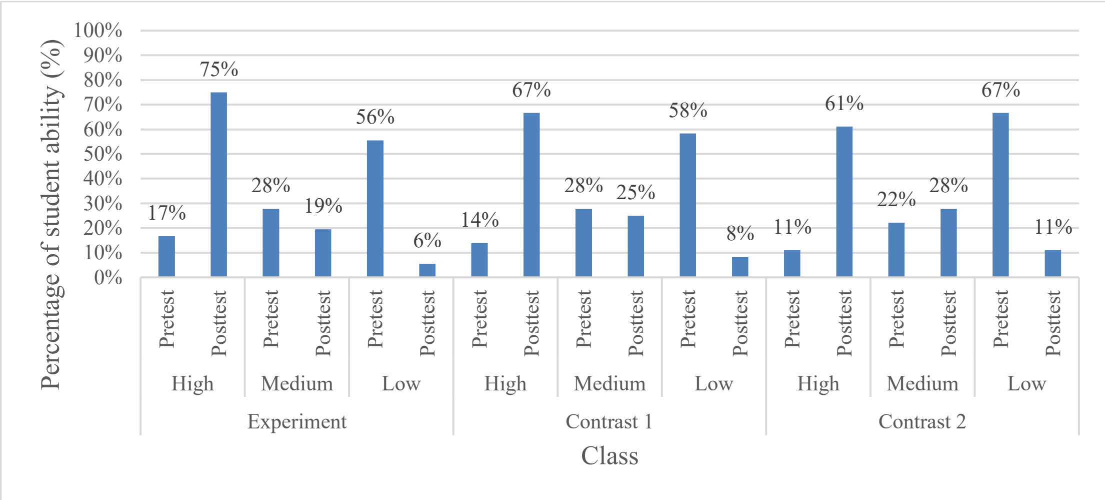

Figure 4. Achievement of media literacy aspects

For Contrast 1, the profile shifted upward, with high increasing from 14% to 67%, medium slightly decreasing from 28% to 25%, and low decreasing from 58% to 8%—notably improved but still maintaining a small low-proficiency segment. Contrast 2 also improved: high rose from 11% to 61%, medium from 22% to 28%, and low decreased from 67% to 11%, leaving a larger residual low group than the other classes. Overall, media literacy results indicate that the experimental condition produced the greatest gains at high proficiency and the smallest remaining low-proficiency group.

Figure 5 shows the intervention effect on ICT literacy, which reflects operational and strategic skills in using digital tools and technologies for learning. The experimental class again exhibits a strong upward shift from 17% high at pretest to 75% at posttest, with medium changing from 28% to 19%, and low decreasing significantly from 56% to 6%. This pattern suggests that students not only improved conceptually but also enhanced their practical ability to use technology effectively in learning contexts.

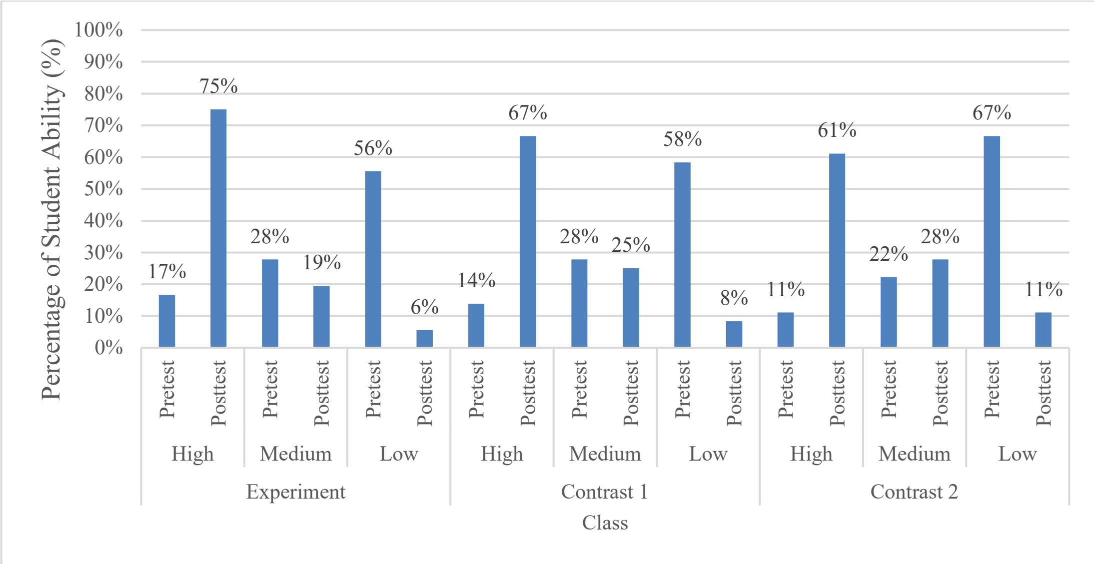

Figure 5. Achievement of ICT literacy aspects

Comparison classes showed improvement but remained less than optimal. Contrast 1 increased from 14% to 67% in the high category, while the low category decreased from 58% to 8%. Contrast 2 rose from 11% to 61% in the high category, yet 11% still remained in the low category after the intervention (down from 67%). These results indicate that the experimental intervention most effectively enhanced ICT literacy and resulted in the lowest residual low-proficiency group. Based on this data, the evidence supports the conclusion that the STEM–5E physics e-book, combined with local wisdom, was linked to stronger and more comprehensive digital literacy development than the conditions experienced by the comparison classes.

IV. DISCUSSION

The findings of this study provide empirical evidence that the synergy between the STEM-5E instructional framework and local wisdom (ethnoscience) significantly outperforms reduced-inquiry models (3E) and conventional textbook approaches. This discussion synthesizes the findings to highlight theoretical implications for physics education. The implementation of a STEM-5E-based physics e-book integrated with the local wisdom of *geblek* making was shown to positively influence students' digital literacy profiles through the combination of a structured instructional framework and interactive learning media. Based on the research data, the experimental group demonstrated superior performance, achieving an average N-Gain of 67.3%, compared to contrast group 1 (55.0%) and contrast group 2 (44.7%). This outcome can be attributed to the structure of the 5E learning cycle, which is designed to foster digital literacy by placing students in a systematic inquiry environment (Kruatong et al., 2022). In particular, during the Explore and Elaborate phases, students were encouraged to utilize digital sensors and data analysis tools to address authentic problems. These findings are consistent with those of Rahayu et al. (2025), who reported that the STEM-5E model supports the development of critical thinking skills and digital literacy by providing opportunities for independent exploration within a dynamic digital learning environment. Moreover, the interactive e-book used in this study extended beyond static PDFs, functioning as a digital learning environment that facilitates non-linear navigation and interaction with multimodal representations of physics concepts.

The integration of ethnoscience through the local wisdom of *geblek*-making served as an important contextual anchor, bridging abstract physics concepts with real-world practices. This traditional process functioned as a contextual physics laboratory in which students engaged in authentic measurement activities, including determining ingredient mass, water volume for starch extraction, and frying temperature (Aristyasari et al., 2023; Rahayu et al., 2025). Such activities enabled students to apply scientific procedures by converting traditional measurement practices into international system units through digital analysis. This approach aligns with the principles of CRT, which emphasize the use of learning materials that connect students' lived experiences with academic content. Previous studies have similarly indicated that integrating local wisdom into science learning can enhance conceptual understanding while supporting the development of contextual and digital literacy (Saripudin et al., 2021). Through this cultural–technological integration, students were encouraged to use digital tools to document and model local practices, thereby supporting contextualized forms of digital literacy (Saleng et al., 2025).

The analysis of each digital literacy dimension revealed a differentiated pattern of improvement, with information literacy showing the most substantial increase, reaching 82% and falling within the effective category. At this level, 92% of students were categorized as having high proficiency in critically searching, filtering, and evaluating the credibility of digital information sources (Andriani et al., 2023; Guillén et al., 2022; Manalu & Wilujeng, 2025; Messaoudi, 2024; Park et al., 2021; Susilowibowo et al., 2024). This finding reinforces the role of information literacy as a core cognitive component in contemporary science education, particularly when learning activities require students to verify data and justify conclusions before validation. In this study, students' information literacy skills were strengthened as they were required to distinguish essential physical variables, such as material mass and frying temperature, from culturally embedded narratives associated with *geblek* making. The importance of this competency is increasingly evident given the challenges posed by scientific misinformation in digital environments (Noskova et al., 2021; Park et al., 2021; Son & Ha, 2025). This interpretation is supported by Kulmus et al. (2025), who emphasized information literacy as a key multidimensional ability that enables learners to move from passive consumption to active knowledge construction. In addition, reported that contextual problem-based learning improves analytical skills, consistent with this study's findings.

Media literacy demonstrated the second-highest level of improvement, with a 60% increase and 75% of students reaching the high proficiency category, indicating a moderately effective capacity to critically evaluate physics content presented through interactive multimedia. This result aligns with Wahidin et al. (2023), who highlighted the role of digital simulations in supporting students' ability to deconstruct abstract scientific concepts. In contrast, ICT literacy showed the lowest improvement (60%), with 64% of students classified in the high category. Although this outcome remains within the moderately effective range, the comparatively lower gain suggests that ICT literacy development may be constrained by the cognitive demands of independent problem-solving and the intuitive design of the E-Book, which may emphasize content use over digital content creation (Boonmoh & Sanmuang, 2024; Siregar, 2024).

The elimination of students in the low digital literacy category from the experimental group suggests that culturally contextualized instruction may help reduce cognitive disengagement often associated with abstract physics learning. By situating digital inquiry within familiar cultural practices, students appeared better able to allocate cognitive resources to higher-order digital processes, such as analysis and evaluation. Rather than indicating the superiority of technology alone, these findings suggest the importance of aligning digital tools with culturally meaningful learning contexts. In this regard, the STEM-5E–ethnoscience approach offers insights into how local cultural knowledge can be integrated with inquiry-based digital learning to support students' development of digital literacy in physics education.

V. CONCLUSION AND SUGGESTION

This study concludes that integrating a STEM-5E-based physics e-book with the local wisdom of geblek-making is an effective instructional intervention for enhancing students' digital literacy in physics learning. The experimental group showed the greatest overall improvement, with a mean N-Gain of 67.3% (moderately effective), outperforming both the reduced inquiry model (3E) and traditional textbook-based instruction. Information literacy was the most significantly improved dimension, reaching an effective category with an 82% increase, while media literacy and ICT literacy also demonstrated positive, though comparatively moderate, gains. Additionally, Rasch-based profile analysis revealed a meaningful structural shift, marked by the complete removal of the low digital literacy category and a substantial increase in the proportion of students achieving high proficiency levels. These findings confirm that combining structured inquiry (STEM-5E), interactive digital media, and culturally contextualized learning can effectively promote comprehensive digital literacy in physics education.

Despite these positive results, some limitations should be acknowledged. First, the study was conducted within a specific cultural context, a *geblek* production area, which may limit the applicability of the findings to regions with different local wisdom or socio-cultural characteristics. Second, the scope of the instructional content was limited to measurement and units, so further research is needed to determine the approach's effectiveness for more abstract physics topics. Third, although ICT literacy improved, the relatively small gain suggests that the current e-book design may still prioritize digital consumption over content creation. Future studies should apply this model across various physics topics, cultural settings, and longer instructional periods, while also including explicit technological scaffolding to support higher-level ICT production skills. Overall, this research contributes to physics education by providing empirical evidence for a culturally grounded digital literacy framework and demonstrating that combining ethnoscience with the STEM-5E cycle and interactive digital media offers a practical, pedagogically solid strategy for developing 21st-century skills.

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