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Personal Digital Inquiry in Human Reproductive System Learning: Students' Health and Digital Literacy Outcomes

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Abstract: The low level of students' reproductive health literacy and the growing need for digital literacy highlight the need for learning innovations that develop both competencies simultaneously. This study aimed to analyze the effect of Personal Digital Inquiry (PDI)-based learning on health and digital literacy among high school students studying the human reproductive system. A quantitative approach with a quasi-experimental non-equivalent control group design was employed, involving 28 Grade XI students in the experimental group and 31 in the control group. Health literacy was measured using a multiple-choice test, while digital literacy was assessed through a self-assessment questionnaire. Data were analyzed using the Mann-Whitney U test, independent-samples t-test, and N-gain analysis. The results showed no statistically significant differences in health literacy ($p = 0.176$) or digital literacy ($p = 0.59$) between the groups. However, the experimental group had a higher mean posttest health literacy score (82.50) than the control group (76.87), and 96% of students responded positively to PDI-based learning.

Keywords: Digital Literacy; Health Literacy; Human Reproductive System; Personal Digital Inquiry.

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Introduction

Challenges related to reproductive health are becoming increasingly concerning, particularly among adolescent student. Data from the World Health Organization (WHO) indicate that approximately 16 million women aged 15–19 give birth every year worldwide (WHO, 2021), while adolescents and young adults constitute a group at high risk of contracting Sexually Transmitted Infections (STIs) (Gottlieb et al., 2024). This condition shows that adolescence, which should be a critical period for identity formation and future readiness, is instead often marked by vulnerability due to a low understanding of reproductive health (Ardiana, 2022). In Indonesia, the results of the 2023–2024 Indonesian Demographic and Health Survey (IDHS) indicate that reproductive health knowledge among adolescents remains limited. Only 5.8% of female adolescents aged 15–19 years correctly identified the fertile period, while 41.8% did not know when the fertile period occurs. In addition, only 7.0% of adolescents aged 15–19 years demonstrated good understanding of HIV prevention (Badan Riset dan Inovasi Nasional, 2025). These findings indicate that reproductive health literacy among Indonesian adolescents still needs to be strengthened. These data also indicate the low level of reproductive health literacy among Indonesian adolescents, making the improvement of health literacy an important point in equipping adolescents with the ability to understand, appraise, and apply health information (Supratno et al., 2021).

On the other hand, the development of digital technology in the 21st century has changed the way adolescents seek and understand information, with the internet and social media now serving as the main sources of information (Meilinda et al., 2020). Data from BPS-Statistics Indonesia (2025) show that adolescents constitute the largest group of internet users (34.49%), and approximately 77.50% of them use the internet to seek information and news, although not all circulating content can be trusted (Sekedang & Siregar, 2025). This condition requires individuals to possess comprehensive 21st-century competencies, one of which is digital literacy, which enables individuals to access, evaluate, and use information critically and responsibly in digital environments (Cynthia & Sihotang, 2023). Digital literacy itself involves the dimensions of technical, cognitive, and socio-emotional literacy, which together shape the ability to think critically, communicate responsibly, and participate meaningfully in the digital space (Tinmaz et al., 2022). These abilities are particularly important in the context of reproductive health, where adolescents may encounter health information from diverse digital sources and need to assess its credibility before using it. Thus, digital literacy can support health literacy by enabling adolescents to critically access and evaluate reproductive health information. However, the reality of biology learning in schools tends to remain textual, relying on lectures and textbooks, thereby limiting students' interaction with scientific concepts (Mutanaffisah et al., 2021) and creating a gap with the constructivist nature of science learning objectives (Yanti et al., 2024).

One effective approach to bridging this gap is inquiry-based learning, in which students actively explore scientific questions or problems in a systematic manner (Mahyuna et al., 2024; Rustaman & Widodo, 2001). Through the inquiry process, students do not merely receive information passively, but are also involved in formulating questions, searching for sources, collecting and analyzing data, and drawing conclusions based on evidence (Prasetiyo & Rosy, 2020), thereby developing critical thinking skills and independence in solving scientific problems (Azzahra et al., 2024). This inquiry approach can be strengthened through the Personal Digital Inquiry (PDI) model, which combines the scientific process with the use of digital technology. In PDI, students search for information from digital sources, compare and evaluate its credibility, discuss their findings, and use the information to develop digital products. These processes can support health literacy by engaging students in accessing, understanding, evaluating, and applying reproductive health information, while simultaneously strengthening digital literacy through purposeful use of digital tools, information evaluation, digital communication, and content creation (Coiro et al., 2017). Thus, technology serves not merely as a medium for accessing information but as an integral part of the inquiry process through which both health literacy and digital literacy can be developed.

The implementation of PDI in the human reproductive system topic provides opportunities for students to connect scientific concepts with reproductive health issues that are relevant to their lives (Tyansha et al., 2022). In PDI, students formulate inquiry questions, search for information from digital sources, examine the reliability of the information, discuss their findings, and present them through digital products and reflection (Coiro et al., 2017). These activities provide opportunities to develop health literacy because students are required to seek, understand, evaluate, and use reproductive health information, while the use of digital devices, information evaluation, digital communication, and digital content creation simultaneously provides opportunities to develop digital literacy (Coiro et al., 2019; Law et al., 2018). Previous studies on the human reproductive system have used various instructional models and digital media, including problem-based learning, cooperative learning, guided-inquiry e-modules, and digital or augmented-reality learning resources (Alfiah et al., 2026; Khasanah et al., 2023; Mulyaningsih et al., 2025; Sianturi & Silitonga, 2025; Sugianto et al., 2023). However, these studies have generally addressed instructional models or digital media separately, while the integration of digital information use within an inquiry process has received less attention. Therefore, PDI provides a relevant approach for integrating digital information exploration, collaboration, and reflection within inquiry-based learning, with the potential to address health literacy and digital literacy simultaneously. Accordingly, this study aimed to examine the effect of PDI-based learning on high school students' health literacy and digital literacy in the human reproductive system topic.

Methods

This study employed a quantitative method with a quasi-experimental approach in the form of a non-equivalent control group design (Creswell, 2012). The experimental class implemented PDI-based learning, while the control class used a learning method commonly applied at the research site, namely interactive lectures combined with discussion. Both groups were given a pretest and a posttest to measure changes in ability following the treatment (Table 1), allowing the effect of PDI implementation as the independent variable on the improvement of students' health literacy and digital literacy as the dependent variables to be assessed under relatively controlled conditions.

Table 1.
Non-Equivalent Control Group Research Design

Class	Initial Data	Treatment	Final Data
A (Control)	O	–	O
B (Experimental)	O	X	O

Note: – = conventional learning (interactive lecture/discussion); X = PDI-based learning; O = measurement of health literacy and digital literacy. Adapted from Creswell (2012).

The participants consisted of 59 Grade XI students from a public senior high school in Bandung, Indonesia, during the 2025/2026 academic year, with 28 students in the experimental class and 31 in the control class. The study focused on the subtopics of diseases and disorders of the reproductive system within the Human Reproductive System topic. Preliminary observations indicated limitations in students' digital practices: most students rarely checked their account security settings, 84% experienced difficulties in online group work, and 23% considered health information on social media trustworthy solely because it received many likes. These findings indicated a need to strengthen students' digital security and critical information-evaluation skills through structured learning. Purposive sampling was used to select classes with adequate access to digital devices and internet connectivity, which were required for PDI-based learning. Because the classes were selected based on these criteria, the sample may differ from classes with different levels of digital access, potentially limiting the generalizability of the findings.

Health literacy was measured using a written test consisting of 22 multiple-choice items administered before and after the implementation of the learning. The test material focused on the human reproductive system, covering the structure and function of reproductive organs, hygiene practices, and the prevention of sexually transmitted diseases, and was designed to reflect PDI activities, namely accessing information, analyzing digital sources, and applying knowledge in real-world contexts. The test blueprint was developed based on the framework of Sørensen et al. (2013), which covers four competency dimensions accessing, understanding, appraising, and applying health information, across three domains: healthcare, disease prevention, and health promotion. This framework was also adapted as applied by Ma et al. (2021) for the reproductive health

context. The health literacy instrument was analyzed using Anates version 4 and demonstrated very high reliability, with a reliability coefficient of 0.96. The digital literacy instrument was assessed using Cronbach's alpha and yielded a coefficient of 0.797, exceeding the reliability threshold of 0.60 and indicating acceptable internal consistency.

Digital literacy was measured using a self-assessment questionnaire adapted from the Digital Literacy Global Framework (DLGF) by Law et al. (2018), consisting of 16 statement items based on a four-point Likert scale (1 = Strongly Disagree to 4 = Strongly Agree) covering five main domains: technical, information, communication & collaboration, safety, and creativity literacy. Each dimension consisted of indicators representing 21st-century skills, particularly within the context of PDI-based learning, in which students actively search for, evaluate, and use digital information in the science learning process. The digital literacy instrument was tested for validity using the Pearson Product Moment correlation and for reliability using Cronbach's Alpha ($\alpha = 0.797$), while the health literacy instrument was analyzed using Anates version 4.

Student responses to PDI-based learning were collected through a questionnaire administered at the end of the intervention. The questionnaire was developed based on from Fredricks et al.'s (2004) student engagement framework and adapted to the stages of PDI-based learning. It consisted of 15 statements rated on a four-point Likert scale (1 = Strongly Disagree to 4 = Strongly Agree) and measured four aspects of engagement: cognitive, affective, social, and reflective. The questionnaire was completed only by students in the experimental class to explore their perceptions of PDI-based learning.

Data were analyzed using SPSS version 25. Prerequisite tests, including the Shapiro-Wilk normality test and Levene's test for homogeneity, were conducted to determine the appropriate hypothesis test (Sudjana, 2005). Independent-samples t-tests were used when the data met the normality and homogeneity assumptions, whereas the Mann-Whitney U test was used when these assumptions were not met. Pretest scores were used to describe baseline performance and to calculate N-gain scores, but were not included as covariates in the between-group comparison of posttest scores. Therefore, posttest comparisons were interpreted cautiously because the study used a non-equivalent control group design. N-gain analysis was additionally conducted to describe the magnitude of improvement in health literacy and digital literacy from pretest to posttest, with categories of high ($g \geq 0.70$), medium ($0.30 \leq g < 0.70$), and low ($g < 0.30$) according to Hake (1999). Students' responses were analyzed using percentage scores for each engagement aspect and categorized according to response levels toward PDI-based learning (Purwanto, 2009).

Results & Discussion

The effect of Personal Digital Inquiry (PDI)-based learning on students' health literacy and digital literacy in the human reproductive system topic is presented below, with the discussion organized separately for each variable.

A. Health Literacy

A comparison of health literacy achievement between the experimental and control classes was analyzed using pretest and posttest data, summarized in Table 2. The pretest mean score of the experimental class was 75.98 (Sufficient category), while the control class scored 60.77 (Problematic category). After the treatment, the experimental class's mean score increased to 82.50 (Excellent), and the control class increased to 76.87 (Sufficient). The Mann-Whitney U test on the pretest data yielded a significance value of 0.00 ($p < 0.05$), confirming a significant difference in students' initial health literacy before the intervention.

Table 2.
Descriptive Statistics and Hypothesis Test Results for Health Literacy

Measure	Experimental	Control
n	28	31
Pretest mean (category)	75.98 (Sufficient)	60.77 (Problematic)
Posttest mean (category)	82.50 (Excellent)	76.87 (Sufficient)
N-gain (category)	25% (Low)	40% (Medium)
Mann-Whitney U, pretest (Sig.)	0.00*	
Mann-Whitney U, posttest (Sig.)	0.176 (ns)	
Mann-Whitney U, N-gain (Sig.)	0.993 (ns)	

*Note: * p < 0.05 (significant difference); ns = not significant (p > 0.05).*

This initial difference is plausibly related to the experimental class students' greater tendency to seek reproductive health information through digital media, in line with Karima et al. (2023), who found that online media is the primary source of reproductive health information for Indonesian adolescents, as well as BPS-Statistic Indonesia (2025) data showing that adolescents spend 77.50% of their online time searching for information and news. Differences in initial conditions between classes are also a common occurrence in quasi-experimental designs without randomization (Gopalan et al., 2020).

The Mann-Whitney U test on the posttest data produced a significance value of 0.176 ($p > 0.05$), indicating no significant difference between the final health literacy scores of the experimental and control classes. This finding suggests that PDI-based learning produced health literacy outcomes equivalent to conventional learning on the human reproductive system topic, even though the two classes started from significantly different initial positions.

The N-gain analysis showed that the control class obtained 40% (medium category), while the experimental class obtained 25% (low category) (Hake, 1999). The Mann-Whitney U test on the N-gain data yielding a significance value of 0.993 ($p > 0.05$), indicating no significant difference in improvement between the two classes. This difference in N-gain magnitude is plausibly influenced by the experimental class's already relatively high initial ability, which left a narrower room for improvement compared to the control class, as Bao (2006) explains that normalized gain values are strongly influenced by a group's starting ability. This condition also reflects a ceiling effect, in which improvement becomes harder to detect because the initial score is already close to the upper bound of the measurement

instrument (Kim & Willson, 2010; Staus et al., 2021). Nevertheless, the experimental class still achieved a posttest mean of 82.50 (Excellent), compared to 76.87 (Sufficient) for the control class, showing that the effectiveness of learning should not be assessed solely by the magnitude of score improvement, but also by the quality of the final achievement (Ciapponi et al., 2021).

Descriptive improvement in each health literacy domain was further examined using N-gain, as shown in Table 3. In the understanding domain, the experimental class obtained a higher N-gain (0.48) than the control class (0.30), indicating a greater descriptive improvement in the experimental group. However, because these N-gain values are descriptive, the difference should not be interpreted as evidence that PDI-based learning was statistically more effective than conventional learning. The higher descriptive gain in the experimental class may be related to the characteristics of PDI activities. In the Wonder & Discover stage, students formulated inquiry questions about reproductive health topics after exploring digital sources, potentially supporting understanding through self-directed exploration (Green & Chassereau, 2023). Subsequently, the Collaborate & Discuss stage provided opportunities for students to exchange and clarify their understanding through Google Docs (Tinmaz et al., 2022). In the control class, the more teacher-centered learning approach provided fewer opportunities for active engagement with the information, which may have contributed to the lower descriptive gain (Kozanitis & Nenciovici, 2023; Woods & Copur-Gencturk, 2024).

Table 3.
Mean Scores and N-gain for Each Health Literacy Domain

Domain	Class	Pretest	Posttest	N-gain	Category
Accessing	Control	72.59	92.03	0.31	Medium
	Experimental	82.74	84.13	0.18	Low
Understanding	Control	56.76	72.14	0.30	Medium
	Experimental	65.13	83.78	0.48	Medium
Appraising	Control	55.17	71.76	0.41	Medium
	Experimental	77.52	82.61	0.32	Medium
Applying	Control	66.90	83.45	0.51	Medium
	Experimental	86.96	86.96	0.38	Medium

By contrast, in the accessing, appraising, and applying domains, the control class obtained higher N-gain values (0.31, 0.41, and 0.51, respectively) than the experimental class (0.18, 0.32, and 0.38), although all remained in the medium-to-low N-gain category. This pattern can be explained through (Vygotsky, 1978) zone of proximal development (ZPD): in the control class, direct guidance from the teacher as the more knowledgeable other (MKO) helped students who initially had lower abilities achieve greater gains (Taba et al., 2022). Meanwhile, experimental class students already had relatively high initial scores in these three domains (82.74, 77.52, and 86.96), which left less room for improvement (Brod, 2021; Jennings & Cribbie, 2016). PDI-based learning, which emphasizes independent

exploration, also gives the teacher a more limited scaffolding role, so students relied more on their prior ability and peer discussion in accessing, appraising, and applying health information (Tullis & Goldstone, 2020).

Overall, students in the PDI-based learning group showed positive descriptive changes in health literacy through activities involving information seeking, group discussion, digital product creation, and learning reflection. These activities provided opportunities for students to evaluate reproductive health information, such as Human Immunodeficiency Virus (HIV) infection, Polycystic Ovary Syndrome (PCOS), and cervical cancer, more critically and contextually (Coiro et al., 2017; Hinostroza et al., 2024). This was reflected in the increase in the proportion of students in the Excellent category from 48% at pretest to 74% at posttest. Although the experimental class's learning outcomes were relatively equivalent to those of the teacher-centered control class, PDI-based learning provided a more student-centered learning process, in which students actively managed their learning while the teacher acted as a facilitator (Coiro et al., 2017; Kriewaldt et al., 2021).

B. Digital Literacy

A comparison of digital literacy achievement between the experimental and control classes was conducted using pretest and posttest data (Table 4). The mean pretest scores were 77.11 and 74.52 for the experimental and control classes, respectively, placing both in the Advanced category. After the intervention, the experimental class's mean posttest score remained relatively stable at 77.46, whereas the control class increased to 78.68, with both classes remaining in the Advanced category. The Mann-Whitney U test showed no significant difference in pretest scores between the two classes ($p = 0.30$), indicating comparable initial digital literacy levels and providing a basis for interpreting posttest and N-gain results (Gopalan et al., 2020).

Table 4.
Descriptive Statistics and Hypothesis Test Results for Digital Literacy

Measure	Experimental	Control
n	28	31
Pretest mean (category)	77.11 (Advanced)	74.52 (Advanced)
Posttest mean (category)	77.46 (Advanced)	78.68 (Advanced)
N-gain (category)	-7.1% (Low)	5.3% (Low)
Mann-Whitney U, pretest (Sig.)	0.30 (ns)	
Independent *t*-test, posttest (Sig.)	0.59 (ns)	
Mann-Whitney U, N-gain (Sig.)	0.24 (ns)	

*Note: * $p < 0.05$ (significant difference); ns = not significant ($p > 0.05$).*

The independent samples t-test on the posttest data yielded a significance value of 0.59 ($p > 0.05$), indicating that PDI-based learning produced digital literacy outcomes equivalent to conventional learning. However, the N-gain results showed values of -7.1%

for the experimental class and 5.3% for the control class (Mann-Whitney U test on N-gain, Sig. = 0.24; p > 0.05). The negative N-gain in the experimental class plausibly reflects changes in scores on the self-assessment instrument rather than an actual decline in digital ability, as students' perceptions of their own digital competence are often higher than their actual ability (Porat et al., 2018). After being directly engaged with various digital platforms during PDI-based learning, such as Google Docs and Canva, and the search for foreign-language scientific sources, students obtained a more realistic picture of their digital competence, which may have lowered some students' posttest self-ratings (Reichert et al., 2023; Rohatgi et al., 2016). This is also consistent with the ceiling effect, in which an already-high initial score leaves limited room for improvement (Staus et al., 2021; Westphale et al., 2022). Meanwhile, the control class's N-gain of 5.3% suggests that digital literacy develops gradually and is difficult to improve through short-term interventions. (Spante et al., 2018).

Improvement in each digital literacy domain was further analyzed through N-gain, as shown in Table 5. In the technical literacy domain, the experimental class improved from 72.52 to 82.22 (N-gain 0.20), which was better than the control class, which only improved from 79.21 to 80.48 (N-gain -0.07). This improvement is plausibly related to PDI activities that directly involved the use of various digital platforms, such as Google Docs for group discussion and information searching, which helped students become more accustomed to using digital technology in an academic context (Song et al., 2025; Tinmaz et al., 2022).

Table 5.
Mean Scores and N-gain for Each Digital Literacy Domain

Domain	Class	Pretest	Posttest	N-gain	Category
Technical	Control	79.21	80.48	-0.07	Low
	Experimental	72.52	82.22	0.20	Low
Information	Control	70.86	75.17	0.14	Low
	Experimental	74.35	77.17	-0.13	Low
Communication & Collaboration	Control	71.17	77.17	0.05	Low
	Experimental	74.83	68.61	-0.41	Low
Digital Safety	Control	88.59	88.83	0.23	Low
	Experimental	94.61	92.04	-0.15	Low
Creativity	Control	71.24	75.62	0.23	Low
	Experimental	71.43	74.05	-0.07	Low

By contrast, the information literacy and communication-and-collaboration literacy domains showed less optimal results in the experimental class, with N-gain values of -0.13 and -0.41, respectively, compared to 0.14 and 0.05 in the control class. In the information literacy domain, the large number of foreign-language digital sources containing technical terminology that students had to analyze independently, such as those from the World Health Organization (WHO), Centers for Disease Control and Prevention (CDC), and Joint United Nations Programme on HIV/AIDS (UNAIDS) may have caused information overload, a condition in which students struggle to select and determine the most relevant information (Drisya, 2025). This condition aligned with (Nuraeni et al., 2022), who suggest

that while technology-based learning can potentially generate extraneous cognitive load, the use of sufficient scaffolding, such as clear written guides and gradual complexity, is crucial to ensure it does not interfere with students' ability to process information, thereby keeping the cognitive load in a low category and optimizing learning outcomes.

Similarly, the communication-and-collaboration domain, the decline in the experimental class is consistent with Puspitaningrum & Nuraeni (2024), who found that collaboration in more structured, face-to-face inquiry with direct teacher support can run more smoothly than digital interaction in PDI, which requires students to express their opinions in writing without the support of facial expressions or direct conversation (Siregar & Scheffer-Sumampouw, 2021). Moreover, digital collaboration without clearly defined roles may also lead to uneven participation, particularly among students who tend to be passive during group discussion (Strauß, 2021).

In the digital safety and creativity literacy domains, both classes showed N-gain values still in the low category, even negative in the experimental class (-0.15 and -0.07). This is plausibly because digital safety was not taught explicitly during the lessons, so this competence only develops when students receive specific instruction on data protection and digital privacy (Guillén-Gámez et al., 2024). In the creativity domain, some students tended to rely on ready-made Canva templates, which limited idea exploration and design development, as digital creativity requires broader opportunities for exploration and may be constrained by time pressure during task completion (Amabile et al., 2002; Li et al., 2025; Tsabary & Hewitt, 2026).

Although the N-gain improvements in digital literacy in this study remained in the low category, PDI-based learning still demonstrated an advantage in providing students with direct experience accessing and evaluating digital information from credible sources, as well as collaborating through Google Docs (Law et al., 2018; Song et al., 2025). The fact that the experimental class's digital literacy remained equivalent to that of the control class, despite a more student-centered process less dependent on teacher explanation, suggests that PDI has the potential to serve as an alternative that can help reduce teacher dominance. The less optimal improvement in some domains may be related to the short intervention duration and students' adaptation to complex digital activities, suggesting that PDI may benefit from longer implementation. (Oyarzun & Martin, 2023; She et al., 2023).

C. Student Response toward PDI-Based Learning

After implementing PDI-based learning, students completed a response questionnaire to describe their perceptions of the learning experience. The responses were distributed as 32% very positive, 32% positive, 32% fairly positive, 4% less positive, and 0% very less positive. Thus, 96% of students provided responses ranging from fairly positive to very positive, indicating generally favorable perceptions of the PDI implementation. This positive tendency is plausibly related to the opportunities given to students to actively engage in information seeking, group discussion, digital product development, and learning

reflection Coiro et al. (2016), consistent with Cahyaningrum et al. (2025) who reported that digital-inquiry-based learning tends to receive positive responses because it creates an active, contextual, and student-centered learning experience. The small proportion of students with less positive responses may reflect difficulty adapting to learning that demands greater independence, particularly among students accustomed to teacher-centered instruction (Novak et al., 2023).

Across the engagement aspects, the reflective aspect obtained the highest percentage (84.50%; positive), followed by the social aspect (83.57%; positive), cognitive aspect (79.68%; positive), and affective aspect (74.46%; fairly positive). The relatively high reflective response may be related to the opportunity to connect reproductive health topics, such as HIV, PCOS, and cervical cancer, with everyday contexts and to revisit the learning process during the Analyze & Reflect stage (Antonio & Prudente, 2024; Coiro et al., 2023; Khairina & Rahman, 2022). The social response may be related to students' use of Google Docs for collaborative digital product development, which provided opportunities for communication and participation during group work (Kriewaldt et al., 2021; Siregar & Scheffer-Sumampouw, 2021). The cognitive response was also positive, consistent with the Wonder & Discover activities in which students formulated inquiry questions, searched information, and evaluated information from different sources (Coiro & Hobbs, 2016; Pedaste et al., 2015).

The affective aspect obtained the lowest percentage (74.46%; fairly positive). This relatively lower response may be related to the sensitivity of reproductive health topics and the demands of more independent digital learning. The thesis observations indicated that some students appeared uncomfortable when discussing topics such as HIV, gonorrhea, and cervical cancer, while differences in confidence and readiness for independent learning may also have influenced students' responses (Ardiana, 2022; Bahri et al., 2022; Heena & Nidhi, 2022). However, these factors were not directly measured in the present study and therefore should be regarded as possible explanations rather than established causes of the differences among engagement aspects. Overall, the questionnaire results indicate that PDI was generally well received, while the variation across engagement aspects suggests that students may experience different levels of comfort and engagement during PDI-based learning.

Conclusion & Recommendation

Based on the research results, Personal Digital Inquiry (PDI)-based learning did not produce statistically significant differences in students' health literacy or digital literacy compared with conventional learning on the human reproductive system topic. Therefore, the findings do not provide evidence that PDI was statistically superior to conventional learning for either outcome. Descriptively, both groups showed increases in health literacy from pretest to posttest, with the experimental group reaching the Excellent category and

the control group reaching the Sufficient category. The experimental group also showed a higher descriptive N-gain in the understanding domain than the control group; however, this pattern should not be interpreted as evidence of greater effectiveness. For digital literacy, no statistically significant difference was found between groups. In addition, 96% of students provided positive responses to the implementation of PDI, indicating generally favorable perceptions and acceptability of the learning experience rather than evidence of improved literacy outcomes.

A limitation of this study is that the health literacy pretest scores differed between the experimental and control groups, reflecting baseline differences in the non-equivalent control group design. Because these baseline differences were not statistically adjusted, the between-group posttest findings should be interpreted cautiously. Future implementations of PDI may consider more structured initial scaffolding and explicit guidance on digital information processing and safety. Future research should employ baseline-adjusted analyses and longer implementation periods to further examine whether PDI can produce statistically significant changes in students' health and digital literacy.

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