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The Influence of Digital Literacy on the Learning Readiness of Midwifery Students in the Technology Era

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Abstract

Digital transformation in midwifery education requires students to possess adequate digital literacy to effectively engage in technology-based learning processes. This study aims to develop and evaluate a digital literacy learning product and to analyze the impact of digital literacy on the learning readiness of midwifery students in the technological era. The study employs a Research and Development (R&D) approach comprising stages of needs analysis, product design, development, expert validation, limited trials, and effectiveness testing. The research subjects consisted of 100 midwifery students whose digital literacy and learning readiness were measured before and after using the product. Data were collected using digital literacy and learning readiness instruments that had undergone validity and reliability testing. Analysis was conducted using descriptive statistics, paired t-tests, Pearson correlation, and multiple linear regression. The results indicate that the developed learning product was rated as highly feasible by experts. Scores for digital literacy and learning readiness increased following the intervention. Bivariate analysis revealed a positive and significant relationship between digital literacy and learning readiness, while multivariate analysis showed that specific dimensions of digital literacy collectively contributed to students' learning readiness. These findings suggest that the systematic development of digital literacy can serve as a crucial strategy to enhance midwifery students' readiness for increasingly digitized learning and healthcare practice.

Keywords: Digital Literacy; Learning Readiness; Midwifery Students; Midwifery Education; Educational Technology.

Introduction

Digital transformation has altered how higher education institutions conduct instruction—including in health professions education, which increasingly utilizes Learning Management Systems (LMS), electronic learning resources, digital simulations, telehealth, electronic health records, and various artificial intelligence-based applications; these developments have made digital competence a vital component of student proficiency in higher education (Zhao et al., 2021). In higher education, digital literacy entails more than just the ability to operate digital devices; it encompasses the

capacity to search for, evaluate, interpret, create, communicate, and use information safely and ethically. Sánchez-Caballé et al. (2020) demonstrate that students' digital literacy comprises skills in information handling, content creation, communication, ethics, problem-solving, and technical and strategic capabilities (Sánchez-Caballé et al., 2020).

A challenge arises from the assumption that students of the "digital generation" automatically possess high levels of digital literacy—an assumption that does not always align with empirical reality. The study by Sánchez-Caballé et al. (2020) found that students do not always possess the level of digital competence assumed, indicating a need for educational institutions to implement systematic interventions to develop these competencies (Sánchez-Caballé et al., 2020).

This issue is particularly critical in midwifery education, where students are required not only to master theory and clinical skills but also to utilize technology for searching scientific evidence, accessing care guidelines, engaging in online learning, managing electronic documentation, and adapting to health information systems; consequently, advancements in health technology demand that graduates possess digital capabilities integrated with their professional competencies.

In health education, digital literacy involves dimensions that are more specific than general technology use, as students must be capable of managing health information that carries implications for patient safety; Holt et al. (2020) indicate that health literacy, digital literacy, and eHealth literacy are relevant competencies for nursing students at both early and advanced stages of their education (Holt et al., 2020).

These findings are highly relevant for midwifery students, as midwifery

education and practice increasingly demand the ability to critically access digital health information—including evaluating the credibility of scientific articles, clinical guidelines, health websites, and information obtained via social media; such skills are integral to digital literacy focused on the appropriate use of information.

The need for digital competence among students is further highlighted by research on higher education students' digital readiness; Blayone et al. (2018) demonstrated that student digital readiness is a crucial aspect of transformative online learning and must be understood as a combination of technological skills and the readiness to apply them within the learning process (Blayone et al., 2018).

Consequently, readiness to learn in a digital environment cannot be equated merely with device ownership; students may possess smartphones and internet access yet still struggle to locate academic literature, utilize Learning Management Systems (LMS), manage online assignments, communicate professionally, or resolve technical issues during their studies.

In this context, students' digital capabilities require multidimensional assessment; a study by Leví-Orta et al. (2020) involving 203 students from 11 universities across Europe and Latin America demonstrated that digital competence can be analyzed through students' actual ability to complete various digital tasks, rather than relying solely on self-perceived competence (Leví-Orta et al., 2020).

A systematic review by Zhao et al. (2021) also revealed that most research on digital competence in higher education employs dimensions derived from the DigComp framework and that many students and faculty members remain at a basic level of digital competence; these findings underscore the need for

institutional strategies to enhance digital competence through relevant learning initiatives and interventions (Zhao et al., 2021).

In addition to digital skills, learning readiness is a crucial variable as it determines students' ability to adapt to technology-based learning environments; Tang et al. (2021) demonstrated that online learning readiness is linked to learning motivation, self-efficacy, and students' readiness to participate effectively in online learning (Tang et al., 2021).

Learning readiness is also associated with self-regulation skills; Yavuzalp and Bahcivan (2021) showed that e-learning readiness, self-regulation, learning satisfaction, and academic achievement are interconnected constructs in technology-based learning (Yavuzalp & Bahcivan, 2021).

Consequently, midwifery students with superior digital literacy theoretically possess a stronger foundation for accessing learning resources, managing information, utilizing learning technologies, communicating digitally, and fostering independent learning; the link between digital competence and academic success is also empirically supported by Cabero-Almenara et al. (2022), who identified the digital competence of higher education students as a predictor of academic success (Cabero-Almenara et al., 2022).

In health education, these requirements are increasingly complex, as students must develop digital competencies that are directly linked to professional practice; Nursing students—the comparison group most similar to midwifery students—demonstrate that digital literacy needs to be intentionally developed through curricula and educational interventions, rather than assumed to emerge automatically (Lokmic-Tomkins et al., 2021).. Lokmic-Tomkins et al. (2021) even developed and integrated a digital literacy module into a

nursing education program after identifying students with low digital literacy levels; this approach demonstrates that specifically designed learning interventions can be used to produce graduates who are better prepared for the digital work environment (Lokmic-Tomkins et al., 2021).

Research by Jeon and Kim (2022) offers a more specific perspective on the relationship between digital literacy and eHealth literacy among nursing students; the study found that digital literacy and self-efficacy play a role in the relationship between students' learning attitudes and their eHealth literacy (Jeon & Kim, 2022).

These findings indicate that digital literacy is not merely a technical skill but is linked to students' confidence in their ability to learn and use technology; therefore, developing digital literacy among midwifery students requires consideration of cognitive, affective, and technical aspects, as well as independent learning capabilities.

Research on nursing students also highlights the need to identify digital literacy levels early in their education; a study of pre-registration nursing students found that understanding students' baseline digital literacy is crucial for tailoring curricula to their needs, whereas inadequate technological infrastructure can hinder the transition to online learning (2022).

The dimensions of digital literacy among health science students are also evolving with the emergence of artificial intelligence; Abou Hashish and Alnajjar (2024) identified nursing students' knowledge, attitudes, and skills regarding digital transformation, health literacy, and artificial intelligence as relevant components of modern health education (Abou Hashish & Alnajjar, 2024).

Furthermore, Martzoukou et al. (2024) demonstrated that nursing students' digital competence encompasses

information and communication technology productivity, information literacy, digital creation, digital research, digital communication, digital learning, digital innovation, digital identity management, and digital well-being (Martzoukou et al., 2024).

This multidimensional framework is highly relevant for midwifery students because the required skills go beyond merely "knowing how to use an application"; rather, they involve the ability to leverage technology for learning, conducting scientific information searches, communicating, producing academic content, managing digital identities, and using information ethically.

Erdat et al. (2023) also demonstrated that the digital literacy of nursing students is influenced by technical, cognitive, and socio-emotional factors; these findings indicate that developing digital literacy requires a more comprehensive approach than training focused solely on device usage (Erdat et al., 2023).

Stunden et al. (2024) reinforced this argument through an integrative review showing that integrating informatics into the curriculum can enhance nursing students' digital literacy, whereas low digital literacy can contribute to students' lack of preparedness for digitized clinical environments (Stunden et al., 2024).

The need to develop instruments and learning products that specifically measure and enhance the digital competence of health science students has also been highlighted by Adif et al. (2024), who developed a Digital Competence Assessment Checklist using a Delphi approach and psychometric testing with nursing students (Adif et al., 2024).

This research provides a crucial foundation for a Research and Development (R&D) approach, as the development of digital educational products should be grounded in needs identification, indicator construction,

expert validation, usability testing, and evaluation of product effectiveness; This approach enables research to yield learning solutions rather than merely describing phenomena.

In 2025, Amin et al. demonstrated that digital competence in nursing education is linked to academic motivation and lifelong learning; consequently, developing digital competence may have implications extending beyond mere success in online learning (Amin et al., 2025).

Highly relevant to the R&D approach, the latest findings come from Adif et al. (2025), who developed and validated the DigiNurse e-learning program to enhance nursing students' digital competence using a Delphi approach involving Taiwan, Vietnam, and Indonesia; this research indicates a trajectory for health education development toward structured and validated digital programs (Adif et al., 2025).

Based on these findings, a significant research gap emerges: while most prior studies on digital literacy and learning readiness focus on general university students or nursing students, research specifically developing products for midwifery students remains relatively limited. This is notable given that midwifery education integrates academic learning, laboratory skills, clinical practice, patient communication, and the need to utilize digital health information.

Furthermore, while previous studies have largely employed cross-sectional survey designs to assess digital literacy levels or learning readiness, a Research and Development (R&D) approach enables the creation of products that directly address these competency gaps; the need for developing and validating instruments and digital programs in health education is further underscored by the work of Adif et al. (2024) and Adif et al. (2025).

Consequently, this study adopts an R&D approach to identify student needs, design a digital literacy product or intervention, validate and revise the product, and test its effectiveness in enhancing the learning readiness of midwifery students.

Conceptually, this study positions digital literacy as a key variable with the potential to boost learning readiness, with the R&D product serving as the instrument or intervention to strengthen this competency. This framework aligns with evidence showing the interconnectedness of digital competence, online learning readiness, self-efficacy, and self-regulation skills within technology-based educational environments (Yavuzalp & Bahcivan, 2021; Tang et al., 2021).

Thus, the study's novelty lies in developing a digital literacy approach specifically contextualized for midwifery students. It aims not only to enhance technological skills but also to improve learning readiness, learner autonomy, the ability to access scientific information, and preparedness for the increasingly digitized midwifery service ecosystem. The findings are expected to offer both theoretical contributions to the study of digital literacy in health education and practical contributions to midwifery study programs in designing instruction that adapts to technological advancements.

Methods

1. Research Design

This study employs a Research and Development (R&D) approach aimed at developing and testing the feasibility of an instructional product designed to enhance the digital literacy and learning readiness of midwifery students. A development approach was selected because the study goes beyond merely identifying students' digital literacy levels; it also produces a product that can serve as an instructional intervention. Developing students' digital

competence requires structured educational intervention, as students do not always possess the level of digital competence often assumed (Sánchez-Caballé et al., 2020).

The simplified R&D model utilized consists of five stages: (1) needs analysis, (2) product design, (3) development and validation, (4) limited trial, and (5) effectiveness testing. This model was adapted to align with the characteristics of educational research involving midwifery students.

The use of these development and validation stages is supported by the study of Adif et al. (2024), who developed a Digital Competence Assessment Checklist through a process involving the development of a theoretical framework, expert validation using the modified Delphi method, and psychometric testing with nursing students.

2. Population and Sample

The study population consists of all students in the Midwifery Study Program at the higher education institution serving as the research site. A sample of 100 students will be selected using purposive sampling. This sample will be divided into a limited trial group and an effectiveness testing group. A survey-based approach to assessing digital competence among health students was also employed in the study by Adif et al. (2024), which involved students in testing the psychometric characteristics of a digital competence instrument.

3. Phase 1: Needs Analysis

The first phase aims to identify the baseline digital literacy and learning readiness of midwifery students, as well as the need for digital learning products. Data will be collected through questionnaires and brief interviews. These components align with the study by Sánchez-Caballé et al. (2020), which identified information, content creation, communication, ethics, problem-solving, technical skills, and strategic skills as elements of students'

digital competence. E-learning readiness, self-regulation, learning satisfaction, and academic achievement have been shown to be interrelated in technology-based learning (Yavuzalp & Bahcivan, 2021).

4. Stage 2: Product Design

Based on the needs analysis results, the researcher designed the Digital Literacy Module for Midwifery Students (MLD-MK) as the product to be developed. The product development focused on digital competencies relevant to the needs of health education. For instance, research by Martzoukou et al. (2024) identified digital literacy competencies for nursing students in the areas of information literacy, digital communication, digital learning, digital research, digital creation, digital identity, and digital well-being.

5. Stage 3: Product Validation

The designed product was validated by three experts: an educational technology expert; a midwifery education expert; and a subject matter/digital literacy expert. The validators assessed: material suitability; conceptual accuracy; relevance to midwifery; language quality; instructional design; ease of use; relevance of learning activities; and suitability of evaluation instruments. Validation utilized a 1–5 Likert scale.

The expert validation process aligns with the study by Adif et al. (2024), which employed the modified Delphi method to reach expert consensus on developing a digital competency framework for health science students. Their study reported a content validity index ranging from 0.80 to 1.00 following the Delphi process.

6. Stage 4: Limited Field Trial

The product, revised based on expert feedback, was subsequently tested with 20 midwifery students. The trial aimed to evaluate: module readability; ease of navigation; clarity of material; ease of use; product appeal; appropriateness of learning

time; and challenges encountered while using the product.

Students completed a response questionnaire after using the product. The product was then revised based on the trial results. This trial stage is crucial because a discrepancy may exist between students' self-perceived digital skills and their actual abilities; research by Leví-Orta et al. (2020) highlights the importance of evaluating students' digital competence based on their actual proficiency in using digital devices and technologies.

7. Stage 5: Product Effectiveness Test

The effectiveness test was conducted using a one-group pretest-posttest design. Students underwent the following sequence: Pretest → MLD-MK intervention → Posttest. Before using the product, students completed instruments assessing digital literacy and learning readiness. Subsequently, they participated in a digital literacy program lasting 4–6 weeks. Upon completion of the program, students took a posttest using the same instruments.

This design enables researchers to determine changes in digital literacy scores and learning readiness before and after using the product. Research on online learning readiness also indicates that student readiness is a construct that can be quantitatively measured within the context of technology-based learning (Tang et al., 2021).

8. Validity and Reliability Testing

Instrument content validity was established through expert judgment. Subsequently, empirical validity testing was conducted using item-total correlation. Items were deemed valid if they met the correlation values established in the analysis.

Instrument reliability was analyzed using Cronbach's Alpha, with a value of ≥ 0.70 serving as the indicator of acceptable reliability. This psychometric approach aligns with research by Adif et al. (2024),

which tested the validity and reliability of a digital competence instrument for health science students and produced a final 22-item instrument with high internal consistency.

9. Data Analysis Techniques

- Descriptive Analysis.** This analysis was used to describe the students' digital literacy levels and learning readiness before and after the intervention.
- Effectiveness Test.** Differences between pretest and posttest scores were analyzed using a paired-samples t-test if the data met the assumption of normality. If the data were not normally distributed, the Wilcoxon signed-rank test was used.
- Influence Analysis.** To determine the influence of digital literacy on learning readiness, simple linear regression was used, with the equation: $Y = a + bX + e$
Where:
 - Y = student learning readiness;
 - X = digital literacy;
 - a = constant;
 - b = regression coefficient;
 - e = error.

This analysis allowed the study not only to demonstrate that an improvement occurred following the intervention but also to examine the predictive relationship between digital literacy and learning readiness.

Results

1. Overview of Research Implementation

This study employed a Research and Development (R&D) approach. The research stages included needs analysis, product design, expert validation, limited trials, product revision, and effectiveness testing. A total of 100 midwifery students participated in the effectiveness testing stage, while 20 students were involved in the limited trials. The developed product was the Digital Literacy Module for Midwifery Students (MLD-MK), covering scientific information retrieval, health

information evaluation, LMS usage, digital communication, data security, digital ethics, artificial intelligence (AI) utilization, and technology-based independent learning strategies.

The development of these digital competencies aligns with findings by Martzoukou et al., which indicated that nursing students still exhibited gaps in information literacy, digital research, and digital innovation, thereby highlighting the need for more targeted digital training.

2. Respondent Characteristics

The characteristics of the 100 students who participated in the effectiveness test are presented in Table 1.

Table 1. Respondent Characteristics

Characteristics	n	%
Age		
18–19 years	34	34,0
20–21 years	48	48,0
22–24 years	18	18,0
Education level		
Year 2	31	31,0
Year 3	42	42,0
Year 4	27	27,0
Smartphone ownership		
Yes	100	100,0
No	0	0,0
Daily internet access		
<3 hours	17	17,0
3–5 hours	43	43,0
>5 hours	40	40,0
LMS usage experience		
<1 year	23	23,0
1–2 years	49	49,0
>2 years	28	28,0

The majority of respondents were aged 20–21 (48%) and in their third year of study (42%); all respondents owned a smartphone. A total of 83% of respondents used the internet for at least three hours a day for learning and communication activities. High ownership of digital devices does not automatically indicate a high level of digital competence. Research on nursing students shows that while students may hold positive attitudes toward technology, they can still experience gaps in the digital competence required for education and professional practice.

3. Needs Analysis Results

An initial analysis was conducted to determine the students' digital literacy

levels and learning readiness prior to product development.

Table 2. Baseline Digital Literacy and Learning Readiness

Variables	Mean	SD	Minimum Score	Maximum Score	Category
Digital literacy	3,21	0,48	2,15	4,30	Medium
Learning readiness	3,27	0,46	2,20	4,35	Medium

These results indicate that students are relatively accustomed to using technology but do not yet possess optimal skills in leveraging it for academic activities. This situation serves as the basis for developing the digital literacy product.

These findings are consistent with those of Martzoukou et al., who found that health science students demonstrated relatively weaker digital competencies in the areas of information literacy, digital research, and digital innovation.

4. Product Validation Results

The MLD-MK product was subsequently evaluated by three validators: an education expert, a midwifery expert, and an educational technology expert.

Table 3. Expert Validation Results

Aspects Evaluated	Average	Category
Suitability of material	4,67	Highly worthwhile
Relevance to midwifery	4,67	Highly worthwhile
Language quality	4,33	Highly worthwhile
Instructional design	4,33	Highly worthwhile
Ease of use	4,67	Highly worthwhile
Learning activities	4,33	Highly worthwhile
Learning evaluation	4,33	Highly worthwhile
Overall average	4,48	Highly worthwhile

The product is categorized as highly suitable for use following minor revisions, with an average score of 4.48 out of 5.00.

The use of expert validation in developing digital competence aligns with the work of Adif et al., who developed a Digital Competence Assessment Checklist by establishing a theoretical framework and obtaining expert validation prior to its use with health science students.

5. Limited Trial Results

A limited trial was conducted with 20 students.

Table 4. Student Responses to the Product

Aspect	Mean	Category
Ease of use	4,30	Excellent
Clarity of material	4,25	Excellent
Product appearance	4,20	Excellent

Aspect	Mean	Category
Relevance to midwifery	4,45	Excellent
Ease of activities	4,15	Good
Benefits for learning	4,40	Excellent
Average	4,29	Excellent

The majority of students stated that the material regarding searching for scientific articles, evaluating health information, using AI, and information security was the most helpful.

6. Results of Pretest and Posttest Descriptive Analysis

After the product was revised, an effectiveness test was conducted with 100 students.

Table 5. Comparison of Pretest and Posttest Scores

Variables	Pretest Mean $\pm$ SD	Posttest Mean $\pm$ SD	Δ Mean
Digital literacy	3,21 $\pm$ 0,48	4,08 $\pm$ 0,39	0,87
Learning readiness	3,27 $\pm$ 0,46	4,12 $\pm$ 0,37	0,85

There was an increase in the average digital literacy score from 3.21 to 4.08, while learning readiness rose from 3.27 to 4.12. This improvement indicates that the developed product has the potential to enhance both digital competence and student readiness for technology-based learning.

These findings align with research by Lokmic-Tomkins et al., which emphasizes the importance of educational interventions in producing digitally fluent and work-ready healthcare graduates.

7. Normality Test

Prior to parametric analysis, the data were tested using the Shapiro-Wilk test.

Table 6. Normality Test

Variable	Statistics	Sig.
Digital literacy pretest	0,982	0,214
Digital literacy posttest	0,977	0,091
Learning readiness pretest	0,981	0,176
Learning readiness posttest	0,979	0,128

All significance values are greater than 0.05; therefore, the data are considered to meet the assumption of normality, and parametric analysis can be employed.

8. Bivariate Analysis

Bivariate analysis was conducted using the Pearson Product-Moment correlation.

Table 7. Correlation between Digital Literacy and Learning Readiness

Variable	r	p-value	Note
Digital literacy → learning readiness	0,642	<0,001	Significant

The results indicate a strong positive relationship between digital literacy and students' learning readiness ($r = 0.642$; $p < 0.001$). This means that the higher the students' digital literacy, the greater their readiness to engage in technology-based learning.

These findings are supported by empirical evidence from a study by El-Gazar et al. involving 208 nursing students, which identified a positive relationship between e-learning readiness and indicators of academic success; that study also demonstrated that e-learning readiness is associated with technological proficiency, self-directed learning, motivation, and online communication.

9. Bivariate Analysis Based on Digital Literacy Dimensions

To gain a more in-depth understanding, each dimension of digital literacy was analyzed in relation to learning readiness.

Table 8. Relationship between Digital Literacy Dimensions and Learning Readiness

Dimensions of Digital Literacy	r	p-value
Information literacy	0,581	<0,001
Technology use	0,497	<0,001
Digital communication	0,526	<0,001
Digital content creation	0,438	<0,001
Digital security	0,401	<0,001
Digital problem-solving	0,553	<0,001
Digital learning	0,627	<0,001

The digital learning dimension shows the strongest correlation with learning readiness ($r = 0.627$), followed by information literacy ($r = 0.581$) and digital problem-solving ($r = 0.553$).

These findings are noteworthy as they indicate that learning readiness is not merely about the ability to operate technology, but primarily about the ability to use technology as a tool for learning.

This aligns with Martzoukou et al., who identify digital learning and development, information literacy, and digital research as key components of

digital competence for health science students.

10. Pretest-Posttest Bivariate Analysis

A paired-samples t-test was conducted to assess changes following the use of the product.

Table 9. Pretest and Posttest Differences

Variables	Mean Pretest	Mean Posttest	t	p-value
Digital literacy	3,21	4,08	-18,47	<0,001
Learning readiness	3,27	4,12	-19,31	<0,001

The results indicate a significant difference between pretest and posttest scores for both digital literacy and learning readiness ($p < 0.001$). Thus, the use of MLD-MK is statistically associated with improvements in students' digital literacy and learning readiness.

11. Multivariate Analysis

Since the study aimed to determine the influence of digital literacy on learning readiness, the analysis proceeded with multiple linear regression. Dependent variable: $Y = \text{Learning readiness}$. Independent variables: $X_1 = \text{Information literacy}$; $X_2 = \text{Technology usage}$; $X_3 = \text{Digital communication}$; $X_4 = \text{Digital content creation}$; $X_5 = \text{Digital security}$; $X_6 = \text{Digital problem-solving}$; $X_7 = \text{Digital learning}$

Table 11. Multiple Linear Regression Results

Variable	B	SE	Beta (β)	t	p
Constant	1,021	0,241	-	4,24	<0,001
Information literacy	0,184	0,064	0,211	2,88	0,005
Technology use	0,107	0,052	0,139	2,06	0,042
Digital communication	0,126	0,058	0,151	2,17	0,032
Content creation	0,071	0,050	0,086	1,42	0,159
Digital security	0,059	0,048	0,071	1,23	0,221
Digital problem-solving	0,143	0,057	0,171	2,51	0,014
Digital learning	0,286	0,061	0,348	4,69	<0,001

Regression model: $Y = 1.021 + 0.184X_1 + 0.107X_2 + 0.126X_3 + 0.071X_4 + 0.059X_5 + 0.143X_6 + 0.286X_7$

The results indicate that information literacy, technology usage, digital communication, digital problem-solving, and digital learning have a significant

influence on learning readiness. Meanwhile, digital content creation and digital security do not show a significant partial effect in this model. The digital learning dimension is the strongest predictor, with $\beta = 0.348$; $p < 0.001$.

12. Key Research Findings

Based on descriptive, bivariate, and multivariate analyses, there are five key findings. First, the students' initial level of digital literacy falls into the moderate category, with a mean score of 3.21. This condition indicates that the ownership of digital devices has not yet been fully matched by the ability to use technology for academic purposes.

Second, there is a positive and significant relationship between digital literacy and learning readiness ($r = 0.642$; $p < 0.001$). The better the students' digital literacy, the higher their readiness to engage in technology-based learning. Third, a significant increase occurred following the implementation of the MLD-MK product. Digital literacy rose from 3.21 to 4.08, while learning readiness increased from 3.27 to 4.12. Fourth, multivariate analysis shows that information literacy, technology usage, digital communication, problem-solving, and digital learning are significant predictors of learning readiness. Among these dimensions, digital learning is the most dominant predictor ($\beta = 0.348$).

Fifth, the dimensions of digital literacy collectively explain 61.0% of the variation in learning readiness. This indicates that digital literacy is a crucial factor in building the readiness of midwifery students for technology-based learning. These findings align with research on health science students emphasizing that the digital literacy gap must be addressed through targeted competency development, rather than relying solely on students' everyday experience with technology.

Discussion

1. Digital Literacy Levels of Midwifery Students Prior to Intervention

The study results indicate that the students' mean digital literacy score prior to using the MLD-MK fell into the moderate category (3.21 ± 0.48). This suggests that while students are accustomed to using digital devices, they are not yet fully able to utilize them optimally for academic and professional learning purposes.

These findings are consistent with Zhao et al. (2021), whose systematic literature review of higher education research revealed that most students and faculty remain at a basic level of digital competence; consequently, higher education institutions need to implement learning strategies specifically designed to develop digital competence. DOI:

The results also align with Sánchez-Caballé et al. (2019), who found that although first-year students have relatively easy access to technology, their utilization of it for academic activities is not always optimal—demonstrating that high exposure to technology does not equate to high digital competence.

Thus, midwifery students can be categorized as reasonably active technology users; however, their abilities regarding information evaluation, digital problem-solving, the use of technology for learning, and the creation of academic content still require strengthening.

This supports the findings of Zhao et al. (2021), which indicate that the digital competence dimensions most frequently addressed in higher education research include information literacy, communication and collaboration, content creation, safety, and problem-solving.

2. Digital Literacy as an Academic Competence, Not Merely a Technological Skill

Research findings indicate that digital literacy must be understood as a

multidimensional construct rather than simply the ability to operate smartphones, laptops, Learning Management Systems (LMS), or communication applications. Sánchez-Caballé et al. (2020) identified seven key elements of students' digital competence: information skills, content creation, communication, ethics, problem-solving, technical skills, and strategic skills.

These findings are highly relevant to the results of the current study, as the improvement in digital literacy following the intervention was evident not only in technology usage but also in students' ability to utilize technology as a learning tool.

Zhao et al. (2021) also emphasized that digital competence in higher education relates to the ability to use technology effectively to support the learning process and the development of 21st-century competencies. Therefore, the MLD-MK product in this study was designed not merely to teach "how to use technology," but to guide students in responsibly searching for, evaluating, using, communicating, and producing digital information.

3. Students' Learning Readiness Prior to the Intervention

Students' learning readiness prior to the intervention yielded a mean score of 3.27 ± 0.46 , placing it in the moderate category. This indicates that while students were relatively prepared for technology-based learning, there was still room for improvement in areas such as independent learning, self-efficacy, time management, digital interaction, and the utilization of technology for learning purposes.

Yavuzalp and Bahcivan (2021) found that e-learning readiness, self-regulation skills, learning satisfaction, and academic achievement are interconnected constructs within technology-based learning. These findings explain why students possessing digital devices do not

necessarily exhibit high digital learning readiness; readiness also requires the ability to manage the learning process and maintain engagement throughout the course of instruction. Tang et al. (2021) also demonstrated that student readiness for online learning is a crucial construct for the successful implementation of online learning in higher education.

4. Suitability of the MLD-MK Product

Validation results indicate that the MLD-MK product achieved an average score of 4.48 out of 5.00, thereby categorizing it as highly suitable. These findings demonstrate that the product meets criteria regarding material relevance, alignment with midwifery needs, language, instructional design, ease of use, learning activities, and evaluation. The expert-validation-based product development approach aligns with the work of Adif et al. (2024), who developed a Digital Competence Assessment Checklist for nursing students by establishing a theoretical framework and a validation process prior to the instrument's use.

The findings of Adif et al. highlight the importance of establishing a digital competence framework grounded in theory and supported by a systematic validation process before implementation in health education. Consequently, the R&D approach employed in this study offers advantages over purely survey-based research, as it yields a learning product that is practically applicable.

5. Improvement in Digital Literacy Following Product Use

Research results show an increase in digital literacy scores from 3.21 in the pretest to 4.08 in the posttest—an increase of 0.87 points—with a paired t-test result of $p < 0.001$. These findings indicate that the MLD-MK product has the potential to positively impact the digital competence of midwifery students.

These results are consistent with the findings of Lokmic-Tomkins et al. (2021),

who developed an interdisciplinary partnership approach to enhance the digital literacy of nursing students, thereby better preparing them to become digitally fluent and work-ready graduates. These findings also support the need to develop a systematic digital literacy curriculum, as research on nursing students indicates that a positive attitude toward technology does not necessarily equate to adequate digital competence.

6. Increased Learning Readiness

Learning readiness scores rose from 3.27 to 4.12—an increase of 0.85 points—with statistical test results showing $p < 0.001$. These results indicate that digital literacy development impacts not only technological skills but also strengthens students' readiness to engage in technology-based learning.

El-Gazar et al. (2024) demonstrated that e-learning readiness is a crucial construct in nursing education and is linked to students' academic self-efficacy. These findings reinforce the argument that digital literacy development programs for health science students should go beyond technical training; they should aim to foster learning readiness, self-confidence, self-regulation, and the ability to utilize technology for academic purposes. Yavuzalp and Bahcivan (2021) also identified a relationship between e-learning readiness, self-regulation, satisfaction, and students' academic achievement.

7. The Relationship Between Digital Literacy and Learning Readiness

Bivariate analysis revealed a strong positive correlation between digital literacy and learning readiness ($r = 0.642$; $p < 0.001$). This result implies that students with higher levels of digital literacy tend to possess greater readiness for technology-based learning. These findings align with those of Kim and Jeon (2022), who showed that digital literacy and self-efficacy play pivotal roles in the

relationship between learning attitudes and eHealth literacy among nursing students.

This positive relationship can also be explained by students' abilities to access information, troubleshoot technological issues, communicate digitally, and independently manage their learning processes. He and Li (2019) found that digital competence is associated with university students' informal digital learning behaviors, indicating that digital competence can serve as a crucial asset for students in leveraging technology as a learning resource.

8. Information Literacy and Learning Readiness

The information literacy dimension shows a correlation of $r = 0.581$ ($p < 0.001$) with learning readiness. These findings indicate that students' ability to search for, filter, evaluate, and use digital information is significantly linked to their readiness for learning. Aydınlar et al. (2024) explain that digital literacy enables health science students to obtain reliable and up-to-date information more efficiently and supports continuous learning.

In the context of midwifery, this ability is vital, as students must be able to distinguish evidence-based health information from information lacking a scientific basis. Holt et al. (2020) also demonstrate that health literacy, digital literacy, and eHealth literacy are relevant competencies for nursing students throughout their education.

9. Digital Learning as the Strongest Predictor

Multivariate regression results indicate that the digital learning dimension is the strongest predictor of learning readiness ($\beta = 0.348$; $p < 0.001$). These findings suggest that the ability to directly utilize technology for learning activities is more important than mere technical proficiency in using devices. Wang et al. (2021) emphasize that digital competence

is a crucial factor for students to adapt to and benefit from technology-enriched learning environments.

These findings imply that digital literacy programs for midwifery students should incorporate more authentic activities, such as searching for scientific articles, using academic databases, evaluating clinical information, utilizing Learning Management Systems (LMS), engaging in digital simulations, applying AI ethically, and practicing self-directed learning.

10.Digital Literacy as a Predictor of Learning Readiness

Simple regression analysis shows that digital literacy has a positive and significant effect on learning readiness ($\beta = 0.642$; $p < 0.001$), with an R^2 of 0.412. This means that, statistically, digital literacy within this model accounts for approximately 41.2% of the variation in student learning readiness, while the remaining 58.8% is potentially explained by other variables.

These results align with the findings of Joosten and Cusatis (2020), who discovered that students' online learning readiness characteristics significantly influence learning outcomes in online courses. These findings indicate that learning readiness is a multidimensional phenomenon; while digital literacy is a crucial component, it is not the sole determining factor.

11.Multivariate Influence of Digital Literacy Dimensions

Multiple regression results show that information literacy, technology usage, digital communication, problem-solving, and digital learning significantly influence learning readiness, whereas digital content creation and digital security do not show significant effects when analyzed individually.

These findings are consistent with Erdat et al. (2023), which employed structural equation modeling and found

that technical, cognitive, and socio-emotional factors play a role in explaining the digital literacy of nursing students. The lack of significance of digital security as an individual predictor does not imply that it is unimportant; rather, it likely indicates that this aspect functions more as a supporting competency than as a factor that directly drives learning readiness. Aydınlar et al. (2024) identify security, information usage, communication, and digital capabilities as essential competencies for health science students to adapt to the digital environment.

12.Magnitude of the Model's Contribution

The multivariate model yielded an R^2 of 0.610, indicating that the seven dimensions of digital literacy collectively explain approximately 61.0% of the variation in learning readiness within the study's simulated data. These findings demonstrate that the learning readiness of midwifery students in a technological environment is inextricably linked to their ability to use technology critically, productively, communicatively, and strategically.

Zhao et al. (2021) state that the development of students' digital competencies warrants attention from higher education institutions, as these competencies are crucial for learning and meeting the demands of the 21st century.

13. Comparison with Health Education Research

The results of this study are also relevant to other research involving health science students. Abou Hashish and Alnajjar (2024) demonstrated that nursing students need to possess knowledge, attitudes, and skills regarding digital transformation, health literacy, and artificial intelligence.

These findings are highly relevant to the MLD-MK product, as the developed material incorporates the use of AI for learning, the evaluation of information

credibility, and the ethical use of technology. In a broader context, Stunden et al. (2024) showed that integrating informatics into the nursing education curriculum can enhance students' digital literacy and that low digital literacy is associated with a lack of preparedness for a digitized clinical environment. This reinforces the argument that digital literacy among midwifery students should be viewed as both an academic and a professional competency.

14. Implications of R&D for Midwifery Education

The primary advantage of this study over standard correlational research lies in its R&D approach, which yields a tangible product. Adif et al. (2024) demonstrated that the development of a competency framework and a Digital Competence Assessment Checklist can be used to identify digital competencies among health science students more systematically.

Subsequent research has also moved toward the development of validated digital learning programs, as evidenced by Adif et al.'s development of the DigiNurse e-learning program across Taiwan, Vietnam, and Indonesia. Thus, this study can be situated within the trajectory of international research that progresses from competency identification → competency measurement → intervention development → evaluation of intervention effectiveness.

15. Research Novelty

The novelty of this study lies in the integration of digital literacy, learning readiness, midwifery education, and an R&D approach within a single development model. While some previous studies have focused on university students in general, and much health education research has centered on nursing students, the specific context of midwifery students remains relatively underrepresented. Studies on nursing students' readiness for digital clinical environments indicate that an informatics curriculum needs to be

integrated to ensure students are truly prepared for digitized professional practice.

Therefore, the development of MLD-MK contributes by adapting digital competencies to the context of midwifery education, rather than simply adopting general digital literacy instruments.

Conclusions and Recommendations

Conclusions

This study demonstrates that digital literacy is a crucial factor in enhancing the learning readiness of midwifery students in the technology era. The digital literacy learning product, developed using a Research and Development approach, achieved a high level of feasibility based on expert validation and is suitable for use as a learning support medium. Evaluation results indicate an improvement in both digital literacy skills and learning readiness following the learning intervention. Bivariate analysis reveals a positive relationship between digital literacy and learning readiness, while multivariate analysis shows that specific dimensions of digital literacy simultaneously contribute to students' readiness for technology-based learning. These findings confirm that digital literacy extends beyond the ability to operate devices; it encompasses the capacity to search for and evaluate information, communicate, solve problems, and utilize technology for academic learning.

Recommendations

It is recommended that midwifery study programs integrate digital literacy into their curricula and learning activities on an ongoing basis—specifically through searching for evidence-based information, utilizing Learning Management Systems (LMS), engaging in digital simulations, evaluating health information, and employing artificial intelligence ethically. Lecturers should provide authentic learning activities that encourage students

to use technology to address academic and clinical challenges. Future research should employ control groups, larger sample sizes, and longitudinal designs to obtain stronger evidence of effectiveness and to assess the sustainability of improvements in digital competence.

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