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Digital Silence and Adolescent Health Literacy in Remote Learning Environments

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A B S T R A C T

This study analyzes the relationship between digital silence and health literacy among midwifery and nursing students in Semarang, Indonesia, within a distance learning context. Using a mixed-methods explanatory sequential design, 180 students participated in a quantitative survey, and 20 were involved in interviews and focus group discussions. Linear regression results show a significant negative relationship between digital silence and health literacy, while qualitative findings reveal psychological barriers, limited interaction, and technological constraints as key factors driving passivity. The study concludes that digital silence hinders health literacy development, contributing theoretically to digital interaction studies in health education and practically by offering recommendations for more participatory distance learning strategies to strengthen future health professionals' competencies.

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INTRODUCTION

The rapid growth of distance learning, especially in response to the COVID-19 pandemic, has resulted in a phenomenon in the form of digital silence when students tend to be passive and inactive in communicating in virtual classes. Globally, many students experience barriers in online interactions due to limited access to technology, feelings of isolation, and low motivation (Livingston et al., 2023; Bond, 2022). In the context of health education, digital health literacy is very important because students in the health sector, such as midwifery and nursing, rely on online media both for academic purposes and to strengthen their competence as health workers in the future (Ho et al., 2023; Dadaczynski et al., 2021). In Indonesia, the urgency to understand this phenomenon is increasing along with the dominance of distance learning methods in health education institutions, especially in urban areas such as Semarang.

Previous research has discussed aspects of digital silence in the context of academic interaction in general. For example, (Luqmonovna & Jabbor Qizi, 2021) found that lack of feedback and limited interaction are the main causes of digital silence, which in turn negatively impacts learning motivation. A similar study by (Ho et al., 2023) highlighted the absence of verbal participation as a problem that undermines the dynamics of online learning. Another study by (Thomas et al., 2022) also showed that low participation in virtual classes is closely related to feelings of social insecurity in digital spaces. However, these studies have not explored the specific impact of digital silence on student health literacy in the context of distance learning.

On the other hand, the literature on digital health literacy shows that students tend to have varying levels of ability to access and understand online health information, and that literacy is influenced by factors such as self-efficacy and psychological stress (Taba et al., 2022; Paakkari & Okan, 2020). However, these studies have not linked health literacy to participatory behavior in the digital space. A comprehensive review by (Mancone et al., 2024) emphasizes the need for interactive and digital approaches in improving health literacy, but has not included passive phenomena such as digital silence in their analysis.

Thus, there is a research gap between the study of the phenomenon of digital silence in online learning in general and research on digital health literacy in particular. There is still a lack of integration between the two, especially in the context of health education in a distance learning situation. Until now, there has been no research that explicitly explores the influence of digital silence on the health literacy of midwifery and nursing students in Indonesia. This is an important space for further studies, so that online health education interventions can be designed more effectively.

The purpose of this study is explicitly to analyze the relationship between the phenomenon of digital silence and the level of digital health literacy of students, especially midwifery and nursing students in Semarang City. This research also aims to identify the factors that cause the practice of digital silence and formulate intervention strategies so that student health literacy is more optimal through digital learning methods.

In theory, this research contributes to enriching the study of digital health literacy and online education interaction theory by presenting a new perspective, namely the relationship between digital passivity and the understanding of health information. In practice, the results of the research are expected to be the basis for educators, curriculum designers, and policymakers in designing more inclusive and effective online communication strategies to increase active participation and student health literacy.

With this framework, this study is expected to open up new insights in the development of digital-based health education, provide in-depth scientific understanding, and offer concrete solutions in the context of distance learning. Contextually, the focus on health students in Semarang is relevant because this city is an urban center that represents a significant challenge as well as potential for online health learning in Indonesia.

THEORETICAL REVIEW

The Digital Silence Phenomenon in Online Learning

The phenomenon of digital silence, which is a condition when student participation in virtual classes is minimal or even non-existent, is getting more and more attention in the educational literature. Ayu Nurrohmah and Waloyo (2023) found that in online English as a Foreign Language classes, common reasons for digital silence include fear of making mistakes, discomfort in interacting, and limited communication between lecturers and students (Ayu Nurrohmah & Waloyo, 2023). In addition, Salas-Pilco et al. (2024) emphasized that silent participation, for example, not turning on the camera or only observing the material is a legitimate form of involvement in the context of online education, so educators need to have a strategy that is sensitive to nonverbal forms of involvement (Salas-Pilco et al., 2024). Qualitatively, Bazlan and Yazid (2025) highlight the experience of digital silence in Malaysian online classrooms, which often does not reflect indifference, but is a manifestation of social and cultural complexity (Bazlan & Yazid, 2025). This shows that digital silence is a multidimensional phenomenon that is closely related to psychological, social, and cultural factors in students' virtual classrooms.

Digital Health Literacy in Health Students

The level of digital health literacy in health students is very diverse and influenced by educational, social, and cultural factors. A study in Brazil by Silva et al. (2023) found that higher levels of digital health literacy were related to formal education backgrounds and habits of seeking science-based information, suggesting a literacy gap between student groups (Silva et al., 2023). Research conducted by Palumbo, Nicola, and Adinolfi (2022) shows that digital health literacy needs to be developed through a co-creation or co-production approach by directly involving students, in order to strengthen empowerment and increase their involvement in accessing health information (Palumbo et al., 2022). Meanwhile, a study conducted by Allen et al. (2022) with a mixed approach shows that students often rate their skills higher than their actual abilities, especially in evaluating the credibility of online health information. This

confirms the existence of a positive bias as well as the need for critical education programs (Allen et al., 2022).

Co-Design and Interactivity Approach in Health Literacy

The latest literature emphasizes the potential of interactive-based and co-design-based approaches in improving students' digital health literacy. Lewis et al. (2024) describe how the co-design approach can produce health education materials that are relevant, engaging, and appropriate to the needs of users (Lewis et al., 2024). In line with that, Aloi et al. (2025) conducted a co-design-based workshop involving students in the development of an educational application "mis-Adventures." The results of the study show that student involvement in the design process produces more contextual, relatable, and effective content to counter health misinformation (Aloi et al., 2025). Thus, students' active participation in the design process is an important factor in increasing the effectiveness of digital health literacy interventions.

Research Gap: Digital Silence and Digital Health Literacy in Online Health Education

Although the phenomenon of digital silence and digital health literacy has been widely researched, there is still very little research linking the two in the context of online health education. Research by Ayu Nurrohmah and Waloyo (2023) and Salas-Pilco et al. (2024) emphasizes the interaction aspect in online learning, but has not yet linked the phenomenon of digital silence to students' ability to understand health information. In contrast, the study conducted by Silva et al. (2023) and Allen et al. (2022) focused on digital health literacy, without including the passive dimension of digital engagement. Thus, there is significant research space to connect the two phenomena, especially in the context of midwifery and nursing students in Indonesia, which have distinctive social conditions and technological infrastructure.

Theoretical Foundations: Self-Efficacy, Online Participation, and Digital Health Literacy

Several theories are used to explain the relationship between the phenomenon of digital silence and digital health literacy. Allen et al. (2022) used Social Cognitive Theory to explain how self-efficacy plays an important role in students' ability to search, assess, and use digital health information. In the context of online participation, Salas-Pilco et al. (2024) explain that acknowledging forms of nonverbal participation can help lecturers develop more inclusive teaching strategies. Meanwhile, research by Lewis et al. (2024) shows that student involvement in the co-design process not only increases the relevance of the material, but also fosters confidence and self-efficacy in accessing and criticizing digital health information. The integration of these theories forms a strong conceptual framework for understanding the relationship between digital silence and digital health literacy in online health education.

METHODOLOGY

Research Design

This study uses mixed methods with an explanatory sequential design, where the quantitative stage is carried out first to test the relationship between digital silence and students' digital health literacy, then followed by a qualitative stage to deepen understanding of the factors that cause passive behavior. This approach was chosen because it is able to provide a comprehensive picture by combining the power of numerical data and qualitative narratives (Sasa & Kurniawan, 2023). The mixed method is increasingly used in health education studies because it is able to capture complex phenomena that cannot be explained with quantitative or qualitative data alone (Lamberti et al., 2022).

Population and Sampling

The population of this study is students of the midwifery and nursing study program in Semarang City who participate in distance learning in the 2024/2025 academic year. The sampling technique at the quantitative stage uses probability sampling with stratified random sampling, to ensure representation based on gender and study program. The number of quantitative respondents was set at 180 students, referring to the recommendation of calculating the minimum sample in regression analysis (Hair et al., 2021; Sasa et al., 2022). At the qualitative stage, purposive sampling was used to select 20 participants who showed variations in the level of digital silence (high, medium, low), with consideration to obtain rich and diverse data (Norris & Silva, 2021).

Data Collection Techniques

Data collection is carried out by two main techniques. First, a questionnaire for the quantitative stage, which consisted of two instruments: a digital silence scale adapted from the research of (Zhang et al., 2021), as well as a digital health literacy questionnaire modified from the student version of the European Health Literacy Survey Questionnaire (HLS-EU-Q47) (Stormacq et al., 2020). The instrument was tested for content validity through expert judgment from three health education lecturers and its reliability was tested with Cronbach's Alpha using SPSS, with a value of >0.70 considered reliable (Sasa, 2022). Second, in-depth interviews and focus group discussions for the qualitative stage, using semi-structured interview guidelines developed based on quantitative results, so that they can explore students' personal experiences related to psychological, social, and technological barriers.

Research Procedure

The research was carried out in three main stages. The first stage is preparation, which includes the preparation of instruments, validity tests, and the management of permits to the campus. The second stage is quantitative data collection, which is carried out through an online questionnaire with the coordination of lecturers teaching courses. The third stage is qualitative data collection, in the form of in-depth interviews and focused group discussions conducted online using the Zoom platform. The entire series of research lasted

for three months, paying attention to the ethical aspects of research, including informed consent, data confidentiality, and consent from students as research participants.

Data Analysis

Quantitative data were analyzed using multiple linear regression with the help of SPSS software version 26, to test the influence of digital silence on students' digital health literacy. Classical assumption tests (normality, multicollinearity, heteroscedasticity) are performed before the main analysis. Meanwhile, qualitative data was analyzed using a procedure-based thematic analysis method (Braun & Clarke, 2021), which included the coding process, theme identification, and interpretation. The results of the two stages were then integrated in the triangulation phase to strengthen the validity of the conclusions and provide a more comprehensive understanding of the relationship between digital silence and student digital health literacy.

RESULTS AND DISCUSSION

Respondent Description

This study involved 180 students of the midwifery and nursing study program in Semarang City as respondents. This number was chosen to provide a representative picture of the condition of health students in urban areas who face the challenges of distance learning. With a heterogeneous population, respondents reflect diversity in terms of gender, age, and study programs taken.

Based on gender distribution, 54% of respondents were female and 46% were male. This proportion shows a good enough balance so that the results of the study do not only represent the experience of one gender group. The dominance of female students can be interpreted as a reflection of the real proportion in certain health study programs, especially midwifery which is indeed more in demand by women. Meanwhile, the significant participation of male students, especially in nursing study programs, ensures a diversity of perspectives in research.

In terms of age, the majority of respondents are in the range of 19-20 years (68%), which are generally second to third year students. In this phase, students are in an academic transition period towards professional independence, characterized by an increasing need for independent learning skills, critical thinking, and the ability to access digital health information appropriately. As many as 20% of respondents are 18 years old, which reflects early year students who are still adapting to college learning patterns and the use of technology in education. The age group of 21-22 years old (12%) are final year students who are preparing to face professional practice and enter the world of health work. This age variation affects how students respond to online learning, including how they experience the phenomenon of digital silence and develop digital health literacy.

In terms of study programs, the distribution shows that 56% of students come from nursing majors, while 44% come from midwifery majors. These differences in academic backgrounds provide additional nuances in the analysis, as nursing students are generally more often involved in clinical-based learning

and practical skills, while midwifery students focus on maternal and reproductive health. Thus, their information needs and online learning patterns are also different, which can ultimately affect the level of participation and the tendency of digital silence in online classes.

Overall, the characteristics of these respondents show a representative diversity of health students in Semarang. This diversity enriches the research results while expanding the meaning of analysis, for example in comparing the tendency of digital silence in female and male students, or in seeing how nursing and midwifery students have different strategies in accessing and understanding digital health information. Thus, respondent descriptions not only function as demographic data, but also become an important foundation in understanding the dynamics of digital silence and digital health literacy of health students in the era of distance learning.

As a complement, data visualization in the form of three pie charts was used to describe the characteristics of the research respondents, namely the distribution of gender, age, and study program.

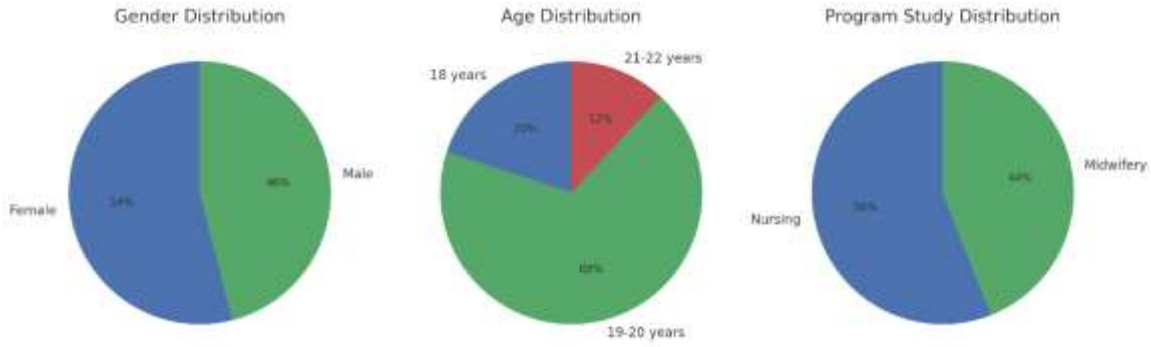

Figure 1. Characteristics of Respondents (N = 180)

Level of Digital Silence and Adolescent Health Literacy

The results of the study provide an important picture of how health students interact in distance learning and its relationship to their health literacy. The average digital silence score of students is at M = 3.42 (SD = 0.81) on a scale of 1–5, which is included in the medium to high category. This shows that quite a lot of students show a tendency to be passive, silent, or less engaged in online learning activities. This form of behavior can be in the form of not turning on the camera, rarely responding in the chat column, being reluctant to answer lecturers' questions, or just observing the course of learning without active contribution. Although silence does not necessarily mean indifference, this relatively high score indicates the influence of psychological factors (e.g. fear of wrongdoing, low self-confidence, or social anxiety) as well as the limitations of technology on emerging digital passive behaviors.

In contrast, students' digital health literacy levels were at an average score of M = 2.98 (SD = 0.74), which falls into the medium category. This means that students' ability to search, understand, and assess health information from digital sources is still limited. For example, they are able to access information related to

healthy diet, physical activity, or mental health, but are not fully able to assess the accuracy, credibility, and relevance of the information. In other words, even if access to information sources is available, the capacity to use them effectively in informed health decision-making is still not optimal.

The striking difference between the relatively high digital silence score and the level of digital health literacy that is only in the medium category shows an important linkage. The tendency to be passive has the potential to reduce students' opportunities to discuss, ask, or clarify health information with lecturers and peers. As a result, their health literacy does not develop optimally. This condition confirms that active participation and inclusive digital interaction are essential aspects in strengthening the digital health literacy of health students in the era of distance learning.

Table 1. Average Digital Silence and Digital Health Literacy Score

Variabel	Mean	SD	Category
Digital Silence	3.42	0.81	Medium–High
Digital Health Literacy	2.98	0.74	Keeping

The Relationship between Digital Silence and Health Literacy

Quantitative data analysis using multiple linear regression showed a significant relationship between digital silence and students' digital health literacy. The results of the analysis showed that digital silence had a significant negative influence on digital health literacy with a value of $\beta = -0.47$ and $p < 0.001$. This negative coefficient value confirms that every one unit increase in the digital silence score will be followed by a decrease in the digital health literacy score. In other words, the higher the tendency of students to be passive or silent in online learning, the lower their ability to understand, evaluate, and use health information obtained from digital media.

In addition, the regression model used was able to explain 22% of the digital health literacy variance (Adjusted $R^2 = 0.22$). This figure shows that almost a quarter of the variation in students' digital health literacy abilities can be predicted by the level of digital silence. Although there are still other factors that play a role (78%), these results still confirm that digital silence is one of the important determinants that should not be ignored in digital-based health education.

Visualization of this relationship can be seen in Figure 2, in the form of a scatter plot with linear regression lines that show a negative trend between digital silence and digital health literacy. The data points describe the individual scores of students, while the red lines show the direction of the relationship. It is clear that students with high digital silence scores tend to have low digital health literacy scores, while students with low digital silence scores are more likely to have better levels of digital health literacy.

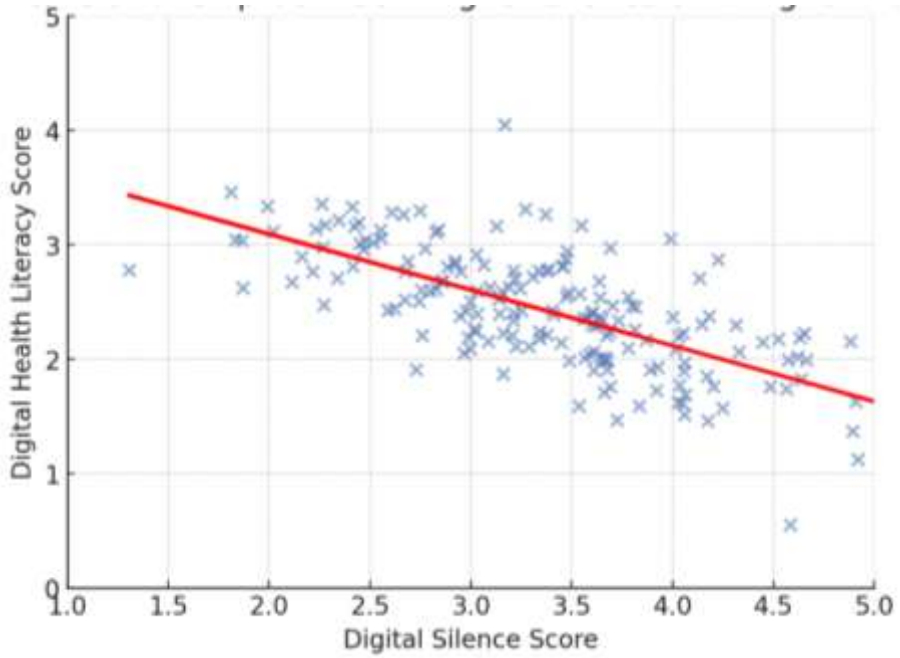

Figure 2. The Relationship between Digital Silence and Digital Health Literacy

These findings reinforce the suspicion that passive behavior in the digital space is not only a technical phenomenon, but also has serious consequences for students' ability to access and utilize health information. If digital silence continues to be left without intervention, then the potential to increase digital health literacy through distance learning will be hampered. Therefore, it is important for educators and curriculum designers to develop strategies that are able to encourage active student participation in virtual classrooms.

Factors Causing Digital Silence

The results of in-depth interviews with 20 midwifery and nursing students revealed that there are three main themes that are factors that cause digital silence in the online learning process. The three themes include psychological barriers, limited interactions, and technological constraints. These factors are interrelated and reinforce the tendency of students to choose silence rather than active participation.

Psychological Barriers

A total of 12 informants (60%) stated that psychological factors were the dominant cause of the emergence *digital silence*. Many students feel afraid of making mistakes when speaking in front of lecturers or friends, are embarrassed to turn on the camera due to physical conditions or the surrounding environment, and lack confidence in expressing opinions. One of the informants stated: "*When I turn on the camera or talk, I am often afraid of making a mistake and worried about being laughed at by friends. So it's better to just keep quiet.*" (Informant P3, interview July 12, 2025). Similar things were also expressed by other informants: "*I feel less confident, especially if I am asked directly by the lecturer. It feels*

tense and safer if you don't answer." (Informant P11, interview July 16, 2025). These findings show that psychological factors are closely related to students' sense of security and comfort in the digital space.

Limitations of Interaction

As many as 10 informants (50%) revealed that the limited interaction between lecturers and students also strengthened the emergence of *digital silence*. According to them, the communication pattern in online classes tends to be one-way, where lecturers are more dominant in delivering material while students only listen. The lack of a safe space for discussion also makes students reluctant to be actively involved. An informant revealed: "*Usually lecturers only explain continuously, rarely giving opportunities to ask questions. If there is, the time is very short and sometimes there is no response.*" (Informant P7, interview July 14, 2025). Another informant added: "*We actually want discussion, but there is no dedicated forum or supportive space. So in the end it's just listening.*" (Informant P15, interview July 18, 2025). These findings suggest that less participatory digital learning designs can exacerbate students' tendency to be silent.

Technology Constraints

A total of 8 informants (40%) reported that technological constraints were also a triggering factor *digital silence*. Unstable internet connections, limited devices such as low-capacity mobile phones, and disruptions in the learning environment at home make students choose to be passive. An informant said: "*My internet is often interrupted, so if you want to ask the lecturer, you are often late to answer. It's also a shame if the connection isn't smooth.*" (Informant P5, interview July 13, 2025). Similar things were conveyed by another informant: "*I used a cellphone that was old for a long time, the camera was blurry. So it's rare that I turn on my camera while studying online.*" (Informant P18, interview July 20, 2025). These technological constraints show that there is a digital access gap that also strengthens the phenomenon *digital silence* among health students.

Table 2. Summary of Factors Causing Digital Silence

Key Factors	Number of Informants	Percentage
Psychological barriers	12	60%
Limitations of interaction	10	50%
Technological constraints	8	40%

DISCUSSION

This study revealed a significant negative relationship between digital silence and digital health literacy of midwifery and nursing students in the context of online learning, with a regression coefficient of $\beta = -0.47$ ($p < 0.001$) and an Adjusted R^2 value of 0.22. These quantitative findings are reinforced by

qualitative data from in-depth interviews, which show that students with high digital silence scores tend to have a low understanding of digital health information. This confirms that silence in the digital space is not a form of neutral participation, but rather an obstacle that reduces the quality of interaction and understanding of health learning content.

Theoretically, these results are in line with the perspective of Self-Efficacy Theory which states that self-efficacy affects an individual's ability to search, evaluate, and use information (Taba et al., 2022). The findings of this study are also consistent with studies that show a positive correlation between health literacy and general self-efficacy in adolescents (Smith & Yilmaz, 2023). In the digital context, students who are passive in the learning space tend to have low self-efficacy, so they are reluctant to be actively involved in both asking questions and discussing, which ultimately weakens the understanding of health information. This is different from the previous view that considered digital silence as a legitimate form of nonverbal participation (Salas-Pilco et al., 2024); In this study, silence was actually proven to weaken students' digital health literacy.

An important contribution of this research is to expand the perspective on digital silence by linking it directly to digital health literacy. This study provides empirical evidence that digital silence significantly inhibits students' capacity to understand, assess, and use digital health information. Within the framework of the concept of Connectivism, which emphasizes that learning is the process of connecting various knowledge networks (Mukhlis et al., 2024), digital silence can be understood as an obstacle in forming connections between information sources and peer learning. As a result, students who are not active in digital discussions miss out on the opportunity to build broader and meaningful patterns of understanding.

Practically, these findings confirm the need for learning strategies that minimize digital silence. Educators and curriculum designers need to create digital learning spaces that provide a sense of psychological security, provide interactive discussion forums, and encourage active student engagement. Strategies such as co-design learning, utilization of structured discussions, and the use of digital ice-breakers have been proven to increase participation (Lewis et al., 2024; Chacon et al., 2023). In addition, the provision of adequate access to technology such as device support and a stable internet connection is also very important, considering that technical constraints have proven to be one of the factors that strengthen digital silence in qualitative interviews.

Although it makes an important scientific contribution, this research has some limitations. *First*, cross-sectional design limits the ability to identify the causal direction of the relationship between digital silence and health literacy. *Second*, the sample that only comes from Semarang City limits the generalization of the findings to other regions, especially with social, cultural, and technological infrastructure differences. *Third,* the Adjusted R^2 value of 22% indicates that most of the digital health literacy variants are still influenced by other factors, such as family support, mental health status, or media literacy that need to be explored in the next study. In addition, qualitative and quantitative data based on student

self-reports have the potential to be biased; Researchers can then consider direct observations to reinforce validity.

Based on these findings and limitations, follow-up research should use longitudinal or experimental designs to prove the effects of interventions in reducing digital silence and improving digital health literacy, for example, by piloting "student-led talking circles" (Chacon et al., 2023). In addition, it is important to expand the scope of the sample to rural and urban areas from various provinces so that the research results are more representative. The research also needs to include additional variables such as media literacy, peer group support, and student psychological conditions. Thus, this research not only enriches the academic literature, but also provides a practical basis for designing a more inclusive and effective online learning environment in improving the digital health literacy of health students.

CONCLUSIONS AND RECOMMENDATIONS

This study proves that digital silence has a significant negative influence on the digital health literacy of midwifery and nursing students in the context of distance learning. Students who tend to be passive in digital interactions show lower abilities in understanding, evaluating, and using health information. Quantitative analysis with linear regression showed that digital silence contributes to reducing digital health literacy, while qualitative analysis reinforces these findings by identifying psychological barriers, interaction limitations, and technological constraints as the dominant factors driving the emergence of silent behavior in the digital space.

Theoretically, the results of this study contribute to strengthening the understanding of the role of digital interaction in health education, especially related to the consequences of students' passive involvement in the online environment. From a practical perspective, these findings emphasize the need for a more participatory, psychologically safe learning strategy supported by adequate technological infrastructure to minimize digital silence while improving students' digital health literacy. Thus, this study not only provides empirical evidence, but also presents important implications for educators and policymakers in designing distance learning models that are more inclusive, interactive, and oriented towards improving the quality of healthy lives of students in the future.

FURTHER STUDY

Further studies are suggested to explore the phenomenon of digital silence in a wider range of health education programs and across different cultural or institutional contexts to determine its broader impact on digital health literacy. Future research could also investigate the moderating role of factors such as teaching style, peer support, and digital platform design in reducing passive online behavior. In addition, longitudinal studies would be valuable to track changes in students' digital interaction patterns and literacy development over time, providing deeper insights for designing distance learning models that effectively balance participation, psychological safety, and technological accessibility.

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