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Breaking the Data Barrier: Teaching Health Informatics and Big Data Literacy to Health Sciences Students

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Abstract: The rapid digitalization of healthcare has increased the need for graduates who can understand, interpret, and responsibly use health-related data. However, students entering health and technology-related programs may encounter barriers when learning health informatics and big data, particularly when technical concepts must be connected with clinical and professional contexts. This qualitative study explored students' experiences of learning health informatics and big data literacy through an interdisciplinary learning approach at Universitas 'Aisyiyah Palembang. The study involved 30 undergraduate students, consisting of 20 Information Technology students and 10 Nursing students, and was conducted from 12 March to 1 April 2026. Data were collected through classroom observations, students' reflective responses, semi-structured interviews, and learning artifacts, and were analyzed using thematic analysis. The findings revealed five interconnected themes: encountering the data barrier, moving from technical complexity toward meaningful understanding, learning through disciplinary complementarity, connecting healthcare data with professional practice, and developing confidence and responsible data awareness. The findings indicate that students' difficulties were not limited to technical skills but also involved unfamiliar terminology, contextual interpretation, disciplinary differences, and uncertainty about the responsible use of health information. Interdisciplinary learning provided opportunities for Information Technology and Nursing students to exchange complementary perspectives, connecting technological knowledge with clinical meaning. The study concludes that health data literacy should be understood as a multidimensional competency involving data understanding, interpretation, contextualization, communication, and ethical use. Interdisciplinary health informatics education can therefore serve as a meaningful pedagogical pathway for preparing future professionals to participate in increasingly data-driven healthcare environments.

Keywords: health informatics, big data literacy, health sciences education, digital health

Abstrak: *Digitalisasi layanan kesehatan yang pesat telah meningkatkan kebutuhan akan lulusan yang dapat memahami, menafsirkan, dan menggunakan data kesehatan secara bertanggung jawab. Namun, mahasiswa yang memasuki program kesehatan dan teknologi mungkin menghadapi hambatan saat mempelajari informatika kesehatan dan big data, terutama ketika konsep teknis harus terhubung dengan konteks klinis dan profesional. Studi kualitatif ini mengeksplorasi pengalaman mahasiswa dalam mempelajari informatika kesehatan dan literasi big data melalui pendekatan pembelajaran interdisipliner di Universitas 'Aisyiyah Palembang. Studi ini melibatkan 30 mahasiswa sarjana, terdiri dari 20 mahasiswa Teknologi Informasi dan 10 mahasiswa Keperawatan, dan berlangsung dari 12 Maret hingga 1 April 2026. Data dikumpulkan melalui observasi di kelas, respons reflektif siswa, wawancara semi-terstruktur, dan artefak pembelajaran, serta dianalisis menggunakan analisis tematik. Temuan tersebut mengungkapkan lima tema yang saling terkait: menghadapi hambatan data, beralih dari kompleksitas teknis menuju pemahaman yang bermakna, belajar melalui komplementaritas disipliner, menghubungkan data kesehatan dengan praktik profesional, serta mengembangkan kepercayaan diri dan*

kesadaran data yang bertanggung jawab. Temuan menunjukkan bahwa kesulitan siswa tidak terbatas pada keterampilan teknis tetapi juga melibatkan terminologi yang tidak familiar, interpretasi kontekstual, perbedaan disiplin, dan ketidakpastian tentang penggunaan informasi kesehatan yang bertanggung jawab. Pembelajaran interdisipliner memberikan kesempatan bagi mahasiswa Teknologi Informasi dan Keperawatan untuk bertukar perspektif yang saling melengkapi, menghubungkan pengetahuan teknologi dengan makna klinis. Studi ini menyimpulkan bahwa literasi data kesehatan harus dipahami sebagai kompetensi multidimensi yang melibatkan pemahaman data, interpretasi, kontekstualisasi, komunikasi, dan penggunaan secara etis. Pendidikan informatika kesehatan interdisipliner dapat menjadi jalur pedagogis yang bermakna untuk mempersiapkan calon profesional berpartisipasi dalam lingkungan kesehatan yang semakin berbasis data.

Kata Kunci: *informatika kesehatan, literasi big data, pendidikan ilmu kesehatan, kesehatan digital*

INTRODUCTION

Healthcare is undergoing a profound transformation as digital technologies increasingly shape how health information is collected, stored, exchanged, interpreted, and used in clinical decision-making. Electronic health records, digital health platforms, telemedicine, mobile health applications, clinical information systems, and data-driven decision-support technologies have changed the nature of contemporary healthcare work. As a result, healthcare professionals are no longer expected to interact only with patients and clinical procedures; they are also required to engage with increasingly complex forms of digital information. The ability to understand, interpret, evaluate, and use health data responsibly has therefore become an important component of professional competence in the digital healthcare environment. For students preparing to enter health-related professions, exposure to health informatics and data literacy is consequently becoming less of an additional technological skill and more of a foundational educational requirement.

The growing volume and complexity of healthcare data make this educational challenge even more significant. Healthcare data are generated from diverse sources, including electronic health records, laboratory systems, medical devices, administrative databases, patient-generated data, mobile applications, and population health systems. The concept of big data in healthcare extends beyond the amount of information available; it also involves the diversity, speed, reliability, and potential value of data for improving healthcare processes and outcomes. Students therefore need to move beyond simply accessing digital information (Lee, M., Vyas, P, 2024) They need to understand where data come from, how data are organized, what patterns may be meaningful, what limitations may exist, and how data can be translated into responsible decisions. In this sense, big data literacy involves not only technical familiarity but also critical interpretation and contextual understanding (Mazzotta, R., Barchitta, M., Alvaro, R., & Agodi, A, 2024).

This challenge is particularly relevant in health sciences education. Previous research has indicated that nursing and other health students may possess moderate or relatively high perceptions of information literacy while demonstrating more limited applied abilities, suggesting that knowing the importance of information does not necessarily mean being able to use it effectively in practice (Lawrence, K., & Levine, D. L, 2024). A recent scoping review of information literacy among higher education health students, for example, identified a distinction between perceived and applied information literacy and emphasized the need to integrate information literacy across

curricula rather than treating it as an isolated conceptual topic. Similarly, research on nursing students has highlighted continuing gaps in digital health education and the need for stronger curricular integration to prepare students for increasingly digitalized clinical environments. These findings suggest that the central educational problem may not simply be students' access to technology, but their ability to make meaningful sense of digital information within professional contexts (World Health Organization, 2010).

Health informatics education faces a related difficulty. Informatics is inherently interdisciplinary because it sits at the intersection of information, technology, people, organizational processes, and professional practice. For nursing students, health informatics must ultimately connect with patient care, clinical documentation, evidence-based practice, and professional decision-making. For Information Technology students, meanwhile, the emphasis may be placed more strongly on data structures, information systems, computational processes, software, and technological infrastructures. These different disciplinary orientations can create a productive learning opportunity, but they can also create a barrier. Students may understand the same health data differently because they approach it through different professional languages and assumptions. Research on multidisciplinary nursing informatics curriculum development has identified differences in terminology, ways of thinking, role expectations, and methodological perspectives as challenges to interdisciplinary collaboration.

The need to bridge these disciplinary perspectives has become increasingly visible in recent health informatics education research. Recent qualitative research involving nursing and health information management students found that structured interprofessional learning could strengthen students' understanding of professional roles, collaboration, communication, and readiness for interprofessional practice. The findings also suggested that early and sustained interaction across disciplines is important for reducing professional silos and developing collaborative competencies (Kleib, M 2024) Likewise, a recent study of design-based learning in nursing informatics reported that authentic informatics activities could support interdisciplinary thinking, informatics skill development, professional identity, and teamwork. These studies point toward an important pedagogical possibility: students may understand health data more deeply when technical and professional perspectives are brought together rather than taught in isolation (World Health Organization, 2025).

However, much of the existing literature has focused on measuring informatics competency, digital health literacy, or students' preparedness for technology-mediated healthcare. Systematic and scoping reviews have documented the importance of nursing informatics and digital health education, while recent intervention studies have examined changes in informatics competency following structured courses or design-oriented learning. Although these studies provide important evidence regarding what students should learn and which competencies are needed, less attention has been given to the students' lived learning experiences when health informatics and big data are introduced through an interdisciplinary learning environment involving both technology-oriented and clinically oriented students. In particular, there remains a need to understand what students perceive as difficult, how they negotiate unfamiliar data concepts, how they connect technical information with healthcare contexts, and how interaction with students from another discipline may reshape their understanding of data (World Health Organization, 2026).

This issue is especially important in the Indonesian higher education context,

where the rapid digitalization of healthcare requires educational institutions to prepare graduates who can participate meaningfully in data-driven healthcare systems. Yet, the transition from conventional health-related learning toward data-intensive and digitally mediated learning is not always straightforward. Students may encounter what can be described as a "data barrier": a combination of unfamiliar terminology, limited experience with health information systems, uncertainty in interpreting data, differences in disciplinary knowledge, and concerns about using health information appropriately. The barrier is therefore not necessarily a lack of technological access. It may instead emerge at the point where students are expected to connect data with meaning, technology with practice, and information with professional judgment.

Against this background, the present study explores the experiences of undergraduate students participating in health informatics and big data literacy learning at Universitas 'Aisyiyah Palembang. The study involved 30 undergraduate students, consisting of 20 students from the S1 Information Technology program and 10 students from the S1 Nursing program. The learning activities were conducted from 12 March to 1 April 2026 and brought together students with substantially different disciplinary orientations. Rather than evaluating the intervention primarily through numerical achievement scores, this study seeks to understand how students experienced the learning process, what barriers they encountered, how they interpreted health data, and how interdisciplinary interaction influenced their developing understanding of health informatics and big data.

Accordingly, this study addresses the following research questions: (1) How do Information Technology and Nursing students experience learning health informatics and big data literacy? (2) What barriers do students encounter when learning to understand and interpret healthcare data? (3) How do students perceive the contribution of interdisciplinary interaction to their understanding of health data? and (4) How does the learning experience shape students' perceptions of the relevance of health informatics and big data literacy to their future professional roles?

By addressing these questions, the study contributes to the growing discussion on digital and data literacy in health professions education from a qualitative and interdisciplinary perspective. Rather than treating students as passive recipients of technological knowledge, the study positions them as learners negotiating the meaning of data within different professional contexts. The central argument is that breaking the data barrier requires more than teaching students how data work; it requires creating learning experiences in which students can connect data, technology, professional knowledge, and human health. This perspective may offer a useful pedagogical direction for higher education institutions seeking to prepare future professionals for increasingly data-driven healthcare environments.

METHODOLOGY

Research Design

This study employed a qualitative descriptive design to explore students' experiences, perceptions, challenges, and learning responses during the implementation of health informatics and big data literacy education (Marlini et al., 2021). A qualitative approach was considered appropriate because the study did not aim to measure the effectiveness of the learning intervention through numerical achievement scores, but rather to understand how students experienced the learning process and how they constructed

meaning from unfamiliar concepts related to healthcare data and digital health technologies (Umar & Purwanto, 2025).

The study was particularly concerned with the notion of a "data barrier," referring to the difficulties students experienced when attempting to understand, interpret, and contextualize healthcare data. The barrier was examined not simply as a technical difficulty but as a multidimensional phenomenon involving students' prior knowledge, disciplinary background, unfamiliar terminology, confidence in dealing with data, ability to connect data with healthcare contexts, and interaction with peers from another academic discipline. The qualitative design therefore enabled the researchers to capture both individual experiences and the interpersonal processes that emerged during interdisciplinary learning (Purwanto, Nurdianingsih, F., Afini, V., & Nozylianty, 2024; Purwanto et al., 2020).

Research Setting and Participants

The study was conducted at Universitas 'Aisyiyah Palembang, Indonesia, from 12 March to 1 April 2026. The participants were 30 undergraduate students from two academic programs: 20 students from the S1 Information Technology program and 10 students from the S1 Nursing program. The two groups were intentionally brought together because they represented complementary disciplinary perspectives relevant to health informatics education.

The Information Technology students generally approached health data from a technological perspective, including information systems, data management, digital platforms, and computational processes (Rahmawati et al., 2026). The Nursing students, in contrast, approached the learning activities from a healthcare and patient-care perspective, with greater familiarity with clinical situations, patient information, and nursing practice. This disciplinary contrast was considered an important feature of the learning environment because the study sought to examine how students with different knowledge backgrounds interpreted the same health-related data and interacted during interdisciplinary learning activities (Faridatul, F., & Purwanto, 2025; Kosali et al., 2026).

Participants were selected purposively based on their involvement in the learning activities during the study period. Participation was voluntary, and students were informed about the purpose and procedures of the study before data collection. Their participation or non-participation did not affect their academic standing.

Learning Context and Instructional Activities

The learning intervention was organized around the introduction of health informatics and big data concepts through contextualized and interdisciplinary learning activities. Rather than presenting big data solely as a technical subject, the learning activities connected data concepts with healthcare situations that could be understood from both technological and clinical perspectives.

The learning process was conducted through several interconnected stages. The first stage introduced students to health informatics and the growing role of digital technologies in healthcare. Students were introduced to concepts such as electronic health records, health information systems, digital health platforms, and the role of information in healthcare decision-making (Febrianti, V., & Purwanto, 2026; Herawati et al., 2025).

The second stage focused on understanding healthcare data. Students explored different types and sources of health data, including demographic information, clinical records, laboratory results, administrative information, and other forms of digitally

generated healthcare information. Particular attention was given to the distinction between raw data, information, and meaningful interpretation.

The third stage introduced the concept of big data in healthcare. Students discussed the characteristics of big data, including volume, velocity, variety, veracity, and value, and examined how these characteristics could be observed in contemporary healthcare environments. Examples and simulated cases were used to prevent the discussion from becoming overly abstract or technically oriented.

The fourth stage involved data interpretation activities. Students were provided with simplified healthcare datasets, tables, visualizations, or simulated health information and were asked to identify patterns, compare information, interpret trends, and discuss possible implications. The emphasis was placed on asking meaningful questions about data rather than merely producing numerical calculations.

The fifth stage addressed ethical and responsible use of health data. Students discussed issues related to privacy, confidentiality, data security, responsible data sharing, and the potential consequences of inappropriate use of patient information. This component was particularly important because healthcare data contain information about real or simulated individuals and therefore require a different level of responsibility from ordinary datasets.

The final stage emphasized interdisciplinary collaboration. Information Technology and Nursing students worked together on selected health data tasks. Information Technology students were encouraged to contribute perspectives related to data organization, digital systems, and technological processes, while Nursing students contributed clinical and patient-care perspectives. Through these activities, students were encouraged to negotiate meanings, explain disciplinary concepts to one another, and consider how technical information could be connected to healthcare practice.

Data Sources and Data Collection

Data were collected from multiple qualitative sources to provide a more comprehensive understanding of students' learning experiences. The primary data sources consisted of classroom observations, students' reflective responses, semi-structured interviews, and learning artifacts produced during the instructional activities.

Classroom observations were conducted throughout the learning period. The observations focused on students' engagement, questions, expressions of difficulty, peer interaction, collaboration between Information Technology and Nursing students, and the ways students responded to health informatics and big data tasks. Particular attention was given to moments in which students appeared to experience confusion, uncertainty, increased confidence, or changes in their understanding.

Students' reflective responses were collected after selected learning activities. Students were encouraged to describe what they had learned, which concepts they considered difficult, how they connected the material with their academic background, and how interaction with students from another discipline affected their learning. Reflection was also used to identify students' perceptions of the relevance of health informatics and big data literacy to their future professional roles.

Semi-structured interviews were conducted with selected participants after the learning activities. The interviews explored students' initial perceptions of health informatics and big data, experiences during the learning process, perceived barriers, changes in confidence, interdisciplinary interaction, and perceived relevance of data literacy. The semi-structured format allowed the researchers to maintain consistency

across interviews while providing opportunities for participants to elaborate on experiences that they considered important.

Learning artifacts were also examined as supporting qualitative evidence. These included students' responses to data interpretation tasks, group discussion outputs, case analyses, and other products generated during the learning activities. The artifacts were not treated as formal achievement scores but as evidence of how students interpreted and communicated their understanding of health data.

The use of multiple data sources enabled methodological triangulation. Observational data provided evidence of students' behavior and interaction, reflective responses captured students' own perceptions, interviews allowed deeper exploration of individual experiences, and learning artifacts provided evidence of students' developing interpretations.

Research Instruments

The researchers served as the primary instruments in data collection and interpretation, supported by observation guidelines, semi-structured interview protocols, reflection prompts, and documentation procedures.

The observation guideline focused on several dimensions: students' engagement with the learning materials, difficulties in understanding terminology and concepts, responses to data interpretation activities, interaction across disciplines, willingness to ask questions, collaboration, and changes in confidence.

The interview protocol included questions such as:

1. How did you understand health informatics before participating in this learning activity?
2. What did you initially find difficult about learning health data and big data?
3. Which activities helped you understand the concepts more clearly?
4. Did working with students from another discipline influence your understanding? Why?
5. What difficulties did you experience when interpreting healthcare data?
6. How did your confidence change during the learning process?
7. How relevant do you consider health informatics and big data literacy to your future profession?
8. What should be improved in future health informatics learning activities?

The reflection prompts were designed to encourage students to move beyond simply describing what happened. Students were asked to reflect on what they understood, what remained unclear, how their disciplinary background influenced their interpretation, and what they learned from peers in the other program.

Data Analysis

The qualitative data were analyzed using thematic analysis. The analysis followed an iterative process consisting of familiarization with the data, initial coding, development of categories, identification of candidate themes, review of themes, definition and naming of themes, and interpretation.

First, all interview transcripts, observation notes, reflective responses, and relevant learning artifacts were reviewed repeatedly to develop familiarity with the data. During this stage, the researchers noted recurring expressions, unexpected observations, and statements related to students' difficulties and learning experiences.

Second, meaningful segments of data were assigned initial codes. Examples of preliminary codes included “unfamiliar terminology,” “difficulty interpreting data,”

"technical confidence," "clinical context," "fear of making mistakes," "peer explanation," "data relevance," "ethical concern," and "increased confidence."

Third, related codes were grouped into broader categories. For example, codes related to unfamiliar terminology, difficulty understanding datasets, and uncertainty about data interpretation could be grouped under a broader category of conceptual difficulty. Similarly, peer explanation, collaborative problem-solving, and disciplinary knowledge exchange could be grouped under interdisciplinary learning.

Fourth, categories were compared across data sources and participant groups to identify broader themes. Particular attention was given to similarities and differences between Information Technology and Nursing students. The analysis did not assume that one group was more capable than the other; instead, differences were interpreted in relation to students' prior disciplinary knowledge and the specific demands of the learning tasks.

Finally, the themes were interpreted in relation to the study's central concept of the data barrier. The analysis sought to determine how barriers emerged, how students attempted to overcome them, and whether interdisciplinary interaction contributed to this process.

Trustworthiness

Several strategies were employed to strengthen the trustworthiness of the qualitative findings. First, data triangulation was conducted by comparing observations, student reflections, interview accounts, and learning artifacts. Second, researcher discussions were used to compare interpretations of emerging codes and themes and to reduce the possibility that findings reflected a single researcher's interpretation. Third, participant quotations were retained during the analysis process to ensure that emerging themes remained grounded in students' own accounts.

The researchers also maintained an analytic record documenting coding decisions, emerging categories, revisions of themes, and interpretive decisions throughout the analysis. Contradictory or negative cases were not automatically excluded; instead, they were examined as potentially important evidence of differences in students' experiences. This approach was particularly relevant because students entered the learning environment with different disciplinary backgrounds and levels of familiarity with digital technologies.

Ethical Considerations

Ethical principles were considered throughout the study. Students were informed about the purpose of the research, the voluntary nature of participation, and the use of their responses and learning experiences for research purposes. Participants' identities were protected through the use of pseudonyms or participant codes in the research records and reporting. Any health-related examples used during the learning activities were presented in simulated, anonymized, or otherwise non-identifiable forms to avoid exposing personal health information.

Students were also informed that their participation in interviews, reflections, and observations would not influence their academic evaluation. Data were stored securely and accessed only for research purposes. The reporting of findings emphasized participants' experiences rather than individual academic performance, thereby maintaining confidentiality and minimizing potential risks associated with participation.

RESULT AND DISCUSSION

Result

The thematic analysis of classroom observations, students' reflective responses, semi-structured interviews, and learning artifacts revealed several interconnected patterns in students' experiences of learning health informatics and big data literacy. Rather than experiencing the learning process simply as an introduction to new technological concepts, students appeared to negotiate a broader set of challenges involving unfamiliar terminology, interpretation of healthcare data, confidence in dealing with data, and the connection between technical information and professional practice.

The analysis also indicated that students' disciplinary backgrounds shaped how they approached the learning activities. Information Technology students tended to engage more readily with the technical and structural aspects of data, whereas Nursing students were more likely to interpret data through clinical situations, patient needs, and healthcare practice. These differences did not necessarily function as obstacles throughout the learning process. In several learning activities, they became a basis for peer explanation, knowledge exchange, and collaborative interpretation.

Overall, the findings were organized into five interconnected themes: (1) encountering the data barrier, (2) moving from technical complexity toward meaningful understanding, (3) learning through disciplinary complementarity, (4) connecting healthcare data with professional practice, and (5) developing confidence and responsible data awareness. The themes illustrate a gradual learning process in which students moved from uncertainty about health data toward a more contextual and professionally oriented understanding of health informatics and big data.

Encountering the Data Barrier

The first theme concerned students' initial encounters with health informatics and big data concepts. At the beginning of the learning activities, students' difficulties were not limited to the technical aspects of data. They also involved unfamiliar terminology, uncertainty about the meaning of health-related datasets, and difficulty understanding how apparently simple pieces of information could become useful for healthcare decision-making.

For some students, the term “big data” initially appeared to be associated mainly with large amounts of complicated numerical information or advanced computer technology. This perception created a psychological and conceptual distance between students and the learning material. Students who had limited prior exposure to health information systems tended to require additional explanation before they could connect abstract concepts such as data integration, data quality, and data interpretation with concrete healthcare situations.

The observations also suggested that students' difficulties became more visible when they were asked to interpret data rather than simply recognize definitions. Students could generally identify familiar terms after explanation, but interpreting relationships between variables, identifying meaningful patterns, or explaining the implications of data required more extensive discussion. In this sense, the initial barrier was not simply a lack of knowledge. It involved the transition from knowing what data are to understanding what data mean.

Students' reflections further indicated that prior disciplinary experience influenced the nature of this barrier. Information Technology students appeared to have

greater familiarity with technological terminology and data structures, while Nursing students could more readily recognize the practical significance of information when it was presented through clinical examples. However, neither disciplinary background completely eliminated the difficulty of interpreting health data. The challenge emerged differently for each group.

This finding suggests that the "data barrier" should be understood as multidimensional. It included conceptual unfamiliarity, disciplinary distance, uncertainty in interpretation, and limited experience in connecting digital information with professional decisions.

From Technical Complexity to Meaningful Understanding

The second theme concerned the gradual movement from abstract technological concepts toward contextual understanding. Students' responses suggested that learning became more accessible when health informatics and big data concepts were presented through concrete healthcare situations rather than through definitions alone.

The use of simulated healthcare cases, examples of patient information, health datasets, digital health systems, and data visualizations provided students with a contextual bridge between theory and practice. Instead of asking students only to define big data or describe health information systems, the learning activities encouraged them to consider questions such as what the data represented, why particular information mattered, and how the information could potentially support healthcare decisions.

This contextualization appeared particularly important for students who initially perceived big data as a highly technical subject. When concepts were connected to familiar healthcare situations, students could gradually move from viewing data as abstract numbers toward understanding data as representations of patients, clinical conditions, healthcare processes, and population health patterns.

The learning process therefore involved a shift from technical recognition to contextual interpretation. Students were not necessarily required to master advanced computational procedures. Rather, they were encouraged to understand the logic behind healthcare data and to recognize the relationship between data, information, and decision-making.

Students' learning artifacts provided additional evidence of this development. In early activities, responses tended to focus on identifying information contained in the dataset. In subsequent activities, students were encouraged to explain patterns, compare information, identify possible problems, and discuss the relevance of findings to healthcare situations. This progression indicates that contextualized activities provided an important pathway for making unfamiliar data concepts more meaningful.

Learning Through Disciplinary Complementarity

The third theme emerged from the interaction between Information Technology and Nursing students. The two groups entered the learning environment with different forms of prior knowledge, and these differences influenced how they approached healthcare data.

Information Technology students generally contributed perspectives related to data organization, information systems, digital platforms, data processing, and technological possibilities. Nursing students, on the other hand, contributed perspectives related to patient conditions, clinical situations, nursing procedures, and the practical meaning of health information.

During collaborative activities, these differences created opportunities for

students to explain concepts to one another. A technical explanation provided by an Information Technology student could be complemented by a Nursing student's explanation of why particular information mattered in a clinical context. Conversely, a Nursing student's interpretation of a patient-related situation could raise questions about how the information should be structured, stored, or processed within a digital system.

The interdisciplinary interaction therefore functioned as more than a classroom management strategy. It became part of the learning process itself. Students were exposed to ways of thinking that were not necessarily present within their own academic discipline. The interaction also encouraged students to recognize that healthcare data cannot be fully understood from a single disciplinary perspective.

An important finding was that disciplinary difference was not consistently experienced as a deficit. Under appropriate learning conditions, it became a resource for collaborative learning. The technical orientation of Information Technology students and the clinical orientation of Nursing students could complement one another, particularly when students were asked to interpret the same healthcare case from different professional perspectives.

Connecting Healthcare Data with Professional Practice

The fourth theme concerned students' developing recognition of the relevance of health informatics and big data to their future professional roles. Initially, some students may have viewed health informatics as primarily belonging to information technology or as an institutional system operating in the background of healthcare services. As learning activities became increasingly contextualized, however, students began to recognize that health data are directly connected to professional activities and decisions.

For Nursing students, the relevance of health data became more apparent when datasets and information systems were connected to patient documentation, clinical monitoring, healthcare decision-making, and continuity of care. The discussion shifted from “what information is stored?” toward “why does this information matter for patient care?”

For Information Technology students, the learning activities provided a different form of contextualization. Healthcare examples demonstrated that technical systems are not valuable merely because they can store or process large amounts of information. Their value depends partly on whether the information they manage is accurate, accessible, meaningful, secure, and useful to healthcare professionals.

This finding highlights an important distinction between technical capability and professional usefulness. Students were encouraged to consider that a technically functional health information system may still be problematic if the data are inaccurate, poorly interpreted, difficult to access, or disconnected from the needs of healthcare practitioners.

The interdisciplinary activities therefore helped position health informatics as a shared professional concern. Technology students could see the practical consequences of system design and data management, while Nursing students could see how their clinical information becomes part of a broader digital ecosystem.

Developing Confidence and Responsible Data Awareness

The fifth theme concerned changes in students' confidence and awareness of responsibility when interacting with health data. Students' initial uncertainty was not only cognitive but also affective. Some students were hesitant to interpret data because they were concerned about making incorrect conclusions or because they perceived the subject

as technically difficult.

Repeated exposure to contextual examples, guided interpretation, peer discussion, and collaborative problem-solving created opportunities for students to become more comfortable with unfamiliar concepts. Confidence appeared to develop gradually as students realized that understanding big data did not necessarily require them to become expert programmers or data scientists. Instead, they could contribute through their own disciplinary knowledge while learning the perspectives of others.

At the same time, the learning process introduced students to the ethical dimension of health data. Discussions of privacy, confidentiality, security, and responsible data use encouraged students to recognize that healthcare data are fundamentally different from ordinary datasets. Behind a data point may be an individual patient whose identity, condition, and personal information require protection.

This awareness broadened students' understanding of data literacy. Being data literate was not limited to being able to read a table or identify a trend. It also involved asking whether the data were appropriate, whether they could be trusted, how they should be interpreted, and whether they could be used responsibly.

The combination of confidence development and ethical awareness suggests that health informatics education should address both competence and responsibility. Students need to feel capable of interacting with data, but they also need to understand the consequences of using health information incorrectly.

Synthesis of the Qualitative Findings

Taken together, the five themes illustrate a gradual movement in students' learning experiences. The process began with unfamiliarity and uncertainty, particularly when students encountered technical terminology and abstract concepts related to health informatics and big data. Contextualized learning activities then provided a bridge between abstract concepts and recognizable healthcare situations. Interdisciplinary collaboration further expanded this process by allowing students to encounter complementary technical and clinical perspectives.

The findings suggest that breaking the data barrier was not a single moment of learning. Rather, it was an evolving process involving exposure, contextualization, interaction, interpretation, and reflection. Students' developing understanding emerged through the relationship between what they already knew, what they encountered during the learning activities, and what they learned from peers in another discipline.

The qualitative evidence consequently points toward a broader interpretation of health data literacy. For these students, becoming more data literate involved not only understanding technological concepts but also learning how to connect data with healthcare contexts, communicate across disciplinary boundaries, question information critically, and recognize the ethical responsibilities associated with health data.

Discussion

The findings of this study indicate that learning health informatics and big data literacy involves considerably more than introducing students to digital technologies, healthcare information systems, or the technical characteristics of large datasets. The students' experiences suggest that the main challenge lies in helping learners cross the distance between data and meaning. At the beginning of the learning process, unfamiliar terminology, abstract concepts, limited experience with healthcare datasets, and differences in disciplinary knowledge created a form of data barrier. As the learning

activities progressed, contextualized examples, collaborative interpretation, and interdisciplinary interaction helped students gradually negotiate this barrier. The findings therefore position health data literacy as a contextual and social learning process rather than simply an individual technical competency.

The Data Barrier as a Multidimensional Learning Challenge

One of the most important findings was that students' difficulties with health informatics and big data could not be explained simply by a lack of technological skills. Students encountered several interconnected forms of difficulty, including unfamiliar terminology, uncertainty about data interpretation, limited knowledge of healthcare information systems, and difficulty connecting abstract data concepts with professional practice. This finding is important because discussions of digital literacy sometimes emphasize access to technology or operational skills while giving less attention to the interpretive work required to make data meaningful.

The experience of the students in this study suggests that the data barrier emerges at the point where learners are required to move from recognizing information to interpreting its significance. A student may understand what a dataset is, for example, but still struggle to determine which variables are relevant, whether a pattern is meaningful, or what the information implies for healthcare practice. In health contexts, this distinction becomes particularly important because data are rarely neutral classroom objects. They represent patients, clinical conditions, healthcare processes, or populations.

This interpretation extends the concept of literacy from technical competence toward critical and contextual competence. Health data literacy requires students to ask not only "What does this data show?" but also "Why does this information matter?", "How reliable is it?", and "What could happen if it is interpreted incorrectly?" The data barrier, therefore, is partly epistemic: students are learning a new way of understanding information, not simply a new software tool.

The finding is consistent with recent literature emphasizing that information literacy in health education involves a distinction between perceived knowledge and applied ability. Students may recognize the importance of information and digital technologies while still requiring structured opportunities to apply those competencies in authentic contexts. This distinction helps explain why contextualized learning activities were important in the present study. Students needed opportunities to work with information before they could fully understand what it meant to be competent users of health data.

Contextualization as a Bridge from Technical Concepts to Healthcare Meaning

A second important finding concerns the role of contextualized learning. Students appeared to engage more meaningfully with health informatics and big data when abstract concepts were connected to concrete healthcare situations. This suggests that the pedagogical challenge is not necessarily to simplify big data concepts but to situate them within problems that students can recognize as professionally meaningful.

For Nursing students, healthcare contexts provided an immediate interpretive frame. Patient information, clinical records, health indicators, and healthcare decision-making could be related to situations that were closer to their professional identity. For Information Technology students, meanwhile, the healthcare context provided an opportunity to understand why data quality, information architecture, security, and system usability matter beyond the technical environment.

This finding reinforces the argument that health informatics education should not be positioned exclusively as a technology-oriented subject. Informatics operates within a complex sociotechnical environment in which technical systems interact with professionals, organizational processes, patients, and clinical decisions. Teaching students how data are structured without discussing how those data are used may produce technically competent learners who remain uncertain about the practical value of their knowledge.

The present findings consequently support a contextual approach in which students learn concepts such as big data, data quality, and information systems through healthcare problems. Such an approach can make unfamiliar concepts more concrete and may reduce the psychological distance between students and technology. In practical terms, students do not necessarily need to begin with sophisticated analytics. They can begin with a relatively simple question: What does this health data tell us, and why should a healthcare professional care?

Interdisciplinary Learning as a Mechanism for Breaking the Data Barrier

Perhaps the most distinctive finding of this study was the complementary role of Information Technology and Nursing students. The two groups approached health data from different disciplinary positions. Information Technology students tended to contribute knowledge concerning technological systems, data organization, and digital processes, whereas Nursing students brought greater attention to clinical situations, patient needs, and healthcare practice.

Rather than treating these differences as a problem, the learning activities created opportunities for them to become a pedagogical resource. Students could explain aspects of the same data from different perspectives, allowing one disciplinary interpretation to challenge or extend another. This process is particularly relevant to health informatics because healthcare technologies are rarely meaningful when separated from the professionals and patients who use them.

The finding supports the broader understanding of health informatics as an interdisciplinary field. Informatics requires collaboration among technical specialists and healthcare professionals because the quality of a digital health system depends not only on technological functionality but also on whether the system reflects real clinical needs. Recent research on interprofessional and multidisciplinary informatics education similarly suggests that interaction between students from different professional backgrounds can strengthen communication, role understanding, collaboration, and readiness for digitally mediated healthcare environments.

The present study adds an important pedagogical dimension to this discussion. Interdisciplinary interaction did not merely teach students about another profession. It helped them interpret data differently. A technical interpretation could be enriched by clinical knowledge, while a clinical interpretation could be reconsidered in light of how information is collected, structured, stored, or processed. In this sense, interdisciplinary learning served as a mechanism for breaking the data barrier because it expanded the interpretive resources available to students.

This finding also suggests that the most productive interdisciplinary learning does not require students to abandon their disciplinary identity. On the contrary, their disciplinary knowledge becomes valuable precisely because it is brought into dialogue with another perspective. The IT student does not need to become a nurse, and the Nursing student does not need to become a programmer. What they need is the ability to

understand enough of each other's professional perspective to collaborate around a shared healthcare problem.

From Data Consumers to Data Interpreters

Another significant implication of the findings is the shift from passive data consumption toward active data interpretation. At the beginning of the learning process, students tended to encounter health data as information that had already been produced by a system. The learning activities gradually encouraged them to question what the information represented, identify patterns, consider relevance, and discuss possible implications.

This shift is important for contemporary healthcare education. Digital health systems increasingly automate the production and presentation of information. Dashboards, electronic records, alerts, and analytical tools may make data more accessible, but accessibility does not guarantee understanding. Healthcare professionals still need to interpret information within a specific clinical, organizational, and ethical context.

For Nursing students, this means recognizing that digital documentation and clinical data are not simply administrative requirements. They can contribute to patient monitoring, continuity of care, communication, and decision-making. For Information Technology students, the implication is equally important: data systems should not be designed merely around technical efficiency. They need to support meaningful use by healthcare professionals.

The students' movement from identifying information toward discussing its meaning can therefore be understood as an early transition from data consumer to data interpreter. This transition is a critical component of big data literacy because the value of large datasets ultimately depends on people's capacity to interpret them appropriately and critically.

Confidence, Uncertainty, and the Human Side of Data Literacy

The findings also reveal an affective dimension of health data literacy. Students' uncertainty was not purely intellectual. Some students were hesitant to interpret unfamiliar datasets because they lacked confidence or were concerned about reaching an incorrect conclusion. This finding reminds us that data literacy is partly about willingness to engage with uncertainty.

Technical explanations alone may not resolve this problem. Students need structured opportunities to make tentative interpretations, discuss them with peers, receive clarification, and revise their understanding. In this sense, the classroom becomes a relatively safe environment for making mistakes before students encounter the consequences of data interpretation in professional settings.

The interdisciplinary setting may have contributed to this process because students could distribute the cognitive burden of interpretation. A Nursing student could ask an IT student about the structure of a dataset, while an IT student could ask a Nursing student about the clinical relevance of a particular variable. Such exchanges can reduce the assumption that one student must possess all the necessary knowledge individually (Alanazi, A. T, 2023).

The development of confidence should therefore not be interpreted simply as students becoming more comfortable with technology. It may represent a deeper change in students' perception of themselves as legitimate participants in conversations about data. This is particularly relevant for health sciences students who may initially believe

that data analytics belongs exclusively to specialists.

Data Literacy as an Ethical Competency

An additional finding concerns the emergence of ethical awareness. Students increasingly encountered health data not as ordinary numerical information but as information connected to real people. This distinction is fundamental. A dataset may appear abstract on a computer screen, yet individual variables can represent a patient's identity, diagnosis, treatment history, or vulnerability.

Consequently, health data literacy should incorporate ethical reasoning alongside technical and interpretive skills. Understanding privacy, confidentiality, data security, responsible sharing, and appropriate data use is essential because healthcare professionals may encounter sensitive information throughout their professional careers (Car, J., et al 2025).

This finding suggests that ethical issues should not be treated as a separate final topic in health informatics courses. They can be integrated into data interpretation activities from the beginning. For example, when students are asked to interpret a simulated patient dataset, they can simultaneously be asked which information should be visible, who should have access to it, and what risks may arise from inappropriate disclosure.

Such integration may help students understand that responsible data use is not an external rule imposed on technological practice. It is part of what makes data literacy meaningful in healthcare.

Implications for Health Informatics Education

The findings have several pedagogical implications. First, health informatics education should begin with students' existing knowledge rather than assuming that all learners possess the same level of technological or health-related literacy. The different backgrounds of IT and Nursing students demonstrate the importance of identifying disciplinary strengths and gaps before designing learning activities.

Second, big data should be introduced through contextualized healthcare problems. Students do not necessarily need advanced programming or sophisticated statistical modeling to develop foundational big data literacy. They need repeated opportunities to identify, interpret, question, and communicate information (Gilbert, J. H. V., Yan, J., & Hoffman, S. J, 2010).

Third, interdisciplinary learning can be deliberately incorporated into health informatics education. Bringing IT and health students together creates opportunities for students to experience how the same data can be interpreted differently depending on professional perspective. Such interaction may help prepare graduates for real healthcare environments, where technology specialists and healthcare professionals must communicate across disciplinary boundaries.

Fourth, ethical reasoning should be embedded throughout the learning process. Data privacy and confidentiality should accompany discussions of data collection, storage, interpretation, and sharing rather than appearing only as an isolated ethics lesson (Almarwani, A. M, 2024).

Finally, educators should recognize that breaking the data barrier is a gradual process. Students may initially feel that big data is distant, technical, or intimidating. With appropriate scaffolding, authentic cases, peer interaction, and opportunities for reflection, the same concepts can become more understandable and professionally relevant.

Contribution to the Literature

This study contributes to the literature by conceptualizing the challenge of health informatics education as a data barrier rather than simply a digital skills deficit. The findings suggest that students' difficulties emerge at the intersection of technical knowledge, contextual understanding, disciplinary identity, confidence, and ethical awareness.

More importantly, the study highlights interdisciplinary learning as a potential mechanism for overcoming this barrier. The interaction between Information Technology and Nursing students created a learning environment in which technical and clinical knowledge could be combined. This suggests that developing health data literacy may be more effective when students are not taught only to operate digital systems but are also given opportunities to negotiate the meaning and relevance of data with learners from other professional backgrounds.

The study therefore proposes a broader understanding of health data literacy as the capacity to understand data, interpret data, contextualize data, communicate about data, and use data responsibly. In an increasingly data-driven healthcare environment, these capacities may be essential for developing professionals who are not merely users of digital systems but informed participants in data-informed healthcare practice.

CONCLUSION

This qualitative study concludes that developing health informatics and big data literacy among undergraduate students requires more than introducing digital technologies or explaining technical concepts. The experiences of 20 Information Technology students and 10 Nursing students at Universitas 'Aisyiyah Palembang demonstrated that students initially encountered a multidimensional data barrier involving unfamiliar terminology, limited experience with healthcare data, uncertainty in data interpretation, differences in disciplinary perspectives, and concerns about the responsible use of health information. Contextualized learning activities and interdisciplinary interaction provided important pathways for addressing these challenges by connecting technical concepts with clinical meaning and allowing students to learn from complementary disciplinary perspectives. The findings suggest that health data literacy should be understood as the capacity to understand, interpret, contextualize, communicate, and ethically use health information rather than merely operate digital systems. Thus, interdisciplinary health informatics education can provide a meaningful foundation for preparing future professionals to participate more confidently and responsibly in increasingly data-driven healthcare environments, although further research involving larger and more diverse student populations and longer-term learning experiences is needed to examine the sustainability and transferability of these findings.

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