Original Article

Understanding artificial intelligence through the eyes of future nurses

Insights from nursing students

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ABSTRACT

الأهداف: تستكشف هذه الدراسة تصورات وفهم طلاب التمريض للذكاء الاصطناعي، بهدف تحديد ومعالجة الفجوات المعرفية الحرجة لدعم التكامل الفعّال في الممارسات التعليمية.

المنهجية: أُجريت دراسة نوعية استكشافية باستخدام مقابلات شبه منظمة مع 20 طالب تمريض من جامعة رائدة خلال شهر أكتوبر 2023م. ركز جمع البيانات على تعريف الطلاب ومفاهيمهم وتصوراتهم حول الذكاء الاصطناعي في مجال الرعاية الصحية.

النتائج: تم استخلاص ثلاثة مواضيع رئيسية: التحول: حيث يُمثل الذكاء الاصطناعي انتقالًا في تعليم التمريض من الأساليب التقليدية إلى التكامل التكنولوجي. القوة: يُبرز الذكاء الاصطناعي دوره كعامل رئيسي في توليد المعرفة وتعزيز التقدم العلمي. استخدام التكنولوجيا: يشير الطلاب إلى التطبيقات المتنوعة للذكاء الاصطناعي لتحسين الكفاءة التشغيلية، وأتمتة الإجراءات، وتعزيز القدرات البشرية في مختلف القطاعات.

الخلاصة: تسلط الدراسة الضوء على الحاجة إلى دمج محتوى متخصص في الذكاء الاصطناعي داخل المناهج الدراسية للتمريض، وذلك لإعداد الطلاب لمواجهة التكامل المستقبلي لهذه التكنولوجيا في مجال الرعاية الصحية.

Objectives: To explore nursing students' perceptions and understanding of artificial intelligence (AI), aiming to identify and address critical knowledge gaps to support effective integration into educational practices.

Methods: An exploratory qualitative study was carried out using semi-structured interviews with 20 nursing students from King Saud University, Riyadh, Saudi Arabia, in October 2023. Data collection focused on their definitions, conceptualizations, and perspectives regarding AI in healthcare.

Results: A total of 3 key themes emerged: I) transformation, where AI represents a shift in nursing education from traditional methods to technological integration; II) power, viewing AI as a driver of knowledge creation and scientific advancement; and III) use of technology, focusing on AI applications to enhance efficiency, automate tasks, and augment human abilities across sectors.

Conclusion: The study highlights the need to integrate AI-related content into nursing curriculum, preparing students for its application in healthcare. These insights emphasize AI's role in shaping the future of nursing education and practice.

Keywords: artificial intelligence, nursing education, qualitative study, thematic analysis, nursing students

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Artificial intelligence (AI) has emerged as a transformative force across various sectors, reshaping the landscape of technology, business, and society. Defined broadly, AI encompasses developing computer systems capable of performing tasks that typically require human intelligence, such as understanding natural language, recognizing patterns, and making decisions.[1] The significance of AI is underscored by its rapid integration into diverse fields, including healthcare, finance, and education, where it enhances operational efficiency and decision-making processes.[2,3] As organizations increasingly adopt AI technologies, understanding the foundational concepts and implications of AI becomes crucial for leveraging its potential benefits while mitigating associated risks.[4,5] The evolution of AI has been marked by significant advancements in machine learning, data analytics, and cognitive computing, which collectively contribute

to its growing capabilities.[6,7] These advancements have led to the emergence of hybrid intelligence, a concept that emphasizes the collaboration between human intelligence and AI systems to achieve superior outcomes in organizational contexts.[8] The ability of AI to process vast amounts of data and derive actionable insights has positioned it as a critical tool for enhancing creativity and innovation within organizations.[9] As AI systems become more prevalent, it is essential to examine their impact on interpersonal relationships and the dynamics of human interaction.[8,10] This necessitates a multidisciplinary approach to understanding AI, incorporating computer science, psychology, and ethics perspectives to foster a comprehensive understanding of its role in contemporary society.[11] In light of these considerations, this paper aims to explore the multifaceted nature of AI and its definitions thereby contributing to the ongoing discourse on the future of intelligence in an increasingly automated world.

The existing literature on AI presents a rich tapestry of definitions and conceptual frameworks; however, significant gaps remain that hinder a comprehensive understanding of AI's multifaceted nature. One notable gap is the lack of consensus on a universally accepted definition of AI, which complicates interdisciplinary communication and collaboration. Various studies have proposed differing terminologies and frameworks, yet these often lack clarity and coherence, leading to confusion among researchers and practitioners alike.[12] For instance, Kühl et al[12] emphasize the need for a common understanding of machine learning within the broader context of AI, suggesting that terminological discrepancies can impede effective discourse and hinder advancements in the field. This lack of clarity is further exacerbated by the diverse applications of AI across sectors, each with its own set of terminologies and operational definitions, which can create barriers to knowledge transfer and integration.[13]

Moreover, while there is a growing body of research examining the implications of AI in various domains, such as marketing, healthcare, and ethics, there is insufficient exploration of how these definitions and frameworks translate into practical applications and real-world scenarios.[14,15] For example, Bawack et al[14] highlight the necessity for conceptual frameworks that bridge the gap between theoretical research and practical implementation. Yet, such frameworks are still underdeveloped in the context of AI adoption and usage. The interplay between human cognition and AI systems remains underexplored, particularly in terms of how these systems can enhance human decision-making rather than replace it.[7] As AI technologies continue to evolve, there is an urgent need for comprehensive frameworks that define AI. Addressing these gaps will be essential for advancing both theoretical understanding and practical applications of AI, ultimately fostering a more integrated and responsible approach to its development and deployment. This study aims to explore and understand nursing students' perceptions, meanings, and definitions of AI, with a focus on their insights into its relevance, implications, and potential applications in the healthcare field.

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Methods. This study employed an exploratory qualitative approach guided by the methodological framework of Reid-Searl and Happell. An exploratory qualitative design was particularly suited for investigating topics that had received limited attention in existing literature, as it allowed participants to actively contribute to the generation of new knowledge in the field.[16] This approach ensured a rich, in-depth exploration of the research topic, fostering a deeper understanding of nursing students' perspectives on AI.

The study utilized purposive sampling, a method well-suited to qualitative research that focused on depth and specificity.[17] Participants were selected based on their ability to provide relevant insights, ensuring the collection of meaningful data. Participants included nursing students enrolled in a program who had completed at least one year of study and voluntarily consented to participate. Exclusion criteria included those with significant academic disruptions or advanced training in AI or information technology (IT) to maintain a focus on general nursing student perspectives. These criteria ensured a relevant and balanced sample for the study.

Purposive sampling was critical in exploring complex perceptions, allowing for the deliberate selection of individuals most likely to provide insightful contributions. This method also supported the achievement of data saturation, a benchmark in qualitative research where data collection continued until no new themes emerged, ensuring comprehensive topic coverage.[17] A total of 20 participants were included in the study, a number deemed sufficient to capture a diverse range of perspectives while adhering to data saturation principles. The study was carried out at King Saud University, Riyadh, Saudi Arabia, adding credibility and contextual relevance to the findings.

Data were gathered through semi-structured interviews, a method well-suited for qualitative research as it facilitates dynamic interaction between researchers and participants. This approach allows the researchers to explore unanticipated viewpoints while maintaining focus on the research objectives.

The interview questions were developed using insights from prior studies in the field.[16,18,19] A funnel strategy was employed in the interview design, beginning with broad, open-ended questions to establish context and gradually narrowing the focus to align with the specific research objectives. This structured approach ensures depth in data collection while maintaining relevance to the study's aim. Interviews were carried out in a manner that encouraged participants to express their perspectives freely, fostering an environment conducive to authentic and meaningful interviews. This method provided robust qualitative data, enabling a nuanced understanding of nursing students' definitions and perceptions of AI. The introductory questions were: I) "how would you define AI in your own words?"; II) "what comes to mind when you hear the term AI?"; and III) "what do you think are the primary functions or purposes of AI in general?". The concluding question was: "do you want to add any points?".

This study adhered to ethical principles, particularly regarding the use of interviews as the primary data collection method. Participants provided informed consent after being fully briefed regarding the study's purpose, the interview process, and their right to withdraw at any time without consequences. All interviews were carried out respectfully and non-intrusively, ensuring participants felt comfortable sharing their views. Data collected during the interviews were anonymized to protect participant identities, and access to the recordings and transcripts was restricted to the research team. Ethical approval for the study was obtained from the institutional review board of King Saud University at College of Nursing (KSU-HE; 23-643, date of approval: 6th Jun 2023) before data collection.

To ensure the credibility, dependability, transferability, and confirmability of this qualitative study, several strategies were employed to maintain methodological rigor. I) Credibility: to enhance the accuracy and trustworthiness of the data, the study utilized prolonged engagement with participants during interviews to build rapport and encourage rich, detailed responses.[20] Triangulation of data sources, including multiple participant perspectives, ensured that the findings reflected a comprehensive understanding of nursing students' perceptions of AI. II) Dependability: a detailed audit trail documenting every step of the research process, from the development of interview questions to data analysis, was maintained. This ensures that the study procedures can be replicated or critically evaluated by other researchers.[21] III) Transferability: thick descriptions of the study context, participant demographics, and findings were provided, enabling readers to assess the applicability of the results to other nursing education settings or contexts.[25] This level of detail supports the transferability of the findings to similar educational environments. IV) Confirmability: reflexivity was practiced throughout the research process, with the researcher maintaining a reflective journal to document personal biases and assumptions. Peer debriefing with experienced qualitative researchers further ensured that the findings accurately represented the participants' perspectives, minimizing researcher bias.[21] V) Data saturation: data collection continued until no new themes or insights emerged, ensuring that the study captured a full range of nursing students' perspectives on AI. This approach aligns with the standard practice in qualitative research for achieving comprehensive and reliable results.[14] These measures collectively ensured that the study adhered to high standards of methodological rigor, contributing to the reliability and validity of the findings.

The data collected through semi-structured interviews were prepared systematically for analysis following established qualitative procedures. Each interview was audio-recorded with participant consent and subsequently transcribed verbatim to ensure accuracy. The transcripts were checked against the recordings to confirm fidelity and completeness, and any identifying information was removed to maintain confidentiality. The transcriptions were then reviewed multiple times to ensure familiarity with the data, as this is a critical first step in qualitative analysis.[22] Notes and initial impressions were documented during the review process to facilitate coding and theme development.

Statistical analysis. Thematic analysis was carried out using Braun and Clarke's 6-step framework, which provides a systematic approach to identifying, analyzing, and interpreting patterns within qualitative data.[22] The steps included: I) familiarization with the data: the researchers immersed themselves in the data by reading and re-reading transcripts, actively noting initial ideas and recurring concepts. This step ensured a deep understanding of the content before formal coding began. II) Generating initial codes: the researchers systematically coded the entire dataset, identifying key features relevant to the research questions. Coding was carried out manually initial codes were kept broad to

capture the diversity of participants' responses. III) Searching for themes: codes were grouped into potential themes by identifying patterns and connections across the data. A thematic map was created to visualize relationships between themes and sub-themes, aiding in developing a coherent narrative. IV) Reviewing themes: the initial themes were reviewed and refined to ensure they accurately represented the data. This involved checking that themes were supported by sufficient data and revisiting the transcripts to confirm their relevance and consistency. V) Defining and naming themes: each theme was clearly defined and named to capture its essence. This step involved refining the thematic narrative to ensure that the themes provided meaningful insights into nursing students' understanding and definitions of AI. VI) Producing the report: the final themes were integrated into a comprehensive narrative, supported by direct quotes from participants to illustrate key points. This step ensured the findings were presented clearly and grounded in participants' perspectives. Braun and Clarke's framework ensured a rigorous and systematic approach to thematic analysis, providing a detailed and nuanced understanding of nursing students' perceptions of AI.

Results. A total of 20 students participated in the study, comprising 7 (35%) males and 13 (65%) females. The largest age group among the participants was 22 years old, accounting for 37.5% of the sample. Most participants (55%) were in their fifth year of study. Table 1 provides a detailed descriptive analysis of the participants.

Main theme unified concept defined the development of a coherent and comprehensive meaning of AI that could be effectively integrated into nursing education. The cohesive idea was that nursing students built a unified definition of AI in nursing education. The participant interviews yielded the following points of contention regarding the meaning of AI; the nursing students viewed the meaning of AI in 3 subthemes: based on transformation, power, and use of technology. The theme concluded that there was variety in the meaning of AI for nursing students and a lack of a unified view of AI, which affected the nursing students' perception of AI in education. The interrelationship among the core themes is illustrated in Figure 1.

The first subtheme was the meaning of AI from the concept of transformation. Participants viewed AI as a rapid evolution and transformation of nursing education from traditional to technology education.

Participant 1 responded "it was like the transformation of education from paper to technology". Participant 4 responded "AI was a qualitative leap in nursing education". Participant 5 responded "AI was the future transformation of nursing education". Participant 3 responded "its meaning was transforming reality into imagination through applications. I imagined a human being, and as soon as I got closer, any part of the human being spoke to me, for example, regarding every layer of skin that existed".

The second subtheme was the meaning of AI from the concept of power. Participants viewed AI as the ability to shape the dynamics of knowledge creation and scientific advancement. Participant 1 responded "I considered it a source of power. We took decisions from it and asked regarding any topic that was unclear to us". Participant 5 responded "it was a source of strength because of the extent of the component we could reach, which somewhat mimicked human work". Participant 6 responded "it was something they used to simulate

Table 1 - Descriptive analysis of the qualitative approach participants (N=20).

Variables	n (%)
Gender	
Male	7 (35.0)
Female	13 (65.0)
Age (years)	
21	5 (25.0)
22	8 (37.5)
23	5 (25.0)
24	2 (12.5)
Year of study	
Year 2	2 (10.0)
Year 3	4 (20.0)
Year 4	3 (15.0)
Year 5	11 (55.0)

Values are presented as numbers and percentages (%).

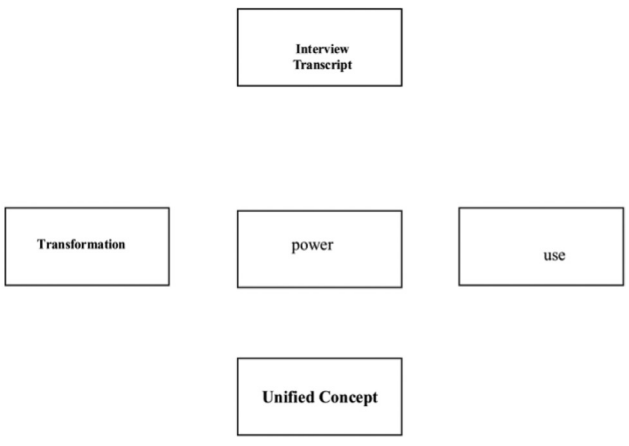

Figure 1 - The interrelationship among the core themes.

the human mind, and it had many uses, including education. I saw it as power".

The third subtheme was the meaning of AI from the concept of technology use. Participants referred to AI as the various applications of AI across sectors and by different stakeholders, concentrating on how AI systems were utilized to improve efficiency, automate operations, and augment human abilities. Participant 4 responded "AI meant using technology to help people, whether in a functional aspect, in a development aspect, or in general". Participant 17 responded "for me, it meant a technology that I used to communicate with others and obtain information from it with less effort". Participant 7 responded "AI was dealing more with devices and facilitating things without intervention for humans". Participant 13 responded "it was the technology used to store information".

Discussion. The results of this study highlight that to expand students' comprehension and enable the integration of AI in nursing education, a precise and uniform definition of AI is critical. One major issue facing nursing education is the lack of a universally accepted definition of AI. Inefficient collaboration and the application of AI technologies face obstacles because of the absence of a broadly accepted definition of AI. Research demonstrates the various ways that AI is interpreted in the literature; definitions of AI frequently center on the concept that it is a technology that mimics human intelligence and carries out particular activities.[23]

According to the literature, the absence of a widely accepted definition of AI complicates issues in the discourse surrounding the technology. It is difficult to set clear rules and regulations for its responsible and acceptable application.[24] The lack of a unified definition of AI also affects nursing education and training programs. Professionals and students must have a solid understanding of the technology to properly incorporate AI into their practice and decision-making processes. Artificial intelligence's successful application in healthcare settings is potentially limited by the absence of a common definition, which can result in misconceptions and misunderstandings regarding the technology's capabilities and limits.[25]

These results are consistent with a study by Tuomi et al,[26] which finds a lack of consistency in the definition of AI, making it difficult for students to acquire AI literacy and competencies and limiting their capacity to use AI technology. Additionally, figuring out important problems, including transparency, responsibility, and interpretability in AI, is limited by the lack of a universal definition. According to Reddy et al,[27] the lack of well-defined definitions and standards presents a challenge in evaluating AI algorithms' safety, dependability, and effectiveness. This lack of clarity also raises concerns regarding potential biases, invasions of privacy, and ethical issues. To ensure that AI-driven systems are comprehensible and understandable to all students, uniformizing the concept of AI is crucial to encourage accountability and transparency in the use of AI.[11]

The impact of nursing students' definition of AI on adoption and integration into nursing practice and education is significant. A thorough education and thoughtful application are essential for ensuring the successful integration of AI into nursing education, as evidenced by the multifarious understanding of AI in nursing that encompasses transformation, power, and usage.

To address this challenge, several practical strategies can be implemented, including simulation-based learning, which shows promise in enhancing nursing students' understanding and application of AI. One of the primary strategies involves the development of simulation-based learning environments that incorporate AI technologies. Such simulations provide nursing students with hands-on experience in using AI tools, thereby reducing anxiety associated with their use and increasing self-efficacy. For instance, Reed[29] highlights that students report lower simulation anxiety when engaging with AI-generated backstories prior to their simulations, suggesting that familiarity with AI can enhance confidence in its application during clinical scenarios.

Additionally, it is essential to integrate AI education into nursing curricula comprehensively. This includes not only technical training in AI tools but also education in data literacy, ethical considerations, and systems thinking. Kwak et al[29] emphasize the need for nursing education programs to develop competencies in these areas to prepare students for the realities of AI in healthcare.

Study limitations. The study's findings are limited by its reliance on a single university sample, which may not fully represent the views of nursing students in different contexts or regions. Additionally, the qualitative design focuses on depth rather than breadth, limiting generalizability. Future research could explore larger, more diverse samples and incorporate comparative studies across institutions or countries.

In conclusion, this study provides valuable insights into nursing students' understanding and conceptualization of AI, emphasizing their interpretations of its meaning and potential applications in healthcare. While students recognized AI as a tool for improving efficiency, streamlining processes, and supporting clinical decision-making, they also expressed concerns regarding its potential to overshadow the human-centered aspects of nursing. The

findings highlight a gap in students' formal education regarding the practical implementation and meaning considerations of AI in clinical settings.

To bridge this gap, nursing curricula should integrate AI-related content, focusing on its role in enhancing patient care while maintaining the empathetic and interpersonal dimensions of nursing. Educating future nurses on the responsible use of AI can empower them to collaborate effectively with AI systems, leveraging their capabilities without compromising the core values of the profession. This study underscores the importance of preparing nursing students for a future where AI will play an integral role in healthcare delivery, ensuring they are equipped to navigate the challenges and opportunities it presents.

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