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Clicking one dot opens a whole new world: a qualitative study on using knowledge graphs in surgical nursing education

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Abstract

Background The integration of intelligent technologies in surgical nursing education offers opportunities to enhance learning outcomes and address challenges in mastering complex topics. Knowledge graphs serve as a visual and interactive learning tool. It represents a novel approach to improving systematic thinking and enhancing knowledge retention in blended teaching models.

Aim This study explored nursing undergraduates' experiences with a knowledge graph platform in surgical nursing education, focusing on perceptions of its usefulness and ease of use, factors influencing engagement, and suggestions for improvement.

Methods A qualitative descriptive study approach was employed to investigate the experiences of 13 nursing students. Semi-structured interviews were conducted after completing a surgical nursing course. The interviews were guided by the Unified Theory of Acceptance and Use of Technology 2 (UTAUT2). Data were analyzed using reflexive thematic analysis to identify key themes related to knowledge graph use.

Results The analysis identified three main themes: (1) Developing conceptual clarity through knowledge integration, where knowledge graphs helped students build systematic thinking, discover learning pathways, and enhance post-class review efficiency; (2) Stimulating interest through enriched content, where enriched and well-organized content increased students' interest and enthusiasm for independent study; and (3) Navigating challenges and envisioning opportunities, where participants reported technical and access limitations, a need for richer content, and requests for clearer usage guidance.

Conclusion Knowledge graphs offer innovative intelligent technology integration within blended nursing education. These tools cultivate systematic thinking, enhance surgical nursing knowledge and skill development, and enrich the comprehensive learning experience. Future studies should explore sustained educational outcomes, broaden technological capabilities, and examine cross-contextual adaptability.

Keywords Knowledge graphs, Nursing education, UTAUT2, Surgical nursing education

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Introduction

Artificial intelligence (AI) has made significant strides toward cognitive intelligence in recent years, reshaping the educational landscape [1]–[2]. Among these developments, Knowledge Graphs (KGs) stand out in enhancing intelligent education by integrating information technology with teaching methods [3]–[4]. KGs are defined as graphs of data that accumulates and conveys knowledge of the real world. The nodes in KGs represent the conceptual entities, and the edges represent the relations between the entities [5].

While KGs have demonstrated considerable success across various domains, their application patterns differ between fields [6]. In clinical medicine and nursing practice, KGs have been successfully applied to integrate large-scale patient data, support precision treatment, streamline clinical decision-making, and facilitate standardization of care pathways [7–9]. These clinical applications primarily focus on patient data integration and evidence-based practice support. However, the application of KGs in nursing educational settings remains relatively limited. Traditional educational tools including concept maps, mind maps, and static visual aids continue to dominate nursing education, despite their limitations in representing complex knowledge relationships and accommodating diverse learning preferences [10–12]. This gap presents a significant opportunity to explore how KGs can transform nursing educational practices, particularly in complex healthcare disciplines.

Surgical nursing education requires students to integrate theoretical principles with clinical reasoning when addressing complex real-world problems. This integration proves particularly challenging in complex surgical nursing domains including burn care and organ transplantation, where each area encompasses intricate knowledge systems [13]–[14]. KGs can potentially overcome the limitations of traditional educational approaches by organizing conceptual hierarchies, identifying critical knowledge nodes, and enabling interactive exploration of related concepts [15]. This approach facilitates the connection between theoretical knowledge and clinical practice while fostering systematic and critical thinking abilities.

In this study, the KGs function of the university's online learning platform *Chaoxing* was utilized. This platform allows instructors to integrate course content, question banks, and assessment data into an interactive KG, enriched with multimedia resources including videos and documents. Teachers can tag key and difficult points, link them to relevant instructional materials and assessments, and configure hierarchical knowledge structures for the entire course. Students can navigate the KG to review content independently, while instructors can monitor

assessment results and mastery of specific knowledge points.

Understanding student acceptance of such systems requires a robust theoretical framework. The study adopted the Unified Theory of Acceptance and Use of Technology 2 (UTAUT2) as the theoretical framework [16]. UTAUT2 incorporates constructs including performance expectancy, effort expectancy, social influence, facilitating conditions, hedonic motivation, price value, and habit to explain individuals' behavioral intentions and technology use. This model has been widely applied to evaluate educational technology adoption and provides a systematic lens for interpreting users' experiences and perceptions [17].

Objective

This qualitative study aims to explore nursing students' experiences and perceptions of a knowledge graph educational platform in surgical nursing education. Specifically, it seeks to:

1. Examine how students perceive the platform's usefulness, ease of use, and motivational appeal when learning complex surgical nursing topics of burn care and organ transplantation.
2. Explore the influence of social and institutional factors on students' engagement with the knowledge graph.
3. Identify challenges and recommendations for improving knowledge graph integration in surgical nursing curricula.

These questions align with the UTAUT2 framework, examining performance expectancy and effort expectancy (RQ1), social influence and facilitating conditions (RQ2), and implementation outcomes (RQ3).

Methods

Study design

This qualitative descriptive study employed semi-structured interviews to systematically explore nursing students' experiences using KGs in surgical nursing education. The UTAUT2 framework guided the study design to ensure comprehensive exploration of factors influencing technology acceptance. The study adhered to the Consolidated Criteria for Reporting Qualitative Research (COREQ) checklist [18].

Research team and reflexivity

The research team consisted of seven members: three "Surgical Nursing" instructors responsible for designing and implementing the knowledge graph; one faculty member with expertise in qualitative research, who supervised two graduate students in conducting and

analyzing semi-structured interviews; and a deputy director of the nursing teaching and research department, who oversaw the knowledge graph's development and provided mentorship in qualitative research.

Several team members had prior teaching roles with the participant cohort. To minimize potential bias and reduce power imbalances, interviews were conducted by two graduate students who had no role in course assessment. Researchers maintained reflexivity throughout data collection and analysis, and coding decisions were cross-checked by multiple team members to ensure that interpretations reflected participants' perspectives. Findings were also shared with several participants for validation.

Setting and context

This qualitative study took place at a medical college within a comprehensive university located in eastern China. The institution enrolls approximately 200 undergraduate students in nursing and medical programs, 300 diploma-level nursing students, and 30 postgraduate students in nursing and medicine each year. Since 2023, knowledge graph applications have been introduced into the teaching curriculum.

For this intervention, the teaching team selected two chapters from the Surgical Nursing curriculum, burn care and organ transplantation. This choice was based on examination results from previous cohorts and end-of-term teaching evaluation surveys, both showing persistent learning difficulties in these areas. The burn care chapter covers the pathophysiology of burn injuries, fluid resuscitation protocols, wound assessment and dressing techniques, and nursing care for burn patients. The organ transplantation chapter includes immunology, surgical procedures, perioperative nursing management, immunosuppressive therapy, and the prevention and treatment of rejection. These topics require students to integrate biomedical knowledge with clinical decision-making, making them particularly challenging for students to master.

Participants and recruitment

Participants were sophomore nursing students from the same surgical nursing course. This provided the homogeneity necessary for thematic saturation. Within this homogeneous group, we employed purposive sampling to capture variation in gender, academic mastery, and leadership roles. Recruitment was conducted through class WeChat group announcements, and interested students were contacted individually. From an initial pool of 165 eligible students, 20 were invited to participate. The sample size was informed by Guest et al. (2006), who reported that thematic saturation is typically reached

within 12–15 interviews in relatively homogeneous groups [19]–[20]. Inclusion criteria:

1. Full participation in the surgical nursing course covering burn care and organ transplantation topics.
2. Completion of all knowledge graph-based learning activities and assessments related to burn care and organ transplantation.
3. Ability to clearly express personal experiences and viewpoints in Mandarin.

Recruitment and data collection took place between May and July 2024.

Data collection

Semi-structured interviews were conducted following the completion of the course. The interview outline (Supplementary File 1) was developed using the UTAUT2 as a theoretical framework [17], and was aligned with the study's objectives. The interview questions were designed to follow constructs of UTAUT2, including performance expectancy, effort expectancy, social influence, facilitating conditions, hedonic motivation, and habit. A preliminary interview was conducted with two nursing undergraduates (one male and one female) to pilot test the questions. Feedback from this pilot informed revisions to the final interview guide, including rewording questions for clarity, simplifying technical terms, and adjusting the sequence of questions to improve the flow of the interview.

Two graduate students trained in qualitative research methods conducted the interviews. Their age proximity to the participants reduced power imbalances and fostered a comfortable and open atmosphere [21]. The researchers thoroughly explained the study's purpose, methods, and ethical safeguards before data collection. Each interview lasted 20–30 min and took place in a private location chosen by the participant. The researchers audio-recorded the sessions and took detailed field notes, capturing non-verbal cues such as tone and body language [22]. Interview transcripts were returned to participants for accuracy checking, and no major corrections were requested. No repeat interviews were conducted.

The study followed a rigorous methodology outlined by Helen J. Streubert [23], emphasizing active collaboration between interviewers and participants. This was achieved by structuring the interviews as open, discussion-like conversations. The interviewers used open-ended prompts, invited participants to clarify or correct our interpretations, and consciously avoided rhetorical or leading questions to ensure the views expressed were genuinely those of the participants. To minimize bias during analysis, the lead research team maintained a reflexive stance, critically examining how the team's

own expertise in knowledge graphs could influence the interpretation of participant data. Data saturation was reached with the twelfth interview, and one additional interview was conducted to confirm that no new themes were emerging.

Data analysis

Data were analyzed using reflexive thematic analysis [24]– [25], combining inductive and deductive approaches in an abductive analytical process. The UTAUT2 framework served as a theoretical sensitizing framework while remaining open to emergent patterns.

Both researchers familiarized themselves with the data through repeated readings. During the inductive phase, they independently conducted open coding, examining transcripts line by line and assigning initial codes to capture meanings. Subsequently, a deductive approach was applied by examining how codes aligned with UTAUT2 constructs. Codes were then grouped into candidate themes through iterative comparison between inductive patterns and deductive theoretical considerations. Themes were refined through constant comparison and defined to capture distinct meanings.

Data saturation was reached when no new codes or themes were identified. Credibility was enhanced through peer debriefing between researchers, maintaining detailed audit trails throughout the analysis process, and member checking by sharing selected findings with participants for validation. Participants confirmed that the findings accurately reflected their experiences, and no major revisions were needed.

Ethical considerations

This study was conducted as part of a teaching reform project at Zhejiang Shuren University and was approved by its Ethics Committee (Approval No. 202401026). Participants were provided with detailed information about the study’s objectives, methods, and procedures, including their right to withdraw at any time without penalty.

All participants provided written informed consent prior to participation, ensuring their voluntary involvement in the study. The research adhered to the principles of the Declaration of Helsinki and complied with all relevant institutional and national ethical guidelines and regulations. Confidentiality and anonymity were strictly maintained; participant data were used solely for research purposes, and all recordings and transcripts were securely stored with identifying information removed at every stage of the research process.

Results

Participant characteristics

A total of 13 nursing students participated in the study, including 11 females and 2 males, aged 19 to 21 years.

Table 1 Characteristics of participants

Number	Gender	Student leader	Mastery rate (%)
S1	female	Yes	82.22
S2	female	No	84.32
S3	female	No	70.42
S4	female	No	80.07
S5	female	Yes	85.56
S6	male	Yes	59.89
S7	female	No	64.16
S8	female	No	65.21
S9	male	No	50.39
S10	female	No	72.64
S11	female	No	56.47
S12	female	Yes	62.92
S13	female	No	48.30

Table 2 Overview of themes and subthemes

Theme	Subthemes
Developing conceptual clarity through knowledge integration	Discovering learning pathways Enhancing learning efficiency
Stimulating interest through enriched content	(No subthemes)
Navigating challenges and envisioning opportunities with knowledge graphs	Technical and access limitations Desire for richer knowledge presentation and content Need for usage support and guidance

Four participants served as student leaders. Each participant’s mastery rate was obtained from the Chaoxing learning platform, which records students’ mastery of course content based on in-platform assessments linked to the knowledge graph. The mastery rate ranged from 48.30% to 85.56%. Table 1

Findings

The analysis identified three overarching themes that capture the essence of participants’ experiences with the KGs in surgical nursing learning: (1) *Developing conceptual clarity through knowledge integration* (2) *Stimulating interest through enriched content* (3) *Navigating challenges and envisioning opportunities with KGs*. Table 2

Developing conceptual clarity through knowledge integration

Discovering learning pathways

Participants consistently reported that the visual and interconnected nature of the knowledge graph enabled them to perceive the logical relationships among concepts, making complex surgical nursing content more accessible. The networked structure allowed them to integrate dispersed knowledge points into a coherent framework, which they described as transforming previously fragmented or overwhelming content into an organized whole. Many participants characterized this

process as “organizing” the subject matter and developing a clearer cognitive structure for understanding burn care and organ transplantation concepts.

- “When I use the knowledge graph on the computer, clicking on one of the dots will lead to other branches of knowledge, which will clearly form a knowledge framework and help me sort out the knowledge points.” (S1).
- “The knowledge graph can organize the knowledge of burn care, which encompasses a wide range of topics. As a beginner, I found burn care is difficult to grasp and disorganized. After using the knowledge graph, the process became clearer, and I could approach it in a consistent way.” (S3).

Enhancing learning efficiency

Students emphasized that the knowledge graph consolidated essential learning resources for surgical nursing, streamlining their ability to review and reinforce content on burn care and organ transplantation. By integrating chapter outlines, key points, and supplementary materials in a single interactive platform, it reduced the time spent searching for information and allowed learners to focus on comprehension and application. The visual emphasis on important and difficult points helped them prioritize their study efforts, particularly during post-class review sessions.

- “The knowledge graph includes a variety of learning resources and highlights the main content of the chapters. I can directly access it for post-class assessments.” (S7).
- “Compared to my mind map, the knowledge graph is more detailed and highlights the important and difficult points. Reviewing with books and the knowledge graph together reduces the time spent screening key points and enhances after-class review efficacy.” (S12).

Stimulating interest through enriched content

The novelty and interactivity of the knowledge graph fostered a sense of curiosity and engagement among students learning the challenging domains of burn care and organ transplantation. Participants valued how the platform extended beyond traditional textbook content, presenting detailed and interconnected knowledge points that invited exploration. For some, these supplementary resources including literature references and extended conceptual links became catalysts for independent study, motivating them to pursue additional information and enhance their understanding. This expanded learning scope rendered the educational process both more comprehensive and more enjoyable.

- “The knowledge graph contains detailed and comprehensive knowledge points, such as literature on organ transplantation and burn care, beyond what is covered in the textbooks. It has motivated me to pursue further research in these areas.” (S4).
- “The knowledge graph systematically organizes nursing knowledge of burns and organ transplantation, enabling quick access to key content and making complex information simple, interesting, and easy to understand.” (S5).

Navigating challenges and envisioning opportunities with knowledge graphs

Technical and access limitations

While students recognized the potential of the knowledge graph for surgical nursing learning, several reported that technical issues interfered with their experience. Slow loading in unstable network environments disrupted their study flow, and the lack of mobile accessibility limited flexibility in reviewing burn care or organ transplantation content outside the classroom. Interface design was also cited as a barrier, with awkward zooming and difficulties in locating certain resources impeding efficient use. These limitations occasionally overshadowed the benefits of the platform, particularly when students needed to access materials quickly during self-study.

- “Network-related factors will influence the utilization of knowledge graphs. In a suboptimal network environment, the loading speed of resources associated with knowledge graphs is diminished, thus impacting the user experience.” (S8).
- “Currently, the knowledge graph is exclusively accessible on the computer, limiting its availability and thereby diminishing user convenience.” (S3).

Desire for richer knowledge presentation and content

Students expressed a desire for broader and more dynamic knowledge representations to better support their learning. Within the surgical nursing context, they sought additional multimedia resources, including clinical operation videos for burn wound care and case studies on organ transplantation, to create more engaging and clinically relevant material. They felt that such enhancements would help bridge the gap between theoretical learning and practical application.

- “Regarding surgical care, I seek information on clinical operation videos, specifically those demonstrating wound care for burn patients.” (S2).
- “I believe it is crucial to expand the pertinent knowledge. The burn chapter could connect to a relevant website offering skin care and

clinical practice films, which would enhance our understanding.” (S11).

Need for usage support and guidance

Some students found the platform’s functions insufficiently intuitive and suggested that explicit guidance could improve usability. This included incorporating video tutorials or recorded demonstrations to explain how to navigate and apply the knowledge graph for topics. Participants believed that these aids would make the tool more approachable, particularly for first-time users, and would enable them to resolve operational issues independently.

- *“I believe it would be more effective and convenient to elucidate the specific application of the knowledge graph through a video format.” (S4).*
- *“I believe that images, texts, or videos are beneficial, as a prior survey indicated that reliance solely on words results in a retention rate of approximately 10%–20%. In contrast, incorporating graphics or videos enhances retention to 50%–70%. Therefore, I suggest that the instructor first demonstrate the application, followed by an explanation or recording of the usage, which can be shared with us, enabling me to refer to the video for resolving operational issues.” (S10).*

Discussion

This qualitative study explored nursing students’ experiences with a KGs online learning platform for surgical nursing education, specifically examining burn care and organ transplantation learning through the lens of the UTAUT2 framework.

Clarity and efficiency gains (RQ1)

Students demonstrated high acceptance of knowledge graphs as an innovative learning method because of its unique value in complex knowledge acquisition. In burn care education, previously scattered knowledge points such as wound assessment, infection control, and fluid resuscitation protocols became interconnected through knowledge graphs into systematic knowledge networks. Content that was previously confusing became organized and clear, with more coherent thought processes. This systematic approach to knowledge organization exemplified the practical utility of knowledge graphs in nursing education. The platform enabled students to quickly organize knowledge frameworks during review sessions, clearly identifying logical relationships between concepts and significantly improving learning efficiency. These findings align with previous research emphasizing the effectiveness of interactive and structured learning approaches in nursing education [26]–[27].

Regarding usability, the visual representation of conceptual relationships in knowledge graphs aligns with cognitive load theory. This theory suggests that well-designed interfaces can reduce extraneous cognitive burden and enhance learning efficiency [28]. For complex content such as differential criteria for various burn depths and post-operative complication management protocols in organ transplantation, the visual structure of KGs enables students to more intuitively understand hierarchical relationships and connections between knowledge elements [29]. Compared to traditional text listings or simple charts, this approach effectively reduces information decoding difficulty, allowing students to more easily master the knowledge framework of complex topics.

The visual structure of KGs shares similarities with mind maps but surpasses them in systematicity and innovation. This approach aligns with findings by Ashraf [30], who reported that intelligent teaching tools elevate students’ performance expectations and alleviate learning burdens. This is particularly critical in surgical nursing education, where practitioners must synthesize complex, interdependent concepts under time-sensitive conditions. For example, when facing burn patients with complications and infections, they must simultaneously consider wound management, antibiotic usage, fluid resuscitation, and multiple other factors [31]. KGs help students rapidly integrate relevant knowledge, enhancing their confidence in solving practical problems and further improving learning motivation.

Regarding effort expectancy, the platform’s consolidated interface design addresses a common barrier of information fragmentation in digital learning environments. By reducing navigational demands, the system allows learners to allocate cognitive resources toward higher-order thinking rather than information seeking. This efficiency gain may be especially valuable in content dense fields like surgical nursing, where students must master both theoretical frameworks and practical applications [32].

Social influence and facilitating conditions (RQ2)

Student engagement with the knowledge graph was influenced by the degree of institutional and instructional support. Student requests for video tutorials, step-by-step demonstrations, and usage guidance indicate a strong demand for support. This shows that structured integration enhances adoption through social influence [33].

Facilitating conditions also played a pivotal role. Reliable internet connectivity, device compatibility, and an intuitive interface were essential for maintaining consistent use. Technical challenges, such as slow loading speeds or lack of mobile accessibility, disrupted learning

routines and reduced motivation. These observations echo recent findings that adequate infrastructure and targeted user support are prerequisites for embedding educational technologies into routine learning [34]. Addressing these conditions is especially important in surgical nursing education, where students often juggle high cognitive demands with limited independent study time.

Challenges, improvement needs, and sustainable use (RQ3)

Participants expressed a strong desire for richer and more clinically relevant resources. Many students expressed a desire for more case studies and links to authoritative clinical guidelines, which reflects the price-value structure where they believe the returns on their investment of time and effort depend on the content's depth, relevance, and practicality [35]. Additionally, some students indicated a lack of clear and accessible usage guidance. This limitation affected their full utilization of the knowledge graph and their motivation for long-term usage.

Regarding content, enhancing platform attractiveness through dynamic multimedia and authentic clinical scenarios can better bridge the gap between theory and practice [36]–[37]. For instance, incorporating actual wound care operation videos in the burn care section and embedding real case analyses in organ transplant content allows students to more intuitively connect theoretical knowledge with clinical practice, thereby improving their perception of the knowledge graph's content value. In terms of guidance, integrating video tutorials, recorded demonstrations, and step-by-step instructions into course delivery is essential. This approach can promote the initial adoption of the knowledge graph and encourage long-term usage.

Overall, achieving sustainable integration of the knowledge graph in surgical nursing courses requires improvement efforts focused on two complementary areas, (1) enriching content to maximize its perceived value and (2) providing course-based guidance to promote confident, habitual usage by students. Through the synergistic effects of technological functions, educational content, and instructional design, the knowledge graph can transition from an optional resource to an embedded element in surgical nursing education.

Implications for nursing education and practice

From a UTAUT2 perspective, initial adoption of the KGs was driven by performance expectancy and effort expectancy, while sustained engagement depended on social influence, facilitating conditions, price value, and habit. For educators, these findings highlight the need to integrate the tool purposefully into course structures, enrich it with clinically relevant resources, and provide ongoing

guidance to maximize its educational impact. Future studies should examine the long-term effects of such integration on knowledge retention, clinical reasoning, and professional performance. They should also explore its adaptability to other nursing specialties and interdisciplinary healthcare training contexts.

Limitations

This study has several limitations that should be considered when interpreting the findings. First, the sample exhibited a gender imbalance, with a higher proportion of female participants. Although it's reflective of the nursing profession, it may limit the applicability of findings to male students. Second, all participants were from a single institution, restricting the diversity of educational settings and potentially limiting transferability to other contexts. Third, data were collected immediately after course completion, capturing short-term perceptions but not the long-term impact of knowledge graphs on retention or practice; longitudinal research is needed to address this gap. Finally, as a qualitative study relying on self-reported interviews, findings may be influenced by recall or social desirability bias, despite steps taken to minimise these effects.

Conclusion

This study highlights the KGs learning method as an innovative application of intelligent technology within a blended teaching model. The findings demonstrate its positive impact on nursing undergraduates by fostering systematic thinking, improving the efficient acquisition of surgical nursing knowledge and skills, and enhancing the overall learning experience.

Future research should explore the long-term effects of integrating KGs on learning retention and professional practice. Additionally, efforts should be directed toward expanding the functionality of KGs and ensuring their adaptability to diverse educational contexts. By addressing these areas, KGs can be further refined into a more effective and versatile tool that supports the evolving demands of modern nursing education.

Abbreviations

AI	Artificial Intelligence
KGs	Knowledge Graphs
UTAUT2	Unified Theory of Acceptance and Use of Technology 2

Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s12909-025-08226-z>.

Supplementary Material 1

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Authors' contributions

FangChi Liu: Data Curation, Formal Analysis, Investigation, Methodology, Writing – Original Draft Preparation MingYan Shen: Conceptualization, Supervision, Writing – Review & Editing YanPing Shen: Data Curation, Formal Analysis, Validation PengXia Wan: Data Curation, Validation Tian He: Data Curation, Validation.

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Data availability

The datasets analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Consent for publication

Not Applicable.

Competing interests

The authors declare no competing interests.

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