education sciences

Article

Utilization of Generative Artificial Intelligence in Nursing Education: A Topic Modeling Analysis

Won Jin Seo [1] and Mihui Kim [2,*]

[1] College of Nursing, Yonsei University, 50-1 Yonsei-ro, Seodaemun-gu, Seoul 03722, Republic of Korea; wjin.seo@gmail.com
[2] Department of Nursing Science, Jeonju University, 303 Cheonjam-ro, Wansan-gu, Jeonju 55069, Republic of Korea
* Correspondence: ystelra50@gmail.com

Abstract: The advent of artificial intelligence (AI) has prompted the introduction of novel digital technologies, including mobile learning and metaverse learning, into nursing students' learning environments. This study used text network and topic modeling analyses to identify the research trends in generative AI in nursing education for students and patients in schools, hospitals, and community settings. Additionally, an ego network analysis using strengths, weaknesses, opportunities, and threats (SWOT) words was performed to develop a comprehensive understanding of factors that impact the integration of generative AI in nursing education. The literature was searched from five databases published until July 2024. After excluding studies whose abstracts were not available and removing duplicates, 139 articles were identified. The seven derived topics were labeled as usability in future scientific applications, application and integration of technology, simulation education, utility in image and text analysis, performance in exams, utility in assignments, and patient education. The ego network analysis focusing on the SWOT keywords revealed "healthcare", "use", and "risk" were common keywords. The limited emphasis on "threats", "strengths", and "weaknesses" compared to "opportunities" in the SWOT analysis indicated that these areas are relatively underexplored in nursing education. To integrate generative AI technology into education such as simulation training, teaching activities, and the development of personalized learning, it is necessary to identify relevant internal strengths and weaknesses of schools, hospitals, and communities that apply it, and plan practical application strategies aligned with clear institutional guidelines.

Keywords: generative artificial intelligence; nursing; nursing education; nursing education research; students; patients; topic modeling

Citation: Seo, W.J.; Kim, M. Utilization of Generative Artificial Intelligence in Nursing Education: A Topic Modeling Analysis. *Educ. Sci.* **2024**, *14*, 1234. https://doi.org/10.3390/educsci14111234

Academic Editor: Han Reichgelt

Received: 23 September 2024
Revised: 6 November 2024
Accepted: 8 November 2024
Published: 11 November 2024

1. Introduction

Nurses play multiple essential roles as educators and connectors in clinical care, public health, and social services across various professional levels in a wide range of settings, including schools, hospitals, and communities [1,2]. Major societal shifts, such as the rapid spread of communicable diseases, accelerated population aging, growing concerns about health equity issues, and the development and adoption of new technologies will change the practice environment for nurses [2]. For nurses to adapt to these changing trends, it is important to ensure the quality of nursing education [1]. Therefore, nursing education needs strategies to adopt the changing social and healthcare trends [3], while also improving the quality of education.

Technological advancements have a significant impact on society and are changing faster than ever [4]. To keep up with the pace of technological advances in healthcare, nursing education needs to balance teaching with the current needs and future expectations of students in academia and nurses in clinical settings [5]. Nursing education can be broadly defined as education provided by nursing educators to nursing students, nurses,

and patients. Therefore, it is necessary to provide a wide range of educational opportunities, such as those involving wearable devices, big data (including patient data), and analytics, and increase patient engagement and empowerment to enhance professional information skills [5,6].

The emergence of new technologies brings about the possibility of changes in teaching delivery methods, improving existing teaching methods, and developing novel teaching methods [4]. The learning environment is evolving with technological advancements, incorporating innovative methods like flipped and blended learning to enhance educational outcomes both inside and outside the classroom [7–9]. These approaches promote personalized and collaborative learning, opening new possibilities for students [4,7]. In nursing education, mobile and flipped learning are increasingly utilized, with an ongoing exploration of artificial intelligence (AI) applications to further enhance these methods [10,11]. Additionally, simulation and multimedia tools are being integrated into virtual settings, such as metaverse environments, which have been shown to improve nursing students' knowledge, self-confidence, and performance compared with traditional teaching methods [12].

Generative AI is a computational technique that can generate seemingly new content, such as text, images, and audio, from training data [13]. Among generative AIs, the emergence of Chat Generative Pretrained Transformer (ChatGPT), a text-based language model, has increased the use of AI technology in various fields [14]. ChatGPT was launched by OpenAI in November 2022, and has undergone continuous development, leading to the release of GPT-4 [15]. The public release of ChatGPT has enabled many people to utilize generative AI in their daily lives, attracting considerable attention to the tool's capabilities, potential applications, and the innovative changes it could bring across various fields [16]. This release has also shifted perceptions of traditional AI tools.

A systematic literature review of nursing education using ChatGPT found that the tool was utilized in the fields of academic writing, healthcare simulation, and data modeling, with reports indicating that the use of this technology has positive effects on personal development, such as critical skills [17]. On the other hand, concerns have emerged regarding several ethical issues, such as plagiarism, the generation of incorrect or misleading information, bias, and lack of privacy and data security [14,17]. Additionally, there is concern about the potential for excessive reliance on technology in educational settings [17]. Accuracy and reliability in nursing education are linked to patient safety and play a crucial role in the provision of high-quality healthcare services [18]. Therefore, it is necessary to establish actionable strategies that will guide the use of these generative AI tools ethically, with the ultimate goal of utilizing this technology to improve the quality of nursing practice and education [19]. However, the existing literature focuses on AI and nursing education or ChatGPT and its application in nursing student education [6,17,20].

For nursing educators to safely and effectively integrate generative AI technology into their education, it is necessary to consider a broad range of possible learning environments (such as schools, hospitals, and communities) and diverse learners. Thus, it is important to review research topic trends in nursing education using generative AI for students and patients in schools, hospitals, and community settings. Additionally, by exploring the strengths, weaknesses, opportunities, and threats (SWOT) of using generative AI in current nursing education, this study provides an overview of internal and external factors, which can suggest future research directions. Furthermore, ego network analysis using SWOT words provides a comprehensive understanding of the factors that impact integrating generative AI technology in education [21]. Therefore, this study aimed to explore research trends in the use of generative AI in nursing education through text network analysis and ego network analysis focused on SWOT.

2. Materials and Methods

This study used text and ego network analyses to explore the core keywords and research topics on generative AI in nursing education. The analysis was conducted using Netminer [22].

2.1. Data Search and Collection

The literature was searched in five electronic databases (PubMed, CINAHL, Embase, Web of Science, and Scopus) using search terms. Search terms were constructed by combining keywords such as "generative AI", "large language models", and "nursing" using Boolean operators. A total of 392 articles were retrieved from the five databases, with 171 duplicates, and 82 articles without abstracts were removed; 139 studies were finally included in the analysis (Figure 1). All selected literature was published between 2023 and 2024, with 101 articles (72.7%) published in 2024.

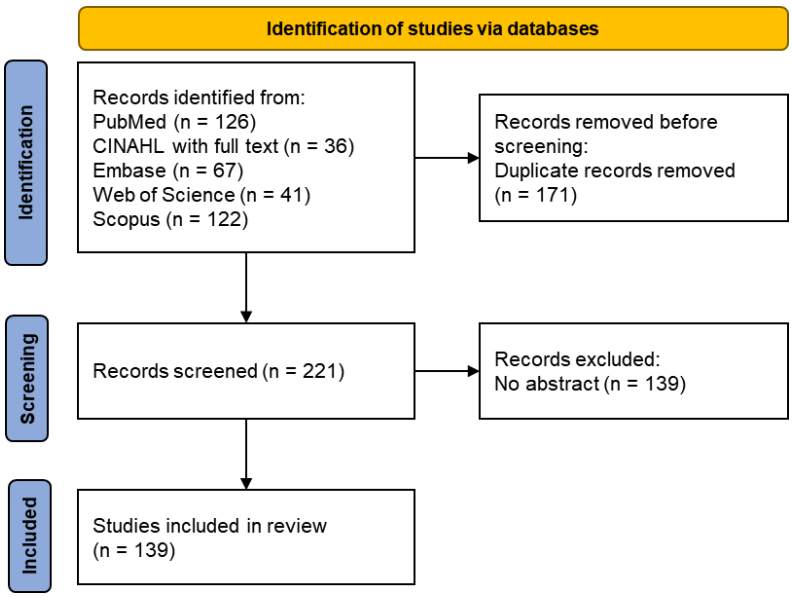

Figure 1. Selection process of studies in the nursing education field using generative artificial intelligence.

2.2. Data Preprocessing

We identified the selected literature by obtaining information on the author, year, title, journal, type, language, and abstract from the databases. The abstracts were used in the analysis because they provide similar information in fewer words compared to full-text literature [23]. For data analysis, all letters in the abstracts of the selected studies were converted to lowercase, and 1555 nouns were identified to create a user dictionary [22]. First, a defined word dictionary was established to identify significant terms that are not generally recognized as nouns; for instance, "augmented reality" was specifically designated as a noun. Second, a thesaurus dictionary was created to standardize variations of terms, ensuring that expressions like "multiple choice questions", "multiple choice question", "multiple choice options", "mcqs", and "mcq" were consistently represented as "mcqs". Finally, a stopwords dictionary was compiled, including words such as "nursing" and "generative ai", which were used for literature search terms, such as "DALL-E", "Gemini", and "ChatGPT"; common section headers like "background", "results", and "conclusion" found in the study abstracts; country names; and meaningless words. For the creation of the user dictionary, the words included in the analysis were independently generated by each author, after which alignment between the two dictionaries was reviewed, revised, and refined. The entire process of dictionary creation was completed through discussion and consensus between the two authors.

2.3. Text Network Analysis

After data preprocessing and dictionary application, we identified 1319 keywords. The keywords were identified using term frequency and term frequency-inverse document frequency (TF-IDF). TF-IDF is a value that takes the inverse of the word frequency, which decreases as a particular word is used in many documents [24]. A higher TF-IDF value

indicates important meaning in the document [25]. The document–word network was transformed into a word–word 1-mode network for the network analysis. A word refers to a node and relationships between words are expressed as links [22]. An ego network examines relationships between words and is centered on words [26]. An ego network analysis was conducted to identify the research trends centered on the SWOT in the literature on the use of generative AI in nursing education. After entering the keywords "strength", "weakness", "opportunity", and "threat", the keywords connected to them were identified, and the top 30 words were derived by applying weights based on the network between the keywords.

2.4. Topic Modeling and Ego-Network Analysis

Topic modeling was performed using Latent Dirichlet Allocation (LDA) analysis. LDA is a probabilistic model used to discover hidden topics in documents [27]. The analysis used parameters related to topics: k represents the number of topics, and α (estimating document–topic density) and β (estimating topic–word density) were also used [28,29]. To obtain the results for coherent topics, a topic modeling evaluation tool in Netminer was used to determine the number of topics with the highest coherence score (c_v measure) [22]. The value of c_v is between 0 and 1, and the closer it is to 1, the more cohesive the topic. To determine the optimal number of topics for analysis, α and β values were set between 0.01 and 0.02, and the coherence score was calculated. The analysis revealed the highest c_v value when the number of topics was 7 (α = 0.01, β = 0.01, c_v = 0.702), followed by 9 topics (α = 0.02, β = 0.02, c_v = 0.650; α = 0.01, β = 0.02, c_v = 0.633). To explain the meaning of the selected seven topics, we reviewed the literature assigned to each topic.

3. Results

3.1. Keyword Structure of Nursing Education Using Generative AI

The top 30 keywords, according to frequency and TF-IDF, are listed in Table 1. The keywords with the highest frequency were "student", "use", "healthcare", "question", and "health", whereas the order of highest scores in TF-IDF was "virtual", "learning outcomes", "strength", "threat", and "mcqs (multiple-choice questions)".

Table 1. Top 30 keywords that emerged from research on nursing education using generative artificial intelligence.

No.	Keyword	Frequency	Keyword	TF-IDF *
1	student	192	virtual	6
2	use	110	learning outcomes	6
3	healthcare	104	strength	6
4	question	92	threat	6
5	health	91	mcqs *	6
6	technology	78	documentation	6
7	patient	76	individual	6
8	application	73	awareness	6
9	information	72	attention	6
10	learning	72	personalized learning	6
11	response	61	discipline	6
12	exam	54	technique	6
13	educator	51	leverage	6
14	practice	51	policy	6
15	concern	48	bias	6
16	accuracy	47	improvement	6
17	challenge	47	assistant	6
18	integration	44	capacity	6
19	performance	44	misuse	6
20	care	43	scale	6
21	potential	40	image	5
22	development	38	answer	5
23	skill	38	interview	5

Table 1. *Cont.*

No.	Keyword	Frequency	Keyword	TF-IDF *
24	training	37	medication	5
25	image	34	adult	5
26	knowledge	34	precision	5
27	text	34	weakness	5
28	opportunity	33	thinking	5
29	time	32	advice	5
30	scenario	31	pilot	5

* TF-IDF = term frequency-inverse document frequency; mcqs = multiple-choice questions.

3.2. Topic Modeling on the Research of Nursing Education Using Generative AI

As a result of the evaluation for topic modeling, the highest c_v coherence score was 0.702 when the number of topics was seven (α = 0.01, β = 0.01). The main keywords of Topic 1 were "healthcare", "use", "science", "application", and "future", and Topic 1 was named "usability in future scientific applications" (Figure 2; Table 2). Topic 2 (application and integration of technology) included keywords such as "application", "integration", "healthcare", "technology", and "challenge". Topic 3 consisted of keywords like "student", "skill", "simulation", "healthcare", and "learning", and was named "simulation education". Topic 4 was the least distributed (5.7%) of the seven topics, with "image", "participant", "student", "text", and "score" as the main keywords, and was labeled "utility in image and text analyses". Topic 5 (performance in exams) included keywords such as "question", "exam", "accuracy", "answer", and "performance". Topic 6 had the highest distribution among the derived topics (28.8%) and was named "utility in assignments" with the keywords "student", "use", "learning", "educator", and "practice". Finally, Topic 7 embedded keywords such as "health", "patient", "healthcare", "care", and "information", and was labeled as "patient education" with the keywords.

Table 2. Topic names and top 20 keywords in research on nursing education using generative artificial intelligence.

	Topic 1	Topic 2	Topic 3	Topic 4	Topic 5	Topic 6	Topic 7
Topic name	Usability in future scientific applications	Application and integration of technology	Simulation education	Utility in image and text analyses	Performance in exams	Utility in assignments	Patient education
Elements	Educator	Educator	Student	Data	Student	Student	Patient
No. of articles (%)	9 (6.5%)	30 (21.6%)	19 (13.7%)	8 (5.7%)	14 (10.1%)	40 (28.8%)	19 (13.6%)
1	healthcare	application	student	image	question	student	health
2	use	integration	skill	participant	exam	use	patient
3	science	healthcare	simulation	student	accuracy	learning	healthcare
4	application	technology	healthcare	text	answer	educator	care
5	future	challenge	learning	score	performance	practice	information
6	faculty	concern	scenario	process	response	technology	rate
7	database	use	technology	quality	student	assignment	response
8	item	impact	patient	symptom	score	benefit	treatment
9	framework	medicine	virtual	filter	college	knowledge	intervention
10	assessment	guideline	health	information	employability	opportunity	professional
11	trend	capability	communication	reliability	error	teaching	outcome
12	theme	practice	interaction	skin	ability	course	field
13	accuracy	training	system	tone	mcqs	concern	satisfaction
14	country	role	competency	diagnosis	information	risk	level
15	discipline	potential	time	question	level	researcher	question
16	value	approach	development	mean	difference	writing	caregiver
17	expert	development	training	design	NLE *	challenge	content
18	opinion	support	program	university	licensing	task	post
19	user	narrative	support	Hep *	explanation	experience	potential
20	source	field	design	Ar *	knowledge	text	time

* ar = augmented reality; hep = health empowerment program; NLE = nurse licensure examination.

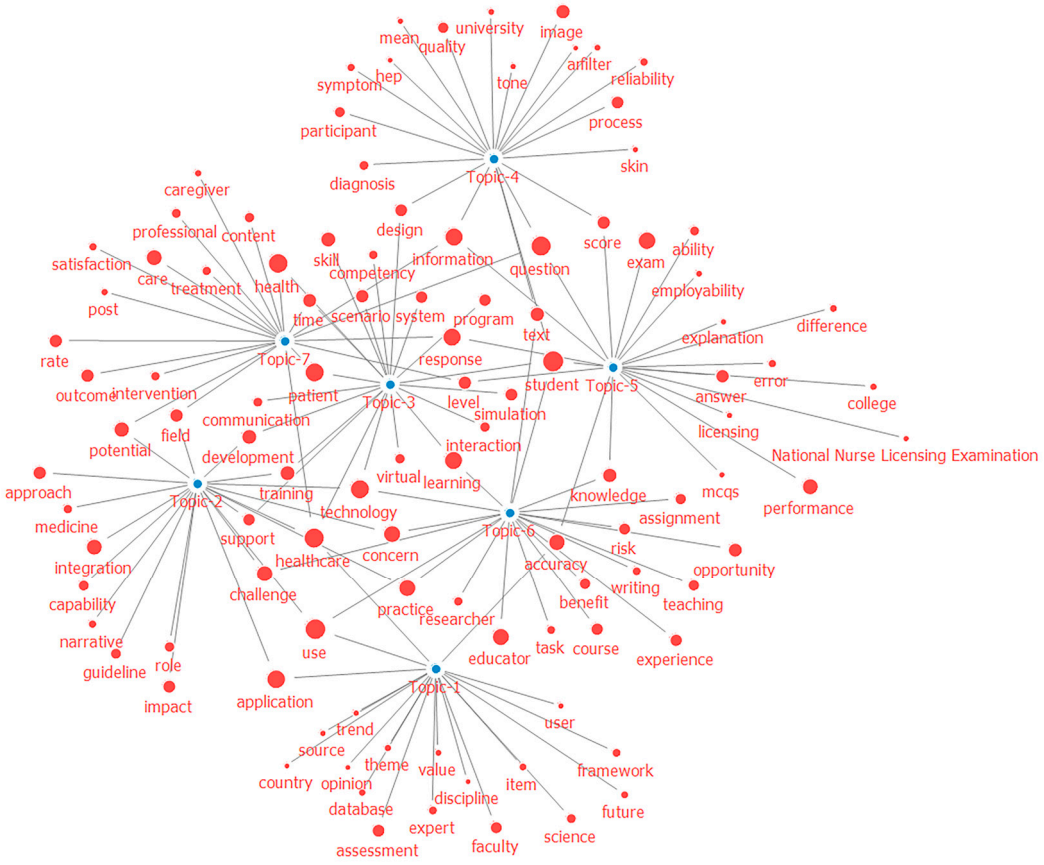

Figure 2. Topic modeling in research on nursing education using generative artificial intelligence.

These seven topics were categorized as educational elements. Topics 1 and 2 corresponded to "educator"; Topics 3, 5, and 6 were related to "student". Topics 4 and 5 were categorized as "data" and "patient", respectively.

3.3. Ego Network Analysis with Strength, Weakness, Opportunity, and Threat

As a result of the ego network analysis using SWOT words, the keywords associated with "strength" were "use", "healthcare", "risk", "task", and "student"; the keywords associated with "weakness" were "use", "healthcare", "risk", "strength", and "opportunity"; the keywords associated with "opportunity" were "use", "healthcare", "student", "application", and "educator"; and the keywords associated with "threat" were "use", "healthcare", "opportunity", "student", and "risk", in that order (Table 3). Figure 3 visualizes the ego network analysis by focusing on "strength", "weakness", "opportunity", and "threat", and the common keywords across the four categories were "healthcare", "use", and "risk". The keywords "task" and "student" were common between "strength" and "opportunity"; keywords such as "practice", "integration", and "training" were related to "opportunity".

Table 3. Top 20 keywords by weight focused on strength, weakness, opportunity, and threat.

Strength		Weakness		Opportunity		Threat	
Keywords	**Weight**	**Keywords**	**Weight**	**Keywords**	**Weight**	**Keywords**	**Weight**
use	27	use	22	use	58	use	23
healthcare	27	healthcare	21	healthcare	41	healthcare	20
risk	16	risk	14	student	32	opportunity	18
task	15	strength	13	application	31	student	15
student	14	opportunity	11	educator	27	risk	14
weakness	13	task	11	risk	26	task	12

Table 3. *Cont.*

Strength		Weakness		Opportunity		Threat	
Keywords	**Weight**	**Keywords**	**Weight**	**Keywords**	**Weight**	**Keywords**	**Weight**
opportunity	13	threat	9	challenge	25	health	12
threat	11	participant	8	health	23	strength	11
integration	9	round	8	technology	22	weakness	9
participant	8	educator	7	system	20	participant	8
round	8	integration	7	learning	19	round	8
educator	8	student	6	practice	18	integration	7
decision making	7	health	6	threat	18	context	7
patient	7	patient	6	teaching	17	challenge	6
benefit	7	benefit	6	integration	17	learning	6
challenge	7	challenge	5	task	15	text	6
application	6	process	5	impact	14	information	6
learning	6	learning	5	strength	13	patient	6
experience	6	implementation	4	training	13	benefit	6
learning outcomes	6	communication	4	concern	13	educator	6

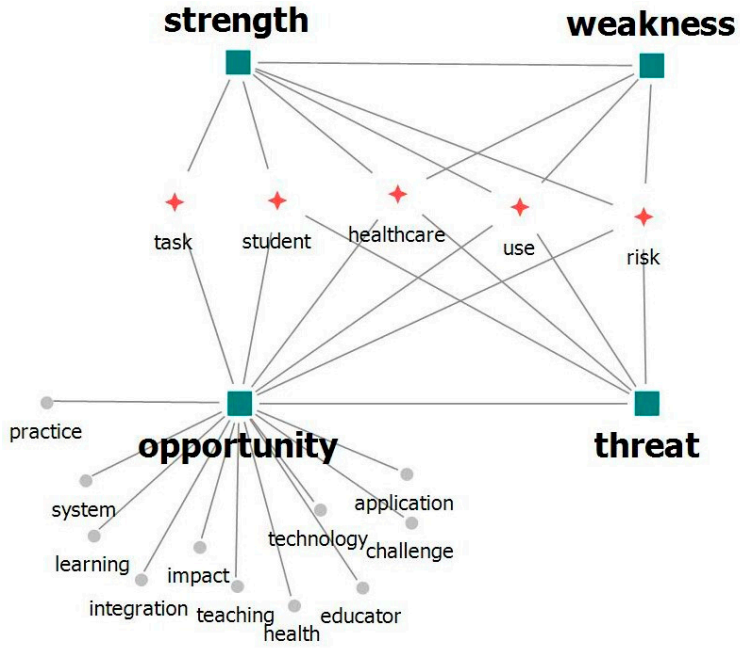

Figure 3. Ego network analysis focusing on strength, weakness, opportunity, and threat.

4. Discussion

This study investigated research trends in nursing education using generative AI through text and ego network analyses, focusing on SWOT elements. Using LDA topic modeling, seven key topics were identified, as follows: usability in future scientific applications, application and integration of technology, simulation education, utility in image and text analysis, performance on exams, utility in assignments, and patient education. These topics were categorized into four elements of nursing education, as follows: educators (Topics 1 and 2), students (Topics 3, 4, and 5), patients (Topic 7), and data (Topic 4).

The first element, "educator", was linked to Topics 1 (usability in future scientific applications) and 2 (application and integration of technology), comprising about 30% of the literature. These topics included keywords highlighting the educator's perspective on the future use of technology in healthcare education. The derived topics were integrated with ego network analysis centered on SWOT, revealing that generative AI is largely viewed as an "opportunity" in nursing education. In contrast, keywords related to "strength", "weakness", and "threat" were less prominent in the literature, suggesting limited discussion

on these aspects. As "opportunity" is an external factor in the SWOT framework [30], the limited focus on "threat" (external factor) and "strength" and "weakness" (internal factors) indicates that these areas remain relatively underexplored in nursing education. Recent studies have highlighted potential threats, such as ethical and legal concerns, and weaknesses, such as AI hallucinations [31,32]. In the field of education, potential risks have been highlighted regarding the use of technology, including reduced opportunities for students' critical thinking, decreased interaction and collaboration, the production of misinformation, issues of academic integrity, and risks of plagiarism and copyright infringement [33,34]. Barriers to the application of technology in education include educators' resistance and lack of institutional support [33]. Therefore, to safely and effectively implement technology in nursing education, hospitals and educational institutions should assess both internal and external factors, and develop strategic, proactive approaches to integrate these technologies. To this end, it is necessary for educational institutions to establish comprehensive and clear guidelines for generative AI-based education to guide educators and students [34]. Educators should consider the weaknesses of technology related to issues like academic integrity and plagiarism, and plan teaching methods that safely leverage the strengths of technology in alignment with educational institutional guidelines and support.

The second element, "student", was linked to Topics 3, 5, and 6, accounting for over 50% of the literature. Among these, Topic 6 (utility in assignments) represented the highest proportion at 28.8%, followed by Topic 3 (simulation education) and Topic 5 (performance in exams). These findings align with a scoping review on generative AI, which explored its potential roles in medical education, such as self-directed learning, simulation scenarios, and writing assistants [35]. Topic 6 focused on how students use technology for assignments, with keywords such as "benefit", "concern", and "writing". This aligns with studies highlighting generative AI's role in supporting student writing tasks [36,37], although it also raises concerns about biased data and plagiarism that need attention [38]. Topic 3 emphasizes improving communication skills through simulation-based training, particularly by integrating conversational AI, which addresses the limitations of traditional simulation methods [39]. This highlights the growing significance of simulation-based training in nursing education. In nursing simulation education, the use of generative AI has been reported to offer the potential for easier and faster development and enhancement of innovative simulation scenarios and evaluation tools [40,41]. It has also been suggested that generative AI can increase student immersion in simulation settings, thereby enhancing the effectiveness of education [39,42]. However, due to the potential for misinformation, missing information, or incomplete information in simulation education, the development process cannot be fully replaced by AI. This indicates the need for educators to be aware of these limitations and to use this tool with caution to ensure appropriate and effective integration [40]. Topic 5, "performance in exams", involved keywords such as "accuracy", "performance", "score", and "error". This topic is particularly relevant for assessing performance, as generative AI can handle tasks like question answering and text summarization [13,43]. In nursing, generative AI has been evaluated using questions from the nursing licensing exam. Although it showed limitations in accurately answering open-ended questions and handling complex content, it still met passing criteria [44,45]. Consequently, integrating diverse assessment methods, including face-to-face or oral exams, alongside traditional approaches, has been suggested [43]. Therefore, strategic approaches are needed to incorporate advanced technologies into student assessments.

The third element, "patient", was linked to Topic 7 (patient education), accounting for 13.6% of the literature, and included the keywords "information", "response", "treatment", "satisfaction", and "caregiver". This indicates that the use of generative AI in nursing education encompasses students in schools and patients and caregivers in hospitals and communities. The recent literature has shown that generative AI may improve patient engagement and enhance communication with healthcare providers by generating customized text responses to patient inquiries, allowing patients to access information relevant to their conditions [46,47]. In contrast, in patient education using generative AI, the lack

of reliability due to the provision of inappropriate information in nursing interventions and medication management, as well as potential biases in training datasets leading to misinformation and bias in developed algorithms, could impact patient safety [48]. Therefore, nurses need to consider the weaknesses of technology used in education and clearly define the areas in which technology can be applied to maintain patient safety. That is, although educators are encouraged to use it to draft patient education materials, patients using it for self-management should not be encouraged [46]. Considering the strengths and weaknesses of using generative AI in patient education, it is necessary to explore ways to use technology to create specific educational modules suitable for target patients.

Finally, "data" was linked to Topic 4 (utility in image and text analyses), accounting for 5.7% of the literature, and included keywords such as "image", "text", "symptom", "filter", and "skin". Among the derived topics, Topic 4 showed that generative AI can be used as a tool to generate images, texts, and videos in education, which is significant because it can provide learners with an innovative educational experience through multimodal learning [49–51]. The "data" element was found to have relatively less attention (5.7%) among all the literature, with only one study published in 2023 and the rest in 2024. ChatGPT is being actively utilized, with GPT-3.5 only generating text output in response to text input. Beyond this, GPT-4 now allows image input within prompts, enabling context consideration for images [52]. Consequently, future research is expected to see increased activity in the area of image and text analysis. Therefore, generative AI is expected to help educators create audiovisual materials, such as clinical images, as a multimodal learning tool to enhance the realism of education. Our study has some limitations. First, abstracts of the selected literature were used for analysis. While abstracts provide essential information in fewer words, they may not fully capture the depth and nuances of the full text, which can limit the interpretation of findings if the abstract does not comprehensively represent the full text. Second, the study was not conducted in chronological order, which restricts our ability to analyze research trends over time. Given the relatively recent surge in interest in generative AI, all selected literature on its application in nursing education was published between 2023 and 2024. Future research should consider conducting a time-based analysis. Lastly, in topic modeling, subjective criteria based on researchers' judgments may influence both data preprocessing and the interpretation process, requiring careful consideration when interpreting the results.

5. Conclusions

This study explored research trends in nursing education using generative AI through text network analysis, topic modeling, and ego network analysis. The seven derived topics were categorized into four educational elements: educator, student, patient, and data. By organizing topics derived from educational elements, nursing education using generative AI is being implemented in schools, hospitals, or communities, and efforts are being made to apply this technology to education. Although this technology is utilized in simulation training, exams, and assignments in school education, it is separated into only one topic (Topic 7) in the area of patient education; future research should be actively conducted to apply technology to patient education. Additionally, although research is actively being conducted to recognize the opportunity to utilize generative AI in nursing education, relatively little research has been conducted to identify the internal strengths and weaknesses of utilizing technology in schools, hospitals, and communities where education is to be applied. Therefore, to integrate generative AI technology into education, institutions, educators, and nurses should identify the strengths and weaknesses of the internal factors and establish practical strategic plans aligned with clear institutional guidelines. This approach will enable generative AI to be effectively utilized as a tool for simulation training, teaching activities, and the development of personalized learning.

Author Contributions: Conceptualization, M.K.; methodology, W.J.S. and M.K.; software, W.J.S.; validation, W.J.S. and M.K.; formal analysis, W.J.S.; resources, W.J.S. and M.K.; data curation, W.J.S. and M.K.; writing—original draft preparation, W.J.S. and M.K.; writing—review and editing, W.J.S.

and M.K.; visualization, W.J.S.; supervision, M.K.; project administration, M.K.; funding acquisition, M.K. All authors have read and agreed to the published version of the manuscript.

Funding: This work was supported by the National Research Foundation of Korea (NRF) grant funded by the Korea government (MSIT) (RS-2024-00357844).

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: The data presented in this study are available upon reasonable request from the corresponding author.

Conflicts of Interest: The authors declare no conflicts of interest.

References

1. Baker, C.; Cary, A.H.; da Conceicao Bento, M. Global standards for professional nursing education: The time is now. *J. Prof. Nurs.* **2021**, *37*, 86–92. [CrossRef] [PubMed]
2. National Academy of Medicine. *The Future of Nursing 2020–2030: Charting a Path to Achieve Health Equity*; National Academy of Sciences: Washington, DC, USA, 2021.
3. van Kraaij, J.; Veenstra, M.; Stalpers, D.; Schoonhoven, L.; Vermeulen, H.; van Oostveen, C.; RN2Blend Consortium. Uniformity along the way: A scoping review on characteristics of nurse education programs worldwide. *Nurse Educ. Today* **2023**, *120*, 105646. [CrossRef] [PubMed]
4. Demir, K.A. Smart education framework. *Smart Learn. Environ.* **2021**, *8*, 29. [CrossRef]
5. Risling, T. Educating the nurses of 2025: Technology trends of the next decade. *Nurse Educ. Pract.* **2017**, *22*, 89–92. [CrossRef] [PubMed]
6. Buchanan, C.; Howitt, M.L.; Wilson, R.; Booth, R.G.; Risling, T.; Bamford, M. Predicted influences of artificial intelligence on nursing education: Scoping review. *JMIR Nurs.* **2021**, *4*, e23933. [CrossRef]
7. Lage, M.J.; Platt, G.J.; Treglia, M. Inverting the classroom: A gateway to creating an inclusive learning environment. *J. Econ. Educ.* **2000**, *31*, 30–43. [CrossRef]
8. Güzer, B.; Caner, H. The past, present and future of blended learning: An in depth analysis of literature. *Procedia Soc. Behav. Sci.* **2014**, *116*, 4596–4603. [CrossRef]
9. Oberer, B. 'Flipped MIS'. The mobile flipped classroom approach shown in the example of mis courses. *Int. J. u-and e-Serv. Sci. Technol.* **2016**, *9*, 379–390. [CrossRef]
10. Ozyurt, O. Empirical research of emerging trends and patterns across the flipped classroom studies using topic modeling. *Educ. Inf. Technol.* **2023**, *28*, 4335–4362. [CrossRef]
11. Yalcinkaya, T.; Cinar Yucel, S. Mobile learning in nursing education: A bibliometric analysis and visualization. *Nurse Educ. Pract.* **2023**, *71*, 103714. [CrossRef]
12. De Gagne, J.C.; Randall, P.S.; Rushton, S.; Park, H.K.; Cho, E.; Yamane, S.S.; Jung, D. The use of metaverse in nursing education: An umbrella review. *Nurse Educ.* **2023**, *48*, E73–E78. [CrossRef] [PubMed]
13. Feuerriegel, S.; Hartmann, J.; Janiesch, C.; Zschech, P. Generative ai. *Bus. Inf. Syst. Eng.* **2024**, *66*, 111–126. [CrossRef]
14. Athilingam, P.; He, H.-G. ChatGPT in nursing education: Opportunities and challenges. *Teach. Learn. Nurs.* **2024**, *19*, 97–101. [CrossRef]
15. ChatGPT—Release Notes. Available online: https://help.openai.com/en/articles/6825453-chatgpt-release-notes#h_026e1e86a4 (accessed on 5 November 2024).
16. Neumann, M.; Rauschenberger, M.; Schön, E.M. We need to talk about ChatGPT": The future of AI and higher education. In Proceedings of the IEEE/ACM 5th International Workshop on Software Engineering Education for the Next Generation (SEENG), Melbourne, Australia, 16 May 2023; Volume 2023, pp. 29–32. [CrossRef]
17. Gunawan, J.; Aungsuroch, Y.; Montayre, J. ChatGPT integration within nursing education and its implications for nursing students: A systematic review and text network analysis. *Nurse Educ. Today* **2024**, *141*, 106323. [CrossRef]
18. Liu, J.; Liu, F.; Fang, J.; Liu, S. The application of chat Generative Pre-trained Transformer in nursing education. *Nurs. Outlook* **2023**, *71*, 102064. [CrossRef]
19. Abdulai, A.F.; Hung, L. Will ChatGPT undermine ethical values in nursing education, research, and practice? *Nurs. Inq.* **2023**, *30*, e12556. [CrossRef]
20. Hwang, G.-J.; Tang, K.-Y.; Tu, Y.-F. How artificial intelligence (ai) supports nursing education: Profiling the roles, applications, and trends of ai in nursing education research (1993–2020). *Interact. Learn. Environ.* **2022**, *32*, 373–392. [CrossRef]
21. Farrokhnia, M.; Banihashem, S.K.; Noroozi, O.; Wals, A. A SWOT analysis of ChatGPT: Implications for educational practice and research. *Innov. Educ. Teach. Int.* **2024**, *61*, 460–474. [CrossRef]
22. Cyram. *Netminer*, Version 4.5; Cyram Inc.: Seoul, Republic of Korea, 2022.
23. Cao, Q.; Cheng, X.; Liao, S. A comparison study of topic modeling based literature analysis by using full texts and abstracts of scientific articles: A case of COVID-19 research. *Libr. Hi Tech* **2023**, *41*, 543–569. [CrossRef]

24. Lee, S.-J.; Kim, H.-J. Keyword extraction from news corpus using modified TF-IDF. *J. Soc. e-Bus Stud.* **2009**, *14*, 59–73.
25. Park, J.; Park, H.; Jung, S.; Lim, K. An analysis of research trends on personalized learning: Using TF-IDF, LDA based text mining. *Korean J Educ. Methodol. Stud* **2022**, *34*, 711–739.
26. Lee, S.-S. *Network Analysis Methods*; Non Hyoung: Seoul, Republic of Korea, 2012.
27. Blei, D.M. Probabilistic topic models. *Commun. ACM* **2012**, *55*, 77–84. [CrossRef]
28. Egger, R.; Yu, J. A topic modeling comparison between lda, nmf, top2vec, and bertopic to demystify twitter posts. *Front. Sociol.* **2022**, *7*, 886498. [CrossRef] [PubMed]
29. Zoya, S.; Latif, S.; Shafait, F.; Latif, R. Analyzing LDA and NMF Topic Models for Urdu Tweets via Automatic Labeling. *IEEE Access* **2021**, *9*, 127531–127547. [CrossRef]
30. Puyt, R.W.; Lie, F.B.; Wilderom, C.P.M. The origins of SWOT analysis. *Long Range Plann.* **2023**, *56*, 102304. [CrossRef]
31. Yu, P.; Xu, H.; Hu, X.; Deng, C. Leveraging generative ai and large language models: A comprehensive roadmap for healthcare integration. *Healthcare* **2023**, *11*, 2776. [CrossRef]
32. Oniani, D.; Hilsman, J.; Peng, Y.; Poropatich, R.K.; Pamplin, J.C.; Legault, G.L.; Wang, Y. Adopting and expanding ethical principles for generative artificial intelligence from military to healthcare. *NPJ Digit. Med.* **2023**, *6*, 225. [CrossRef]
33. Bonacaro, A.; Rubbi, I.; Artioli, G.; Monaco, F.; Sarli, L.; Guasconi, M. AI and Big Data: Current and future nursing practitioners' views on future of healthcare education provision. *Stud. Health Technol. Inform.* **2024**, *315*, 200–204. [CrossRef] [PubMed]
34. Topaz, M.; Peltonen, L.M.; Michalowski, M.; Stiglic, G.; Ronquillo, C.; Pruinelli, L.; Song, J.; O'Connor, S.; Miyagawa, S.; Fukahori, H. The ChatGPT effect: Nursing education and generative artificial intelligence. *J. Nurs. Educ.* **2024**, 1–4. [CrossRef]
35. Preiksaitis, C.; Rose, C. Opportunities, challenges, and future directions of generative artificial intelligence in medical education: Scoping review. *JMIR Med. Educ.* **2023**, *9*, e48785. [CrossRef]
36. Parker, J.L.; Becker, K.; Carroca, C. ChatGPT for automated writing evaluation in scholarly writing instruction. *J. Nurs. Educ.* **2023**, *62*, 721–727. [CrossRef] [PubMed]
37. Singh, H.; Tayarani-Najaran, M.-H.; Yaqoob, M. Exploring computer science students' perception of ChatGPT in higher education: A descriptive and correlation study. *Educ. Sci.* **2023**, *13*, 924. [CrossRef]
38. Kim, J.; Yu, S.; Detrick, R.; Li, N. Exploring students' perspectives on generative ai-assisted academic writing. *Educ. Inf. Technol.* **2024**, 1–36. [CrossRef]
39. Benfatah, M.; Marfak, A.; Saad, E.; Hilali, A.; Nejjari, C.; Youlyouz-Marfak, I. Assessing the efficacy of ChatGPT as a virtual patient in nursing simulation training: A study on nursing students' experience. *Teach. Learn. Nurs.* **2024**, *19*, e486–e493. [CrossRef]
40. Rodgers, D.L.; Needler, M.; Robinson, A.; Barnes, R.; Brosche, T.; Hernandez, J.; Poore, J.; VandeKoppel, P.; Ahmed, R. Artificial intelligence and the simulationists. *Simul. Healthc.* **2023**, *18*, 395–399. [CrossRef]
41. Vaughn, J.; Ford, S.H.; Scott, M.; Jones, C.; Lewinski, A. Enhancing healthcare education: Leveraging ChatGPT for innovative simulation scenarios. *Clin. Simul. Nurs.* **2024**, *87*, 101487. [CrossRef]
42. Reed, J.M.; Dodson, T.M. Generative ai backstories for simulation preparation. *Nurse Educ.* **2024**, *49*, 184–188. [CrossRef] [PubMed]
43. Dwivedi, Y.K.; Kshetri, N.; Hughes, L.; Slade, E.L.; Jeyaraj, A.; Kar, A.K.; Baabdullah, A.M.; Koohang, A.; Raghavan, V.; Ahuja, M.; et al. Opinion paper: "So what if ChatGPT wrote it?" multidisciplinary perspectives on opportunities, challenges and implications of generative conversational ai for research, practice and policy. *Int. J. Inf. Manag.* **2023**, *71*, 102642. [CrossRef]
44. Huang, H. Performance of ChatGPT on registered nurse license exam in Taiwan: A descriptive study. *Healthcare* **2023**, *11*, 2855. [CrossRef]
45. Miao, Y.; Luo, Y.; Zhao, Y.; Li, J.; Liu, M.; Wang, H.; Chen, Y.; Wu, Y. Performance of gpt-4 on Chinese nursing examination: Potentials for ai-assisted nursing education using large language models. *Nurse Educ.* **2024**, *49*, E338–E343. [CrossRef]
46. Johnson, S.B.; King, A.J.; Warner, E.L.; Aneja, S.; Kann, B.H.; Bylund, C.L. Using ChatGPT to evaluate cancer myths and misconceptions: Artificial intelligence and cancer information. *JNCI Cancer Spectr.* **2023**, *7*, pkad015. [CrossRef] [PubMed]
47. Yan, M.; Cerri, G.G.; Moraes, F.Y. ChatGPT and medicine: How ai language models are shaping the future and health related careers. *Nat. Biotechnol.* **2023**, *41*, 1657–1658. [CrossRef] [PubMed]
48. Abujaber, A.A.; Abd-Alrazaq, A.; Al-Qudimat, A.R.; Nashwan, A.J. A strengths, weaknesses, opportunities, and threats (SWOT) analysis of ChatGPT integration in nursing education: A narrative review. *Cureus* **2023**, *15*, e48643. [CrossRef]
49. AlShaikh, R.; Al-Malki, N.; Almasre, M. The implementation of the cognitive theory of multimedia learning in the design and evaluation of an ai educational video assistant utilizing large language models. *Heliyon* **2024**, *10*, e25361. [CrossRef] [PubMed]
50. Imran, M.; Almusharraf, N. Google gemini as a next generation ai educational tool: A review of emerging educational technology. *Smart Learn. Environ.* **2024**, *11*, 22. [CrossRef]
51. Lee, G.-G.; Shi, L.; Latif, E.; Gao, Y.; Bewersdorf, A.; Nyaaba, M.; Guo, S.; Wu, Z.; Liu, Z.; Wang, H. Multimodality of ai for education: Towards artificial general intelligence. *arXiv* **2023**, arXiv:2312.06037. [CrossRef]
52. GPT-4. Available online: https://openai.com/research/gpt-4 (accessed on 4 November 2024).