

Visualizing Reasoning: Concept Mapping to Elevate Critical Thinking among Nursing Undergraduates of Sikkim, India

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ABSTRACT

Background: Critical thinking is an essential competency for nurses working in increasingly complex healthcare environments. Traditional teaching approaches often emphasize rote memorization and may not adequately promote higher-order critical thinking skills. The concept mapping approach has proven to be an effective tool for fostering meaningful learning through linking theory with practice. **Objectives:** To determine the effectiveness of concept mapping in educational settings as a learning method for enhancing the development of critical thinking among third-year B.Sc. nursing students at Sikkim Manipal College of Nursing, India. **Methods:** A quantitative randomized controlled pretest–posttest study was conducted among third-year B.Sc. nursing students. Sixty students were selected using simple random sampling from a total population of 90 eligible students and randomly allocated to either the intervention group (n = 30) or the control group (n = 30) using a lottery method. The experimental group underwent a concept mapping intervention for 12 weeks, while the control group engaged in conventional nursing care plans. Assessment of critical thinking skills was done using a Critical Thinking Questionnaire (CTHQ), which is linked to the six cognitive domains of Bloom's. Analysis of data used both descriptive and inferential statistics such as *t*-tests, independent *t*-tests, chi-square, or Fisher's exact test. **Results:** Critical thinking scores increased significantly in the experimental group following concept mapping (81.67 ± 9.01 vs. 99.97 ± 9.43 ; $t = 8.722$, $p < 0.001$), compared with a smaller improvement in the control group (77.73 ± 10.53 vs. 82.26 ± 10.23 ; $t = 4.871$, $p < 0.001$). Post-test scores were significantly higher in the experimental group across all cognitive domains ($p < 0.05$), with large within-group and between-group effect sizes. **Conclusion:** Students who received concept mapping demonstrated significantly higher critical thinking scores than those who received conventional nursing care planning. These findings suggest that concept mapping may be an effective learner-centered teaching strategy for strengthening critical thinking among undergraduate nursing students.

Keywords: Cognition; Concept Formation; Education; Nursing; Students; Thinking

INTRODUCTION

Critical thinking is generally recognized as an essential competency for nursing education and practice (Papathanasiou *et al.*, 2014). In contemporary healthcare systems, nurses need to cope with complex patient conditions, interpret clinical information accurately, prioritize care needs, and make evidence-based decisions to ensure safe and effective patient outcomes (Profetto-McGrath, 2003). Critical thinking allows nurses to analyze the situation and make appropriate decisions. Nurses are expected to apply critical thinking in different healthcare settings and to solve clinical problems (Papathanasiou *et al.*, 2014). Therefore, the cultivation of critical thinking skills should be one of the primary goals of undergraduate nursing education (Polit & Beck, 2021).

The growing complexity of healthcare systems has increased the demand for nurses who possess strong critical thinking and clinical decision-making abilities (Papathanasiou *et al.*, 2014). Nursing students are expected not only to acquire theoretical knowledge but also to apply it effectively in clinical practice. Traditional teaching methods often emphasize rote memorization and may not adequately promote higher-order thinking

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skills (Lee *et al.*, 2013). Consequently, nursing students may experience difficulty applying theoretical knowledge to clinical situations (Abo-Elenein Abdallah *et al.*, 2023).

Critical thinking is a continuum of mental functions including interpretation, analysis, evaluation, inference, and reflection. This process is essential to clinical reasoning, problem-solving, and evidence-based practice in nursing. Critical thinking is associated with improved clinical judgment among nursing students (Profetto-McGrath, 2003). It also supports effective clinical decision-making and evidence-based nursing practice (Papathanasiou *et al.*, 2014). For this reason, nursing instructors consistently explore new ways to promote critical thinking among their students.

Concept mapping is an educational approach that has received much scholarly interest. Concept mapping refers to a visual-learning approach whereby learners can organize, relate, and integrate their knowledge through hierarchically diagramming the relationship between different concepts. The approach has evolved from the work done by Ausubel with regard to meaningful learning and later refined by Novak and Cañas (2008), who anticipated that concept maps enable learners to integrate new information into their cognitive frameworks to promote deep understanding and long-term knowledge about various topics. Concept maps are widely used in nursing education to integrate patient information, nursing diagnoses, interventions, and outcomes (Kandula & Wake, 2021). Recent evidence also supports concept mapping as an effective strategy for promoting critical thinking and meaningful learning across health professions education (Fonseca *et al.*, 2024).

The advantage of using concept mapping as a teaching tool involves its potential to promote active learning and reflective practices as well as integrating knowledge. Recent studies demonstrate the benefits of applying case-based concept mapping as a way not only to improve understanding of pathophysiology but also to develop critical thinking abilities in nursing students (Pratiwi *et al.*, 2024). Unlike linear care plans used by nurses, concept maps require learners to identify the connections between several variables and create images of complicated situations in clinics. These processes contribute to developing analytical skills and clinical reasoning abilities. Furthermore, integrating concept maps with simulated clinical scenarios has been shown to enhance nursing students' learning confidence and promote active engagement in clinical learning (Lin *et al.*, 2022). The previous research has demonstrated that concept mapping positively affects students' capacity to synthesize data, identify patients' priorities, and apply theoretical knowledge in practice (Hope *et al.*, 2006; Gerdeman *et al.*, 2013).

Recent studies support the efficacy of concept mapping in the context of nursing education. According to Wilgis and McConnell (2008), there were significant developments in the essential skills of critical thinking graduate nurses after using concept mapping in their orientation programs. In addition to that, Kaddoura (2011) demonstrated that the use of concept mapping facilitated nursing students' capacity to critically evaluate patient scenarios and link theory and practice. A systematic review and meta-analysis carried out by Yue *et al.* (2017) also indicated that concept mapping resulted in significant improvements in the critical thinking results of nursing students. More contemporary evidence further supports the positive impacts of concept mapping on students' critical thinking skills, decision-making, and learning involvement. For example, Dirgar *et al.* (2024) found that the use of concept mapping had a positive impact on motivation to develop critical thinking skills among nursing students. Also, Ammar *et al.* (2024) observed significant progress in critical thinking skills of students of pediatric nursing after using concept mapping methods. A recent scoping review by Thapa *et al.* (2025) further highlighted that concept mapping consistently strengthens nursing students' critical thinking, clinical reasoning, and patient-centered decision-making across diverse educational settings.

Despite growing international evidence supporting concept mapping, its integration into nursing education remains inconsistent across institutions (Smitha *et al.*, 2023). Traditional teaching approaches continue to predominate in many nursing programs, limiting opportunities for higher-order thinking and knowledge integration (Sinatra-Wilhelm, 2012). Although concept mapping has demonstrated positive educational outcomes internationally, evidence from undergraduate nursing students in India, particularly the North-Eastern region, remains limited (Smitha *et al.*, 2023). Therefore, context-specific evidence is needed to support curriculum development and innovative teaching strategies in nursing education (Faraji *et al.*, 2025).

Given the limited regional evidence, the present study evaluated the effectiveness of concept mapping in

enhancing critical thinking among undergraduate nursing students at Sikkim Manipal College of Nursing. The findings may support the integration of learner-centered teaching strategies into undergraduate nursing curricula.

The specific objectives are

- To evaluate the effectiveness of concept mapping in improving critical thinking among undergraduate nursing students.
- To compare post-intervention critical thinking scores between students receiving concept mapping and those receiving conventional nursing care planning.
- To determine the association between selected demographic variables and critical thinking outcomes among undergraduate nursing students.

METHODOLOGY

This study employed a quantitative randomized controlled pretest–posttest study design to evaluate the effectiveness of concept mapping as a teaching-learning strategy for enhancing critical thinking among undergraduate nursing students. A randomized controlled design was chosen to compare the effectiveness of concept mapping with the conventional nursing care plan approach while minimizing selection bias through random allocation of participants into intervention and control groups (Polit & Beck, 2021).

The study was conducted at Sikkim Manipal College of Nursing, Sikkim Manipal University, Gangtok, India, which offers undergraduate nursing education. The study population consisted of 90 third-year Bachelor of Science (B.Sc.) Nursing students enrolled during the study period. Third-year students were selected because they had completed the foundational nursing courses and were actively involved in clinical learning, making them suitable participants for evaluating concept mapping as a teaching-learning strategy (Abdallah *et al.*, 2023). The study population comprised 90 eligible third-year B.Sc. nursing students. From this population, 60 students who fulfilled the eligibility criteria and provided written informed consent were selected using a simple random sampling technique based on a lottery method. The remaining 30 students continued with the routine educational activities of the institution but were not enrolled in the study and were therefore not included in the analysis.

The sample size was determined considering the available eligible population, the feasibility of implementing a structured 12-week educational intervention, and the institutional resources available for conducting the study. Following participant selection, the 60 students were randomly allocated in a 1:1 ratio into either the experimental group ($n = 30$) or the control group ($n = 30$) using a lottery method. Individual identification numbers were written on identical slips of paper, thoroughly mixed in an opaque container, and randomly drawn to allocate participants into the two study groups. This process ensured that every selected participant had an equal probability of being assigned to either group.

Study Instruments

Demographic Proforma

A structured demographic questionnaire was used to obtain baseline information regarding participants' age, place of residence, previous knowledge of critical thinking, academic performance, study hours, exposure to problem-based learning, and related educational characteristics.

Critical Thinking Questionnaire (CThQ)

Critical thinking was assessed using the CThQ developed based on Bloom's revised taxonomy, covering the cognitive domains of remembering, understanding, applying, analyzing, evaluating, and creating. The questionnaire underwent pilot testing to assess clarity and feasibility before the main study. Content validity was established through expert evaluation, yielding a Content Validity Index (CVI) of 0.91, while internal consistency reliability was acceptable (Cronbach's $\alpha = 0.84$). Scores were categorized as poor, average, satisfactory, and excellent (Abo-Elenein Abdallah *et al.*, 2023; Binoy, 2023).

Concept Map Grading Criteria

Students' concept maps were evaluated using a structured grading rubric that assessed hierarchical organization, conceptual accuracy, cross-linkages, logical relationships, and completeness of nursing care planning. Performance was classified into poor, average, and satisfactory categories according to the total score obtained.

Intervention

Experimental Group

Students in the experimental group participated in a structured concept mapping program conducted over 12 weeks, with one 60-minute supervised session each week during clinical postings. Sessions were facilitated by two nursing faculty members. The initial session included an orientation to concept mapping and its application in nursing care planning, followed by a demonstration using standardized clinical case scenarios. Students received written guidelines for concept map development. During subsequent sessions, they independently developed concept maps based on clinical case scenarios while receiving faculty guidance and feedback to improve conceptual organization and clinical reasoning. Each concept map was evaluated using standardized grading criteria, and individual feedback was provided to reinforce learning.

Control Group

Students in the control group received routine clinical teaching using the conventional nursing care plan approach. They participated in the same clinical postings and received comparable faculty supervision but were not exposed to concept mapping. Traditional nursing care plans were prepared using standardized clinical case scenarios according to the existing institutional teaching methodology.

Data Collection Procedure

Data collection was conducted in three phases: baseline assessment, intervention implementation, and post-intervention assessment. After obtaining ethical approval and written informed consent, baseline demographic information and pre-test critical thinking scores were collected from both groups using the demographic questionnaire and the CThQ under standardized classroom conditions. The intervention was then implemented over a period of 12 weeks according to the assigned group. Upon completion of the intervention, post-test critical thinking scores were collected from both groups using the same questionnaire under identical assessment conditions. All assessments were administered by the principal investigator to ensure consistency in data collection procedures (Binoy, 2023). To ensure intervention fidelity, all concept mapping sessions followed a standardized instructional protocol and were delivered by the same trained faculty members throughout the study period (Ammar *et al.*, 2024).

Statistical Analysis

Data were analyzed using the Statistical Package for the Social Sciences (SPSS) version 27.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics, including frequency, percentage, mean, and standard deviation, were used to summarize the demographic characteristics and critical thinking scores of the participants. Prior to inferential statistical analysis, the normality of the continuous variables was assessed using the Shapiro–Wilk test, along with visual inspection of histograms and normal Q–Q plots. The results indicated that the data were normally distributed ($p > 0.05$); therefore, parametric statistical tests were considered appropriate. Paired *t*-tests were used to compare pre-test and post-test critical thinking scores within each group, whereas independent *t*-tests were used to compare mean scores between the experimental and control groups. A chi-square test or Fisher's exact test, as appropriate, was used to examine associations between selected demographic variables and critical thinking outcomes. Effect sizes were calculated using Cohen's *d*. Statistical significance was established at $p < 0.05$, and 95% confidence intervals were reported where appropriate.

Ethical Considerations

Ethical approval was obtained from the Institutional Ethics Committee of the Sikkim Manipal Institute of Medical Sciences, Sikkim, India, with the reference number SMIMS/IEC/2022-09 on 5th March 2022.

Written informed consent was obtained from all participants before data collection. Participation was voluntary, and confidentiality and anonymity were maintained throughout the study. Participants were informed of their right to withdraw from the study at any time without any academic consequences.

RESULTS

Socio-demographic Profile of Nursing Students in Experimental Group and Control Group

Table 1: Frequency and Percentage Distribution of Demographic Variables of Nursing Students in Experimental and control Group (n=60)

Sl. No	Demographic Variables	Experimental Group (N=30)		Control Group (N=30)		χ^2 / Fisher's exact test	p-value	Association with Critical Thinking
		f	%	f	%			
1	Age in Years							
	20	8	26.7	9	30	0.275	0.871	NS
	21	17	56.6	15	50			
	22	5	16.7	6	20			
	23	0	0	0	0			
2	Place of Residence							
	Hosteller	6	20	17	55.7	8.531	0.003*	S
	Day scholar	24	80	13	43.3			
3	Previous Knowledge							
	Yes	1	3.3	16	53.3	18.46	0.001*	S
	No	29	96.7	14	46.7			
4	Senior Secondary School Percentage							
	45% - 55%	0	0	0	0	1.184	0.553	NS
	55.1% - 65%	0	0	1	3.3			
	65.1% - 75%	14	46.7	12	40			
	Above 75.1%	16	53.3	17	56.7			
5	5th Semester University Exam Result Percentage							
	50% - 60%	5	16.7	6	20	1.228	0.746	NS
	60.1% - 70%	20	66.6	19	63.4			
	70.1% - 80%	5	16.7	4	13.3			
	Above 80.1%	0	0	1	3.3			
6	Average No. of Study Hours							
	1-2 hours	11	36.7	23	76.7	10.78	0.012*	S
	2.5 – 3.5 hours	16	53.3	6	20			
	4-5 hours	1	3.3	1	3.3			
	More than 5 hours	2	6.7	0	0			
7	As a Student in Nursing, Which Statement BEST Describes Your Experience with Problem-based Learning?							
	"I have been involved with problem-based seminars during each term of each year"	11	36.7	11	36.7	2.073	0.557	NS
	"I have been enrolled in specific course(s) that have used only problem-based learning"	4	13.3	1	3.3			
	"I have been enrolled in some courses which have utilized a problem-based learning approach"	10	33.3	12	40			
	"I have never experienced problem-based learning while I have been in the program"	5	16.7	6	20			

*Note: f= Frequency; %=Percentage; S= Significant; NS = Not Significant; $p < 0.05$; χ^2 =Chi-square Test; Fisher's exact test was applied where expected cell frequencies were less than 5

A total of 60 third-year B.Sc. nursing students participated in the study, with 30 students each in the experimental and control groups. The groups were comparable with respect to age, academic performance, and

previous exposure to problem-based learning ($p>0.05$). Significant baseline differences were observed only for place of residence, prior knowledge of critical thinking, and average study hours ($p<0.05$) (Table 1).

Table 2: Distribution of Performance in Concept Mapping and Nursing Care Plans in Experimental Group and Control Group (n=30)

Concept Mapping Criteria	Poor		Average		Good		Mean
	<i>f</i>	%	<i>f</i>	%	<i>f</i>	%	
Pre-clinical 1		0	15	50	15	50	15.23
Pre-clinical 2	0	0	12	40	18	60	15.63
Post clinical 1	0	0	14	46.7	16	53.3	14.96
Post clinical 2	0	0	13	43.3	17	56.7	15.16
Post clinical 3	0	0	10	33.3	20	66.7	15.66
Post clinical 4	0	0	11	36.7	19	63.3	16.10
Post clinical 5	0	0	10	33.3	20	66.7	15.76
Post clinical 6	0	0	16	53.3	14	46.7	15.50
Post clinical 7	0	0	11	36.7	19	63.3	15.86
Post clinical 8	0	0	12	40	18	60	15.90

*Note: *f*= Frequency; %=Percentage

Table 2 summarizes concept mapping performance among students in the experimental group. Most students demonstrated average to good performance throughout the intervention, with no participants classified in the poor category.

Table 3: Distribution of Level of Nursing Care Plan Score as Per Traditional Linear Care Plan Format Criteria in Control Group (n=30)

Nursing Care Plan Score	Poor		Average		Good		Mean
	<i>f</i>	%	<i>f</i>	%	<i>f</i>	%	
Pre-clinical 1	0	0	27	90	3	10	13.30
Pre-clinical 2	0	0	26	86.7	4	13.3	13.43
Post clinical 1	0	0	25	83.3	5	16.7	13.13
Post clinical 2	0	0	25	83.3	5	16.7	13.40
Post clinical 3	0	0	22	73.3	8	26.7	13.80
Post clinical 4	0	0	23	76.7	7	23.3	14.33
Post clinical 5	0	0	20	66.7	10	33.3	14.50
Post clinical 6	0	0	25	83.3	5	16.7	14.16
Post clinical 7	0	0	22	73.3	8	26.7	14.26
Post clinical 8	0	0	24	80	6	20	14.56

*Note: *f*= Frequency; %=Percentage

Table 3 presents nursing care plan performance in the control group. Most students remained in the average category throughout the study, while only a small proportion achieved satisfactory performance.

Pre-test and Post-test Level of Critical Thinking Score of Nursing Students (N=30)

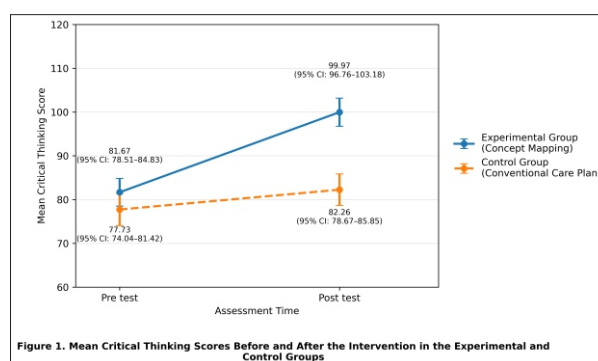


Figure 1: Mean Critical Thinking Scores Before and After the Intervention in the Experimental and Control Groups

Figure 1 shows that both groups demonstrated improvement in critical thinking scores after the intervention. However, the increase was substantially greater in the experimental group than in the control group. Prior to inferential statistical analysis, the normality of the critical thinking scores was assessed using the Shapiro-Wilk test and visual inspection of histograms and normal Q-Q plots. The results indicated that the data were normally distributed ($p > 0.05$). Therefore, parametric statistical tests were used for all subsequent analyses.

Effectiveness of Pre-test and Post-test Critical Thinking Score of Nursing Students (Within the Group)

Table 4: Effectiveness of Concept Mapping and Traditional Plans (Within-Group Comparisons) in Improving Critical Thinking Skills within the Experimental Group and Control Group (n=60, n=30 per group)

Group	Pre-test Mean $\pm$ SD	Post-test Mean $\pm$ SD	Mean Difference	95% CI of Mean Difference	t value	p-value
Experimental (n=30)	81.67 $\pm$ 9.01	99.97 $\pm$ 9.43	18.30	14.01 to 22.59	8.722	0.001*
Control (n=30)	77.73 $\pm$ 10.53	82.26 $\pm$ 10.23	4.53	2.63 to 6.43	4.871	0.001*

*Note: SD = Standard Deviation; CI = Confidence Interval; * $p < 0.05$ Statistically significant

Within-group analysis demonstrated statistically significant improvements in critical thinking scores in both groups ($p < 0.001$). However, the magnitude of improvement was considerably greater in the experimental group than in the control group (Table 4).

Effectiveness of Pre-test and Post-test Critical Thinking Score of Nursing Students (Between the Group)

Table 5: Comparison of Domain Wise Post-test Critical Thinking Skills of Nursing Students Between Experimental Group and Control Group (n=60)

Domain	Experimental Group (Mean $\pm$ SD)	Control Group (Mean $\pm$ SD)	Mean Difference	95% CI of Mean Difference	t value	p-value
Analyzing	15.56 $\pm$ 2.31	12.86 $\pm$ 1.56	2.70	1.68 to 3.72	5.288	0.001*
Evaluating	20.50 $\pm$ 2.58	17.73 $\pm$ 3.11	2.76	1.29 to 4.25	3.743	0.001*
Creating	16.16 $\pm$ 1.87	12.63 $\pm$ 2.82	3.53	2.29 to 4.77	5.710	0.001*
Remembering	11.86 $\pm$ 1.50	10.86 $\pm$ 1.45	1.00	0.24 to 1.76	2.618	0.011*
Understanding	15.80 $\pm$ 1.95	13.36 $\pm$ 2.38	2.43	1.31 to 3.55	4.322	0.001*
Applying	16.63 $\pm$ 2.38	13.76 $\pm$ 2.75	2.86	1.53 to 4.19	4.313	0.001*

*Note: SD = Standard Deviation; CI = Confidence Interval; * $p < 0.05$ statistically significant

Students in the experimental group achieved significantly higher post-test scores than those in the control group across all six cognitive domains of Bloom's revised taxonomy ($p < 0.05$) (Table 5).

Table 6: Comparison of Pre-test and Post-test Critical Thinking Skills of Nursing Students Between Experimental Group and Control Group (n=60)

Comparison	Experimental Group (Mean $\pm$ SD)	Control Group (Mean $\pm$ SD)	Mean Difference	95% CI of Mean Difference	t value	p value
Pre-test	81.67 $\pm$ 9.01	77.73 $\pm$ 10.53	3.93	-1.13 to 8.99	1.555	0.125 ^{NS}
Post-test	99.97 $\pm$ 9.43	82.26 $\pm$ 10.23	17.70	12.61 to 22.79	6.966	0.001*

*Note: SD = Standard Deviation; CI = Confidence Interval; NS = Not Significant; * $p < 0.05$ statistically significant

No significant difference was observed between the groups at baseline ($p = 0.125$). Following the intervention, the experimental group demonstrated significantly higher overall critical thinking scores than the control group ($p < 0.001$) (Table 6).

Association of Nursing Students' Critical Thinking Scores in the Experimental Group and the Control Group with Demographic Variables

Table 7: Associations between Demographics and Critical Thinking in Experimental and Control Groups (n=60, n=30 per group)

Demographic Variable	Experimental Group χ^2 (p-value)	Control Group χ^2 (p-value)	Significance
Age	1.968 (0.374 NS)	0.602 (0.740 NS)	Not significant
Residence	3.750 (0.053 NS)	1.833 (0.176 NS)	Not significant
Prior knowledge	2.069 (0.150 NS)	1.429 (0.232 NS)	Not significant
Senior secondary %	0.067 (0.796 NS)	1.242 (0.537 NS)	Not significant
Exam % (5th Sem)	5.925 (0.052 NS)	2.898 (0.408 NS)	Not significant
Study hours	0.827 (0.843 NS)	2.011 (0.366 NS)	Not significant
Problem-based learning	0.320 (0.956 NS)	4.432 (0.218 NS)	Not significant
Course on critical thinking	0.517 (0.472 NS)	0.690 (0.406 NS)	Not significant
Belief in importance of CT	6.057 (0.048*)	3.426 (0.180 NS)	Significant in Experimental group only

*Note: * $p < 0.05$ level of significance; NS=Non significance; χ^2 =Chi-square Test

No significant associations were observed between most demographic variables and critical thinking scores in either group ($p > 0.05$). A significant association was identified only between students' belief in the importance of critical thinking and critical thinking scores in the experimental group ($p = 0.048$) (Table 7).

DISCUSSION

The present randomized controlled study evaluated the effectiveness of concept mapping as a teaching-learning strategy for undergraduate nursing students. Students allocated to the concept mapping group demonstrated significantly higher post-test critical thinking scores than those receiving conventional nursing care planning. These findings suggest that concept mapping may contribute to improved critical thinking among undergraduate nursing students (Yue *et al.*, 2017).

The greater improvement observed among students in the experimental group may be explained by the learner-centered characteristics of concept mapping. By encouraging learners to organize, integrate, and analyze information visually, concept mapping promotes active engagement with learning content and meaningful knowledge construction. Positive feedback from both students and educators regarding concept mapping has also been reported, particularly in relation to engagement, knowledge organization, and learner participation (El Amouri & Nkosi, 2024). The theoretical basis of concept mapping is grounded in Ausubel's theory of meaningful learning and the work of Novak and Cañas (2008), who emphasized the importance of linking new knowledge with existing cognitive structures to enhance understanding and retention.

A notable finding of the study is the improvement observed across all six cognitive domains of Bloom's revised taxonomy. Students in the experimental group demonstrated significantly higher post-test scores in remembering, understanding, applying, analyzing, evaluating, and creating compared with students in the control group. The greatest improvements were observed in the higher-order cognitive domains of analyzing, evaluating, and creating, suggesting that concept mapping facilitates advanced cognitive processes essential for clinical judgment and evidence-based decision-making. These findings indicate that concept mapping promotes both knowledge integration and higher-order reasoning skills that are critical for professional nursing practice. The findings of the present study are consistent with the previous study, which reported that concept mapping enhanced graduate nurses' critical thinking skills during a hospital orientation program (Wilgis & McConnell, 2008). Similarly, another study found that concept mapping improved nursing students' ability to critically analyze patient scenarios and integrate theoretical knowledge into clinical practice (Kaddoura, 2011). Furthermore, in a systematic review and meta-analysis, it concluded that concept mapping is an effective educational strategy for enhancing critical thinking among nursing students across diverse educational settings (Yue *et al.*, 2017). Similar improvements in critical thinking following concept mapping interventions have also been reported among nursing students in Jordan, supporting the applicability of concept mapping across diverse educational settings (Khrais & Saleh, 2020). Recent evidence also demonstrates the positive influence of concept mapping on critical thinking and decision-making in nursing education (Faraji *et al.*, 2025). The consistency of findings across different educational contexts strengthens

the evidence supporting concept mapping as an effective educational strategy. By contrast, students in the control group who continued with traditional care plans demonstrated only marginal improvement, echoing the findings of Pike and O'Donnell (2010) that lecture-based and linear methods often fail to trigger higher-order thinking. Similar patterns have been reported by Wilgis and McConnell (2008), highlighting the limitations of care plans that encourage checklist-driven thinking instead of integrative reasoning.

The present study also examined the association between selected demographic variables and critical thinking outcomes. No significant associations were observed with most demographic characteristics. A significant association was identified only between students' belief in the importance of critical thinking and critical thinking outcomes in the experimental group, suggesting that positive attitudes toward critical thinking may enhance engagement in higher-order learning activities. Although baseline differences were observed in residence, prior knowledge of critical thinking, and study hours, these variables did not appear to influence post-test critical thinking outcomes. The greater improvement in the experimental group suggests that concept mapping was associated with enhanced critical thinking, consistent with previous evidence indicating that educational strategies have a greater influence on critical thinking than demographic characteristics (Golden, 2023).

Recent evidence has continued to support the impact of concept mapping on nursing education. According to Dirgar *et al.* (2024), concept mapping improves the level of motivation in thinking critically of nursing students. Ammar *et al.* (2024) also showed improvement in critical thinking among pediatric nursing students. The use of concept mapping to improve critical thinking in undergraduate students in Indian nursing education has also been highlighted by Smitha *et al.* (2023). Moreover, Onabadejo's (2023) scoping review reveals that concept mapping is consistently associated with higher post-test scores.

The findings have important implications for nursing education and curriculum development. In recent reviews, increasing attention has been focused on the integration of concept maps into the nursing simulation-based education curriculum (Innis *et al.*, 2023). Contemporary healthcare environments require nurses who are capable of analyzing complex information, solving clinical problems, and making evidence-based decisions. Similar benefits have been observed with other learner-centered educational approaches, which have demonstrated positive effects on professional competence and higher-order thinking among nursing students (Chang *et al.*, 2024). Concept mapping provides a structured approach that encourages active learning, knowledge integration, and reflective thinking. Incorporating concepts of mapping into nursing care planning, simulation-based learning, clinical conferences, and other educational activities may strengthen students' critical thinking and clinical reasoning abilities. Recent educational innovations have similarly demonstrated the value of active and interactive learning strategies in improving nursing students' learning outcomes and engagement (Choenarom & Samputtanon, 2025).

The present study adds to the limited evidence on concept mapping in Indian nursing education. The findings support the integration of concept mapping into undergraduate nursing curricula as an innovative learner-centered strategy to enhance critical thinking and clinical reasoning skills.

Limitations

This study has several limitations. The relatively small sample from a single institution may limit the generalizability of the findings. The 12-week intervention did not allow assessment of the long-term retention of critical thinking skills. Although participants were randomly allocated, baseline differences in residence, prior knowledge of critical thinking, and study hours were not adjusted for in the analysis. Despite these limitations, the findings suggest that concept mapping may be an effective teaching–learning strategy for enhancing critical thinking among undergraduate nursing students.

Future Scope

Future multicenter studies involving larger and more diverse samples are recommended to improve the generalizability of the findings. Longitudinal research is also needed to evaluate the long-term retention of critical thinking skills and to explore the effectiveness of digital and simulation-integrated concept mapping in enhancing student learning and clinical decision-making.

CONCLUSION

The findings of the present study suggest that concept mapping may serve as a valuable learner-centered teaching strategy for undergraduate nursing education. Students who participated in concept mapping demonstrated higher critical thinking scores than those receiving conventional nursing care planning. Integrating concept mapping into nursing education may strengthen critical thinking, clinical reasoning, and evidence-informed decision-making among nursing students. Further multicenter randomized studies involving larger samples are recommended to confirm these findings.

AI Assistance Declaration

The authors used generative Artificial Intelligence (AI) solely to improve the language, grammar, readability, and presentation of the manuscript. All AI-generated outputs were critically reviewed, edited, and verified by the authors. The authors accept full responsibility for the accuracy, integrity, and originality of the manuscript, including all scientific interpretations, analyses, conclusions, and intellectual contributions.

CRedit Authorship Contribution Statement

B. D.: Conceptualization, Methodology, Investigation, Data Curation, Formal Analysis, Writing – Original Draft Preparation, Project Administration. C. S.: Methodology, Supervision, Validation, Writing – Review and Editing. S. P.: Investigation, Data Collection, Resources, Project Administration, Writing – Review and Editing. N. L.: Investigation, Data Collection, Resources, Validation, Writing – Review and Editing.

Conflict of Interest

The authors declare that there are no conflicts of interest regarding the publication of this study.

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