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The effectiveness of case-based concept map to improve pathophysiology knowledge and critical thinking among first-year nursing students: a quasi-experimental study

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ABSTRACT

Introduction: Improving pathophysiology knowledge and critical thinking skills of nursing students remains as a challenge faced by nursing educators. To improve those, an innovative learning method is required. Concept map by adding cases might assist increasing students' pathophysiology knowledge and critical thinking skills.

Methods: A quasi-experimental study with pre- and post-test with control group design involved 104 first-year nursing students of Universitas Jenderal Soedirman, Purwokerto, Central Java from April to June 2023. Participants were divided into two classes at the beginning of the first semester and randomly allocated into the intervention group (54 respondents) and the control group (50 respondents). The intervention group was provided typical learning added with a case-based concept map development weekly for 7 weeks, while the control group underwent regular lectures based on the syllabus. Pathophysiology knowledge was measured by using Multiple Choice Questions, while critical thinking was evaluated by using the Critical Thinking Disposition Inventory questionnaire. Independent-t test and paired test were applied to evaluate the effectiveness of implementing the case-based concept map.

Results: The mean score for knowledge the pathophysiology of the disease in the intervention group was significantly higher than the those in the control group (t =5.24, p = 0.000). However, there was no difference in the average scores of critical thinking between two groups discovered in the study (t =0.90, p = 0.37).

Conclusions: Case-based concept map can be recommended as an innovative and effective learning method for teaching disease pathophysiology to nursing students. However, the case-based concept map in this study is still not consistent in improving students' critical thinking skills.

Keywords: critical thinking, nursing education, nursing students, pathophysiology understanding

Introduction

A comprehensive understanding of pathophysiology is fundamental to the clinical nursing practice, whether pathophysiology material is taught in a separate course or integrated with other courses in the nursing curriculum. The pathophysiology is part of bioscience knowledge becoming progressively more crucial due to the disease complexity (Taylor *et al.*, 2015). It provides patients safe, comprehensive care and establishes credibility with other medical professionals and patients (Ashelford, Raynsford and Taylor, 2016). Pathophysiology of disease also assists students to perceive patients more as the most affected parties by the disease process and entitled to receive qualified

care to improve quality of life from their illness (Cheng, Zhao and Guo, 2016).

Although mastering pathophysiology and its application in clinical practice is a predictor of success in nursing, this material is challenging and tough. New nurses and nursing students have to put in a lot of effort to learn it (Dunn, Osborne and Rakes, 2013; Van Horn *et al.*, 2014; El Hussein, Salyers and Osuji, 2016a). Nursing students discovered the pathophysiology course was quite terrifying (due to the extensive content, the degree of difficulty degree, and the lack of connectivity between biomedical concepts, nursing subjects and subsequent nursing clinical practice. Therefore, students do not recognise the importance of disease pathophysiology in the undergraduate learning process (Craft *et al.*, 2013).

Pathophysiology understanding relates to critical thinking skills. The high pathophysiology knowledge becomes a foundation to increase the critical thinking skills and clinical reasoning among nursing students in providing nursing care (Fonseca *et al.*, 2020). The ability to think critically allows students to recognise important information and discriminate between issues that are life-threatening and those that don't require immediate attention (Shirazi and Heidari, 2019). The critical thinking in disease pathophysiology is essential in determining how to organise patients' nursing care, to encounter complicated issues and make quick decisions in order to determine the needs of patients and implement optimal nursing practices and patient safety (Kaddoura, Van-Dyke and Yang, 2016; Ali-Abadi, Babamohamadi and Nobahar, 2020).The American Association of Colleges of Nursing (2021) also concurs that it is crucial for recent nursing graduates to exercise critical thinking when resolving issues in various clinical settings. However, several studies reported that nursing students acquired low critical thinking skills (Shirazi and Heidari, 2019; Nemati-Vakilabad *et al.*, 2023). Moreover, Azizi-Fini, Hajibagheri and Adib-Hajbaghery (2015) found poor critical thinking skills in both first-year and senior nursing students.

Meanwhile, as nursing educator, escalating nursing students' pathophysiology knowledge and critical thinking skills is a challenge. Taylor et al. (2015) recommended that, to improve comprehension, application and integration of pathophysiology knowledge, a greater variety of biosciences teaching and learning techniques should be included. Ninety per cent of students agreed that the relevance of nursing learning to patients' disease process supported with bioscientists' teaching approach that prioritises on student needs is able to contribute increase students' knowledge of patient conditions and students' confidence for caring for the patients (Christensen et al., 2015). Numerous active learning techniques, both individual and group, encouraging students and teachers to engage in problem analysis and discussion, and encouraging self-directed learning are several strategies that could be employed to enhance critical thinking among nursing students (Shirazi and Heidari, 2019). Therefore, innovative learning methods in pathophysiology and critical thinking require to be improved and added in nursing education.

Concept map is a creative learning method that is able to link the theory and clinical practice. This method was first originated by Novak and Gowin (1984). Concept maps connect concepts with linkages and nodes that provide explanations, displaying ideas in a hierarchical graphical structure (Machado and Carvalho, 2020). The effectiveness of concept mapping for improving student learning quality has been consistently shown, and it has been well-received in higher education. This teaching method is repeatedly proven to have positive and significant effect in critical thinking skills of nursing students (Lee *et al.*, 2013a; Kaddoura, Van-Dyke and Yang, 2016; Bilik, Kankaya and Deveci, 2020). Meanwhile, there has only been limited research on the application concept map on the pathophysiology knowledge of nursing students. Previous studies applied visual narrative illustrations (El Hussein, Salyers and Osuji, 2016b), blended learning (Blissitt, 2016), and team-based learning ((Branney and Priego-Hernández, 2018) in escalating pathophysiological knowledge among nursing students. In addition, the current study applies a modification in concept map by adding vignettes or cases as triggers for students to compile a concept map consisting of signs and symptoms of disease experienced by patients as well as physical examinations and supporting examinations carried out and their results. Therefore, this research was conducted with the aim of evaluating pathophysiology knowledge and critical thinking skills after applying the concept map with the case among nursing students.

Materials and Methods

Design

This research was a quasi-experimental study with a pre-test/post-test with a control group design.

Setting and Sample

This study was conducted from April to June 2023. All 110 first-year nursing students who had registered for the Nursing Biomedical Science course were recruited to the study. Because of the large number of the students, all respondents were divided at the beginning of the first semester into two 54 and 56-student group classes for the four-year education programme. Both classes were randomly allocated to either an intervention or a control group through coin flipping. This study included all active first-year nursing students (110 students). Meanwhile, students who declined to participate were excluded from this study.

Methods

The study spanned a period of seven weeks. The control and intervention groups attended different classes. All respondents in both groups remained in each class until the research was completed. In addition, different day schedules for the pre-test, post-test and interventions were arranged for both groups The pre-test was carried out in week 8 of course learning because the disease pathophysiology material began to be taught in the Basic Science in Nursing course from week 9. The intervention and the control group filled out questionnaires via the Google Form and worked on questions through the University's Learning Management system (ELDIRU) on different days. The intervention group and control group filled out questionnaires and quizzes on different days through the learning management system site and online forms. Then, the intervention group was provided with training on making concept maps using the Cmaptools software. Concept map creation was carried out by the intervention group every week with different topics, while the control group attended usual lectures based on the course syllabus. In week 15, both groups completed the post-test on different days through the ELDIRU website and Google Form.

Measurement and Data Collection

Respondents filled out a respondent characteristic questionnaire and a Critical Thinking questionnaire through the Google Form. The critical thinking skills questionnaire used in this study was the Chinese Version of the Critical Thinking Disposition Inventory (Huang and Yeh, 2017). This instrument consists of 20 questions with a Likert scale of 1-6 (1 = never, 6 = always), so the score range for this instrument was 20 - 120. This instrument consists of four domains, which are systematic and analytic ability (9 questions); open-mindedness (4 questions); curiosity (3 questions); and reflective thinking (4 questions). The score range of this instrument was 20 -120, where the higher the score obtained, the better the critical thinking ability. This instrument was culturally adapted and translated into the Indonesian language by the researchers. This instrument has also been tested for content validity by Pearson correlation with a score range of 0.426 – 0.762 and the value of the reliability test using Cronbach's alpha was 0.904, so this instrument was valid and reliable.

To evaluate the understanding of the pathophysiology of the respondent's disease, the researchers compiled a quiz consisting of 30 questions in a vignette form. Quiz questions were completed within 30 minutes through the Learning Management System. Topic questions according to the disease were prepared with a concept map. The questions were created from the textbook *Pathophysiology of Disease: An Introduction to Clinical Medicine* (Hammer and McPhee, 2018). The vignette questions were arranged in the form of multiple-choice questions by the collaboration between the research team and course coordinator focusing on clinical manifestations and studies in patients with the disease. The score range for this quiz was 0 – 100; the higher the score obtained, the higher the level of understanding of the pathophysiology of the disease that the respondent owned.

Intervention

The control group followed lectures under the syllabus of the Basic Science in Nursing course from weeks 9 to 15. The intervention group attended the lectures according to the syllabus with the addition of the Case-Based Concept Map, and the concept map application was carried out from week 9 to 15 of the Basic Science of Nursing course. The intervention group was previously given training on creating concept maps using Cmap tools software (IHMC Cmap Tools, Florida). The intervention group was divided into six small groups. Each week, these groups carried out discussions and practised constructing a case-based concept map according to the available cases, which were facilitated by the lecturers within 100 minutes per session. There were six topics of disease pathophysiology arranged in the case-based concept map creation, including the endocrine system (diabetes mellitus), the cardiorespiratory system (tuberculosis), the haematological system (anaemia), the urinary system (chronic kidney failure), the immunological system (HIV-AIDS), and digestive system (Hepatitis B). Then, the facilitator provided feedback and suggestions related to the concept map that had been prepared and presented by the intervention group at the end of the session. The post-

test was conducted at the end (week 15) of the Basic Science in Nursing course. Both groups filled out questionnaires via the Google Form and took post-test quizzes through the university's Learning Management system on different days.

Data analysis

The analysis in this study applied SPSS version 23.0, IBM Corp, New York. Frequency, percentage, mean and standard deviation were used to analyse univariate data. The chi-square test and independent t-test were performed to analyse the homogeneity of the characteristics between the two groups. To determine the difference score of pathophysiology knowledge and critical thinking between the intervention and control group, the independent t-test also was used in this bivariate analysis, while a paired t-test was used to analyse differences in data before and after treatment within the groups. The significance level considered in this study was $p < 0.05$.

Ethical Consideration

This research has received ethical clearance with number 1026/EC/KEPK/II/2023 issued by the Health Research Ethics Commission of the Faculty of Health Sciences, Universitas Jenderal Soedirman. The researchers explained the research procedure and then allocated the Google Form link for informed consent approval, respondents' characteristics questionnaire, and critical thinking skill questionnaire during the pre-test and post-test. For the control group, after the post-test was carried out, the researcher provided training on how to make a case-based concept map using the Cmap tools application and provided other cases as independent exercises. After data collection, all respondents were given a research souvenir, which was a stationery set.

Results

This study involved 110 research respondents of which104 respondents completed the study and were analysed, consisting of 54 respondents in the concept map group and 50 respondents in the control group with a participation rate of 94.54%. Two respondents declined to be involved in the research, and four respondents were excluded from the analysis due to filling out incomplete questionnaires (See Figure 1).

Based on the respondents' characteristics, the majority of respondents were female students (85.58%), had a GPA of > 3.5 (75.97%), resided outside Banyumas (70.19%), had organisational experience (74.04 %), and had no experience in participating in student competitions at both the

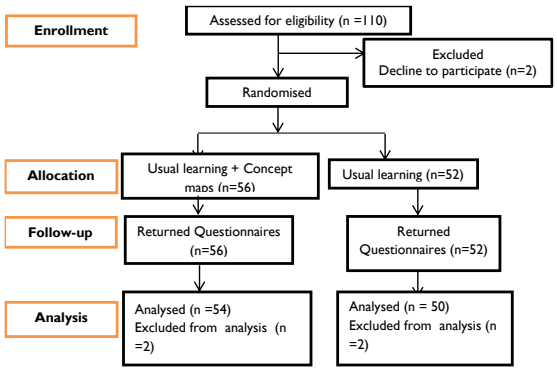

Figure 1. Participant Consort flow

national/international level (88.46%). The intervention and control groups had similar characteristics (homogeneous), except for organisational experience. Respondents in the control group had more organisational experience compared to respondents in the intervention group ($t = 4.97$, $p = 0.026$). (See Table 1.)

The mean score of pathophysiology knowledge of the disease before intervention in the concept map group (49.57 ± 11.73) and the control group (47.80 ± 11.06) was not significantly different ($t = 0.79$, $p = 0.45$). Whereas, after the intervention, the mean score for the pathophysiology knowledge in the concept group was significantly higher than those in the

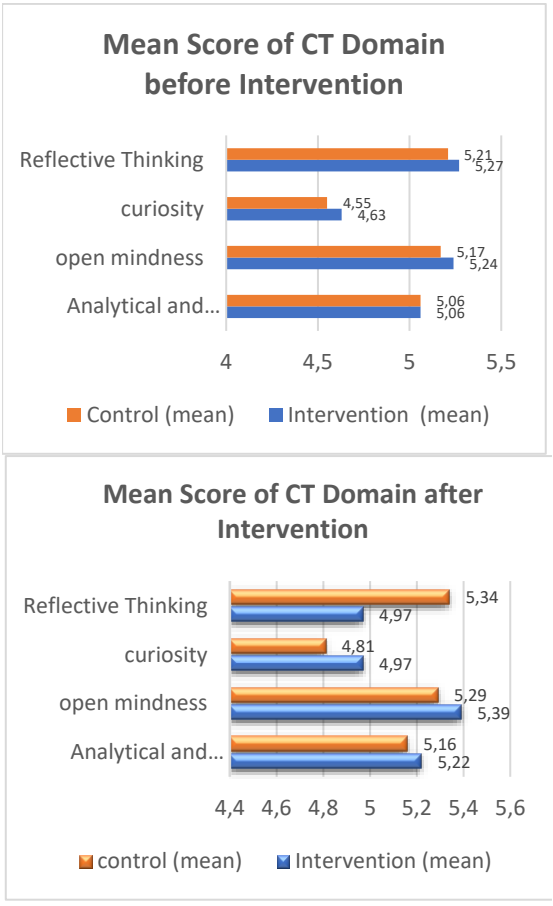

Figure. 2 Mean score of CT domains before and after intervention

Table 1. Demographic characteristics of research respondents (n=104)

Characteristics	Intervention (n=54)		Control (n=50)		Total	χ2/t	p
	mean ± SD	n (%)	Mean ± SD	n (%)	n (%)		
Age	18.67 ±0.67		18.68±0.621			0.12a	0.92
Gender							
Female		49 (47.12)		40 (38.46)	89 (85.58)	2.43b	0.12
Male		5 (4.81)		10 (9.61)	15 (14.42)		
Grade Point Average (GPA)							
3.51- 4.00		43(41.35)		36 (34.62)	79(75.97)	0.86b	0.65
≤ 3.50		11(10.57)		14 (13.46)	25(24.03)		
Origin							
Banyumas		15 (14.43)		16 (15.38)	31 (29.81)	0.22b	0.64
Outside Banyumas		39 (37.50)		34 (32.69)	73 (70.19)		
Organisational Experience						4.97b	0.026*
Yes		35(33.65)		42(40.39)	77(74.04)		
No		19(18.27)		8 (7.67)	27(25.96)		
Competition Experience						0.02b	0.89
Yes		6 (5.77)		6 (5.77)	12 (11.54)		
No		48 (46.15)		44 (42.31)	92 (88.46)		

SD = standard deviation, a = independent test, b = chi-square test, * = p < 0.05

control group (t =5,24, p = 0.000). Significant differences in knowledge scores before and after the intervention in the control group and the intervention group were also reported in this study (t = 9.05, p = 0.000) with a mean score difference of 14.58.

For critical thinking skill, before the intervention was conducted, the highest mean scores for critical thinking skills were in the domains of reflective thinking (5.24 ± 0.45) and open-mindedness (5.20 ± 0.40) (see Figure 2). The mean score of critical thinking skills in all domains before intervention in the intervention group was not significantly different (t= 0.85, p = 0.40). After the intervention, the highest score shifted to the domain of open-mindedness (5.34 ± 0.43), and there was no difference in critical thinking score in the two groups (t = 0.90, p = 0.37) (See Figure 2, Table 2). The results of the paired t-test showed a significant difference between the mean scores of critical thinking skills in nursing students before and after the intervention in both groups, except in the domain of reflective thinking (p > 0.05).

Discussions

Initial pathophysiology knowledge in the majority of nursing students was below average. Pathophysiology of disease, whether taught at the undergraduate or postgraduate level, is a subject that students and instructors fear and find most difficult (Craft *et al.*, 2013; McVicar, Andrew and Kemble, 2015; El Hussein, Salyers and Osuji, 2016b). This finding suggested that teaching pathophysiology was a challenge requiring innovative pedagogical teaching methods to assist lecturers and students (Colsch, Lehman and Tolcser, 2020). In this nursing department, disease pathophysiology was taught in the Basic Science of Nursing course in semester 2, which is a content-intensive subject, due to the combination of several disciplines including anatomy, physiology, microbiology, and anatomical pathology. In the second semester, nursing students still have minimal knowledge related to diseases and medical terms in nursing and health. This might contribute the minimal students' understanding related to the disease pathophysiology. Another possible cause was a change in nursing predominance from medical care to psychosocial aspects results in the bioscience reduction for nursing undergraduate programme. Taylor et al. (2015) reported that biosciences were taught for 20 –113 hours, mostly in the first year. This amounts to 0.24 to 2.4% of the 4600 hours that make up a preregistration nursing programme. It demonstrates that students continuously asked for additional time and emphasis on biosciences in their courses with various pedagogical teaching methods.

This study found that concept map was effective in increasing pathophysiology knowledge of nursing students. This was in line with previous studies (Saeidifard *et al.*, 2014; Kaddoura, Van-Dyke and Yang, 2016; Fonseca *et al.*, 2020). Case based concept map could be recommended as an effective learning method, especially for increasing understanding of challenging lessons or materials. Concept mapping is considered a valuable active teaching method because it encourages learners to make connections and build relationships between new concepts and previous schemata (Sadler, Stevens and Willingham, 2015). This learning methods provided more meaningful learning for the students. Meaningful learning was defined as the process of giving meaning to new knowledge by taking into account the personal

Table 2. Differences in Pathophysiological Knowledge and Critical Thinking Scores among the Intervention and Control Groups (n = 104)

Variable	Before Intervention		After Intervention		Mean difference	t value	p**
	mean	SD	Means	SD			
Pathophysiology Knowledge Score							
Intervention Group	49.57	11.73	69.14	13.18		9.05	0.000
Control Group	47.80	11.06	57.00	10.11	14.58	4.67	0.000
t-value	0.79		5.24				
p*	0.45		0.00				
Domain 1: Systematic and Analytical Thinking							
Intervention Group	45.59	3.81	46.87	3.70	1.28	2.71	0.009
Control Group	45.02	4.64	46.40	4.29	1.38	2.34	**024**
t-value	0.69		0.60				
p*	0.53		0.55				
Domain 2: Open-mindedness							
Intervention Group							
Control Group	20.98	1.41	21.56	1.44	0.57	2.89	0.006
	20.68	1.79	21.18	2.02	0.50	2.06	0.045
t-value	0.95		1.09				
p*	0.34		0.27				
Domain 3: Curiosity							
Intervention Group	13.89	1.78	14.93	1.69	1.04	3.90	0.000
Control Group	13.66	1.91	14.42	1.86	0.76	3.19	0.002
t-value	0.63		1.45				
p*	0.49		0.15				
Domain 4: Reflective Thinking							
Intervention Group	21.09	1.74	21.46	1.99	0.37	1.72	**091**
Control Group	20.84	1.89	21.36	1.65	0.52	1.99	**052**
t-value	0.71		0.29				
p*	0.48		0.78				
CT Total Score							
Intervention Group	101.56	7.28	104.81	7.59	3.21	-4.10	0.000
Control Group	100.20	8.86	103.36	8.91		-3.17	0.003
t-value	0.85		0.90				
p*	0.40		0.37				

component in cognitive structures, as well as the assimilation of linkages connecting previous and current information formed in cognitive structures using an authentic and rational approach (Correia, Cicuto and Aguiar, 2014; de Sousa *et al.*, 2016). The meaningful learning was adapted from assimilating learning theory by Ausubel (1963) which is required to be arranged in a hierarchical manner according to how relevant they are to the topic at issue. This theory was agreed by creating the concept map (Suero López *et al.*, 2020)

The application of the concept map in this study uses the Cmaps tool software (Novak and Cañas, 2006). This software integrates technology, the internet and concept maps and permits users to modify text, files, photos, source links, and other items to add extra information to the concept map. These additional features lead the interactive and collaborative work among students (Cañas and Novak, 2014). It has an appealing graphical design and employs visual codes, which contributes to higher retention of material and understanding (Cañas, Reiska and Shvaikovsky, 2023). In addition, this application is appropriate in facilitating the high technology learning process for nursing students who are Generation Z. Future education for Generation Z is recommended to make close use of technology because it has proven effective in the learning process and experiences (Ziatdinov and Cilliers, 2021).

In addition, this study uses vignette cases to test students' understanding in the form of multiple-choice questions and cases to complete the construction of the concept map. Expertly designed vignettes linked with the phenomenon under investigation may assist in the capture of respondents' beliefs, resulting in a greater comprehension of the phenomenon (Leicher and Mulder, 2018). The vignettes in this study were created from case studies and then they were consulted with the bioscience experts to provide options for triggering patient information related to the clinical manifestations of the disease in cases. Students were required to construct the concept map according to signs, symptoms and physical examination and laboratory results. The vignette cases should allow for further questions related to doubts that arise during self-learning periods, and

prove useful for promoting meaningful learning (Fonseca *et al.*, 2020).

In this study, researchers modified the concept map. Students created pathophysiology pathways with a concept map according to the available cases weekly; students had been given previous training on preparing the concept map. This modification aimed to bridge and connect pathophysiology with clinical practice, including clinical manifestations and patient outcomes in cases. Disease pathophysiology pathways accompanied by appropriate physical and supporting examinations were able to guide students in determining nursing diagnoses and interventions. The lecturers provided comments and feedback to students on concept maps that they had already constructed. Workshops and constructive feedback are essential in supporting the success of concept maps in teaching ((Harrison and Gibbons, 2013). Even though this learning method was successful, applying the concept map requires proper preparation, training for tutor lecturers, a training on creating concept map designs, and sustainable feedback for concept maps prepared by students to support its successful application.

This study found no significant difference in the improvement of critical thinking after the concept map application in intervention group compared to control group. This finding was in line with Lee et al. (2013) and Brune (2014). The high score of critical thinking of nursing students prior to intervention was a possible cause of this finding. Respondents in this study were second semester students who were still included in Generation Z, born between 1995 – 2010 (Bejtkovský, 2016). This generation has a tendency to focus on critical thinking in solving problems compared to memorising information, so that the learning process prefers concrete concepts compared to learning formulae (Gaidhani, Arora and Sharma, 2019). This is also supported by the nursing process and critical thinking courses which are also taught in the second semester at this Department of Nursing. This critical thinking ability becomes a student foundation to assist in formulating qualified and professional nursing care. Nursing students that can think critically are better able to handle complex data, plan and manage patients, and make sensible judgements (Kim and Lundberg, 2016; Berger *et al.*, 2021).

Additionally, due to the shorter application duration, low variations in critical thinking ability scores are also conceivable in both groups. Most studies reported that concept map needs to be applied within 15 – 20 weeks so as to foster critical thinking skills (Huang *et al.*, 2018; Wu and Wu, 2020). Moreover, Lee et al. (2012) reported significant differences in critical thinking skills after applying the concept map for four semesters, whereas this study was just carried out in seven weeks. This finding would suggest that developing critical thinking abilities through idea mapping takes more time and cannot be accomplished in a single semester. In order to derive conclusions from a concept map, students must first choose the key concepts and then arrange the linkages and hierarchical sequences between the key concepts and more specific concepts. This skill takes a long time to develop and cannot be achieved quickly (Lee et al., 2013)

During construction of the concept map, students worked in groups, so it was probable that not every student was actively involved in obtaining information and looking for connections between concepts, which could affect how reflectively they were able to think. Also, according to the syllabus, the control group also received other student-centred learning including case-based learning, cooperative learning, and group presentations in addition to traditional lectures. These teaching methods might assist nursing students to develop their critical thinking skills. Some studies demonstrated that case-based learning and other student-centred learning enhanced critical thinking abilities (Kong *et al.*, 2014; Zhang and Cui, 2018). Therefore, the intervention and control group have slightly different scores.

When determining the effectiveness of case-based concept map within the intervention group, the study has shown improving scores in all domains of critical thinking skills, with the exception of reflective thinking after applying a case-based concept map. Since concept maps made it easier for students to discover information, obtain and gather information from a variety of sources, and to explain the truth in the preparation of interrelationships between the drafted concepts, it therefore assisted students to be more open-minded (Yue *et al.*, 2017). In this study, students were given the chance to find and gather reliable sources connected to the disease in order to apply several pathophysiology-related ideas to the instances that were accessible, resulting in dense and varied materials to construct a concept map.

It has been demonstrated that concept maps enhanced analytical and methodical thinking. Students are required to manage the relationships between concepts that are linked both inductively and deductively, as well as to correlate general concepts with specific concepts or data that have been gathered from various references, which required analytical skills (Yue *et al.*, 2017). This increased demand for analytical skills as the result of

these process. Concept maps also provided students the chance to comprehend and to assess the logical progression of every concept so that they could develop into systematic concepts. Students were able create a transition from a linear to a comprehensive and integrated cognitive process by connecting fundamental and clinical information using the concept map (Saeidifard *et al.*, 2014). In addition, the concept map was also able to increase student curiosity. For nursing students in this study, creating concept maps using the Cmaptools software was novel experiences. Students were encouraged by this novel experience to attempt creating a perfect concept map multiple times, which improved their interest in the process. Over time, students were able to relate the concept quickly and independently, thereby stimulating their curiosity to read more and investigate rather than relying on the instructions (Fawaz and Kavuran, 2021).

This study has some limitations that should be discussed. The shorter duration of concept map application in this study was unable to assist students' critical thinking skills. This was due to pathophysiology began to be taught after half of a semester on the Basic Science in Nursing course; most studies take one semester or more to foster critical thinking. Interventions that are delivered over a long period of time and have a gradual scaffolding of abilities are more likely to succeed in developing critical thinking. The process of selecting how to visually distribute the linkages and nodes (relationships and links between conceptual ideas) may necessitate extensive elaborative processing and longer time. Additionally, because the learning process in the control group was tailored to the syllabus, it used a variety of cooperative learning and case-based learning techniques in addition to traditional lectures to help the control group's critical thinking abilities. This could be the reason why there is no difference in the two groups' critical thinking abilities. The longer duration of concept map appears to be suitable in escalating critical thinking among nursing students.

Conclusion

This study informs that the application of case-based concept maps is effective in increasing understanding of the pathophysiology of the disease. However, the application of the case-based concept map in this study is still inconsistent in improving students' critical thinking skills. This method can be carried out for a longer duration so that it can better evaluate the improvement of students' critical thinking skills in future studies. This method allows it to be applied to other difficult and challenging nursing courses. By using this method, it is also possible to assess other things, such as clinical reasoning in students, particularly nursing students who will participate in clinical education, as a foundation for providing nursing care (assessment, data analysis, enforcement of nursing diagnoses, appropriate nursing care (assessment, data analysis, nursing diagnoses formulations, nursing intervention planning and implementation) while undergoing clinical education at the hospital.

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Conflict of interest

Authors declare no conflict of interest in this study.

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