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Effects of web-based concept mapping education on students' concept mapping and critical thinking skills: A double blind, randomized, controlled study☆

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ABSTRACT

Background: Using concept maps in nurse education improves students' critical thinking skills. Offering web-based concept mapping education can increase motivation for learning in students actively using the Internet.
Objectives: To examine the effects of web-based concept mapping education on nursing students' concept mapping and critical thinking skills.
Design: This is a double-blind, randomized, controlled, experimental study.
Settings: A nursing faculty at a state university in Turkey.
Participants: Second-year nursing students taking the course surgical nursing in the spring term of the academic year of 2018/2019.
Methods: The experimental group (n = 201) was offered web-based concept mapping education before starting practicums. Data were collected using a students' information form, concept map evaluation keys, and the Critical Thinking Motivational Scale at the end of the practicums. A structured questionnaire was used to reveal opinions of the students about concept mapping.
Results: There was a significant difference in concept mapping scores between the students offered web-based concept mapping education (16.45 ± 10.91) and those not receiving this education (12.70 ± 9.31) (p = .000). Also, there was a significant difference in students' scores for the subscales of Critical Thinking Motivational Scale expectancy, attainment and utility between the groups. The students reported that concept maps facilitated their learning and management of nursing processes but that they occasionally experienced difficulty.
Conclusion: It can be concluded that web-based concept mapping education improves concept mapping skills and motivation for critical thinking skills. Web-based education could be utilized as a tool to enhance nursing students' concept mapping and critical thinking skills.

1. Introduction

Concept mapping is a method used to plan and create nursing care through diagrammatic representation of patient problems and nursing interventions. It illustrates the association of concepts with each other, shows relationships between concepts and facilitates learning by visualizing information. Concept maps allow students to collect and categorize data and determine associations between data. They also help students determine priorities for care and improve their clinical reasoning (Schuster, 2016; Dil and Öz, 2014).

Nurses face new problems in complex clinical environments every day and actively use their critical thinking, problem solving and decision-making skills to solve these problems (Burrell, 2014; Huang et al., 2012). Critical thinking is core skill for graduate nurses (Senita, 2008). It allows nurses to put knowledge into practice, to synthesize knowledge and to understand increasing differences between patient populations and complex health care technology (Yıldırım and Taşçı, 2013). Nursing students could be enabled to make and use concept maps and analyses of maps to improve their critical thinking skills during their professional development (Kaddoura et al., 2016). Concept maps not

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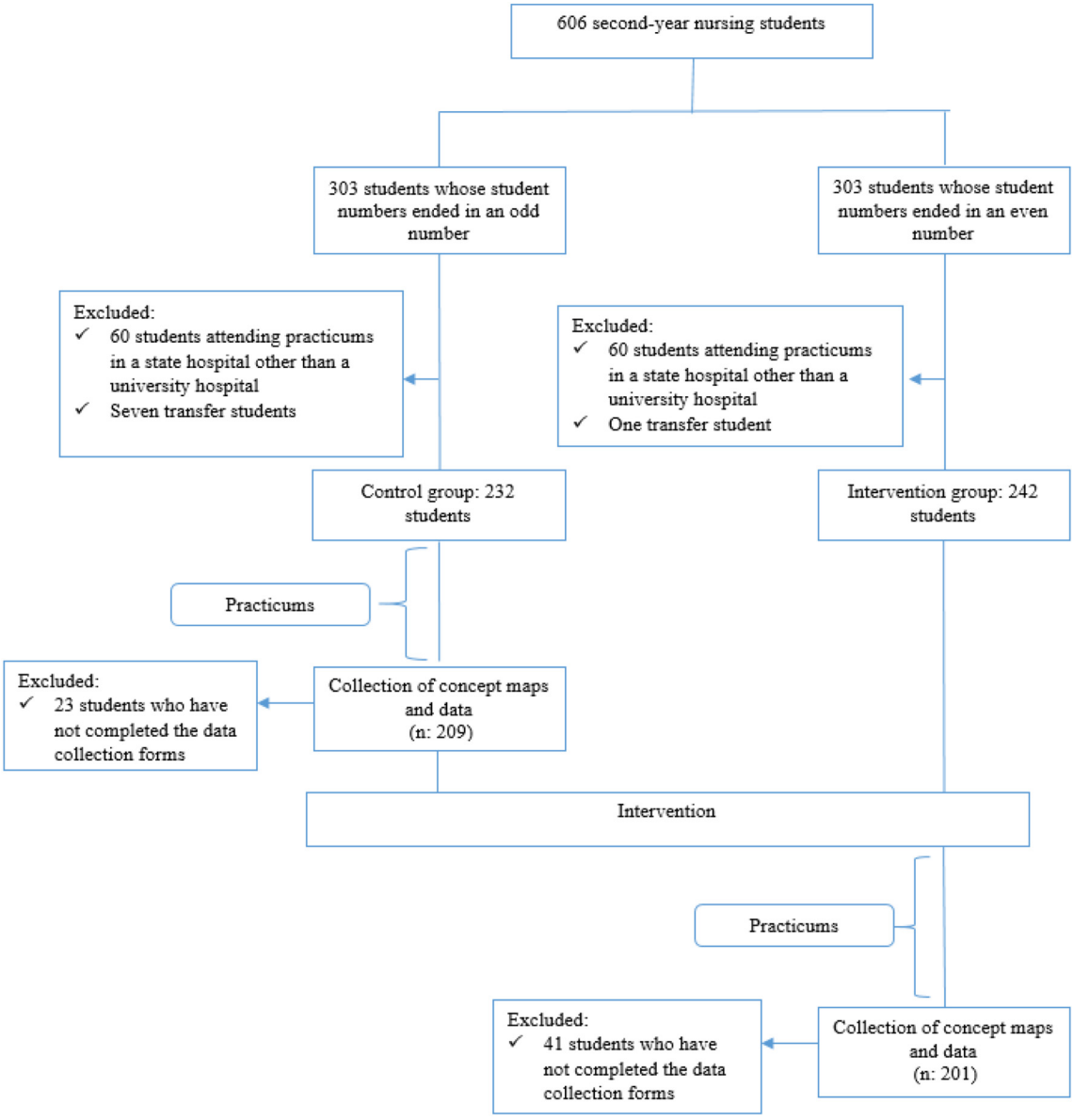


Fig. 1. Study flowchart.

only facilitate planning complex patient care but also help improve critical thinking skills. It has been reported in the literature that using concept maps in nursing education makes learning easier and enhances motivation and critical thinking skills (Hsu et al., 2016; Chan, 2017; Schroeder et al., 2018; Kaddoura et al., 2016; Jaafarpour et al., 2016).

At present, information technology is used in various fields including education. Teaching using the internet is very common. The internet assists people to rapidly search information, saving time and expense and helps people to rapidly access many sources of information wherever and whenever they like (Du et al., 2013; Kang and Seomun, 2018). It has been shown that web-based education programs have a positive influence on knowledge, attitudes and behavior of nursing students (Du et al., 2013; Lu et al., 2009; Gerdprasert et al., 2011; McCrow et al., 2014; Kang and Seomun, 2018).

The present study was performed to determine effects of web-based concept mapping education on concept mapping and critical skills of nursing students.

2. Methods

2.1. Research design

The study uses a double-blind, randomized, controlled and experimental design. There were two hypotheses:

H1. There is a difference in mean scores for concept map evaluation keys between students receiving web-based concept mapping education and those not receiving this education.

H2. There is a difference in mean scores on the Critical Thinking Motivational Scale (CTMS) between students receiving web-based concept mapping education and those not receiving this education.

In addition, the students were asked to answer structured questions about their opinions on their ability to create concept maps.

2.2. Settings and participants

The study was conducted in a nursing faculty of a state university in İzmir, Turkey. Nurse education in this faculty is four years, with each

academic year composed of two semesters. The faculty, which has been accredited this year, only offers nurse education. It provides undergraduate nursing education and MSc in nursing. The study population included 606 seconds-year nursing students taking the course surgical nursing in the spring term of 2016–2017 academic year. Surgical nursing involves both theoretical knowledge and practicums and is given in the spring term in the second year. During the study period, the theoretical teaching was conducted by four lecturers having a PhD degree in nursing and the practicums were supervised by these lecturers and five research assistants. The content of the theoretical part of the course included fundamentals of surgical nursing (i.e. asepsis, wound care and perioperative care etc.) and pre- and post-operative care in patients having different types of surgery. The practicums were held in orthopedics and traumatology, general surgery, neurosurgery, cardiovascular surgery, urology and post-anesthesia units of two hospitals. The aim of sampling was to access the whole study population. Exclusion criteria were being a transfer student (students transferred from other universities might not have taken a course about concept mapping), taking the course surgical nursing for the second time (some students might have taken the course about concept mapping in the previous year), attending practicums in a state hospital other than a university hospital. Randomization of the students were based on their student numbers. The students whose student numbers ended in an odd number were assigned into the control group and those whose student numbers ended in an even number were assigned into the experimental group. The students not meeting inclusion criteria and not fully completing the data collection tool completely were excluded from the study. As a result, the experimental and control groups included 210 and 209 students respectively. The sampling procedure is presented in Fig. 1. Power analysis made by using G power 3.1.9.4. was based on the sample and showed that the strength of the study was 87%.

2.3. Variables, instruments and data collection process

2.3.1. Variables

The independent variables of the study were sex, age and web-based concept mapping education and the dependent variables were mean scores for concept maps and scores for CTMS.

2.3.2. Instruments

Data were gathered with a student information form, concept map evaluation keys, CTMS and a structured interview form.

2.3.2.1. Students' information form. The form was composed of seven questions about age, gender, test scores, how many times the students took surgical nursing, whether the students received education about concept maps, whether they continued their education at another university and whether and how often they read messages about announcements made by the nursing department through the students' common e-mail account.

2.3.2.2. Concept map evaluation keys. By definition, concept map evaluation tools are utilized to evaluate concept maps. To explain, they are used to evaluate students' determining a concept about a given subject and making meaningful associations between the concept and the subject and each meaningful association is assigned one point. Another point evaluated by using these tools is that students' following a hierarchy from general concepts/elements to more specific ones and each hierarchy created by students is assigned five points. Students' associating each concept group, the members of which were associated through a meaningful hierarchy, with another concept, which is called a cross association, is assigned 10 points. Although there was no evidence for validity and reliability of concept map evaluation keys, they were utilized based on the relevant literature (Karayurt et al., 2006; Kear and Bear, 2007; Dil and Öz, 2016).

2.3.2.3. Critical Thinking Motivational Scale (CTMS). The scale was developed in the English language by Valenzuela et al. (2011). It was directed towards collecting information about motivation for a certain critical thinking task. The scale has the subscales expectancy, attainment, utility, value and cost. It is composed of 19 items and a six-point Likert scale. One corresponds to “completely disagree” and six “completely agree”. The validity and reliability of the scale for the Turkish population was tested by Dönmez and Kaya (2016). They reported that item-total correlation coefficients of the scale ranged between 0.44 and 0.68. They also made explanatory factor analysis of the scale and revealed that Kaiser-Meyer-Olkin (KMO) value was 0.85 and that the Chi-square result of Bartlett Sphericity test was 1495.35 ($df = 171, p = .000$). The internal consistency coefficient was found to be 0.90. In light of results of the study by Dönmez and Kaya, the Turkish version of CTMS has an acceptable validity and reliability (Dönmez and Kaya, 2016).

2.3.2.4. Structured interview form. Opinions of the students about concept mapping were determined by using a structured interview form. The form included questions about their names and surnames, the surgical ward where they attended practicums and the following interview questions:

> “What do you think of concept maps (both positive and negative sides of concept maps)?”
>
> “What are the contributions of concept maps to learning?”

Four-hundred and six students enrolled into the study were divided into 12 groups depending on clinical fields of practicums (General Surgery, Orthopedics, Otorhinolaryngology, Chest and Cardiovascular Surgery, Brain Surgery and Urology) and on the order of attending practicums (the first group or the second group) in accordance with maximum variation sampling. The responses of the students in each group were put in an order and 44 students from each group were included into the sample by using simple random sampling. Written responses of the students were analyzed by two researchers separately. Data were categorized by three researchers and the latest version of the data was created by the third researcher.

2.3.3. Data collection process

The students and the researchers were blinded to the experimental stage of the study. First, the control group attended practicums and then the experimental group attended practicums. At the meeting held at the end of the first practicum, concept map evaluation keys and data collection tools were collected from the control group. To enhance the validity of the study and to achieve blinding of the experimental group, first data were collected from the control group and then the intervention was conducted in both the experimental and control groups. The control and experimental groups were offered web-based concept mapping education one week before the second practicums in surgical clinics. The education involved a PowerPoint presentation giving theoretical information about concept maps and their importance, the role of concept maps in nursing processes and teaching, principles of creating concept maps, types of concept maps, model concept maps prepared for different cases, videos about concept maps, studies using concept maps and other sources about concept maps. To support individual learning processes and self-learning skills of the students, they were asked questions in the relevant parts of the model concept maps about surgical patients. The presentations used in the education were sent to email accounts of the students so that they could access them easily. To confirm that they received education, they were asked to prepare a concept map about the case given in the educational content sent to their email addresses and to send it through email. At the last clinical practicum meeting, the students were asked to fill in the students' information form, the concept map and CTMS. To achieve blinding of the researcher, a lecturer not involved in the study assigned

the students into experimental and control groups and the researcher evaluating the concept maps was not informed about the students included into the groups. One researcher recorded obtained data. The researcher evaluating the concept maps analyzed data without knowing about the students in the experimental and control groups.

2.4. Data analysis

Socio-demographic and descriptive characteristics of the students were analyzed with numbers, percentages, standard deviation and Pearson's Chi-square test and differences between dependent and independent variables were analyzed with *t*-test (Hayran and Hayran, 2011).

Recordings about opinions of the students on concept mapping were analyzed by the content analysis method by two researchers separately. The students' responses were categorized by three researchers and the latest version of the data was created by the third researcher.

2.5. Ethical considerations

Written approval was obtained from the nursing department and the ethical committee of the university and written informed consent was taken from the students.

3. Results

3.1. Quantitative results

There was not a significant difference in age and gender between the experimental and control groups (p: 0.91, p: 0.36) (Table 1). The students in the experimental group got a significantly higher mean score for concept mapping (16.45 ± 10.91) than the control group (12.70 ± 9.31) (p:0.00) (Table 2).

The experimental and control groups also significantly differed in their scores for the subscales of CTMS expectancy (p:0.037), attainment (p:0.015) and utility (p:0.015), but they did not differ significantly in terms of the subscales value (p:0.225) and cost (p:0.070) (Table 2).

3.2. Opinions of the students about concept maps

Based on written responses of the students, three main themes emerged, i.e. effects of concept maps on the nursing process, effects of concept maps in learning and difficulties in concept mapping.

The students reported that concept mapping contributed to the nursing process.

"I think concept maps are useful in terms of understanding theoretical information and putting it into practice."

"Concept maps helped us to see what we learned as a whole and to associate them with each other."

"I think concept maps are important in that they helped us to consider a patient as a whole. Since we can see all diagnoses and results in one place, we can easily make nursing diagnoses."

The students emphasized that concept mapping facilitated learning.

"Concept mapping is a method which makes learning easy and make associations between phenomena. Since learning is achieved through more than one sense, things learned are more likely to be permanent."

"Since we created concept maps by ourselves, it contributed to our learning. Thanks to concept mapping, we learned that some diagnoses are interrelated."

"Concept mapping allowed me to associate details with important cases. I felt as if I had been Sherlock Holmes."

"They allow us to see everything about cases on one page in the form of a summary and help us understand them. They provide guidance in detecting sources of problems and deciding what to do."

Concerning difficulties in concept mapping, some students explained that it was difficult and took long time to create concept maps, and caused stress to prepare a concept map for each patient.

"Continuously changing status of surgical patients led to difficulties in managing the process (concept mapping process)."

"It was difficult to create a concept map for each of my patients and it took a lot of time."

Table 1
The distribution and comparison of descriptive characteristics of the experimental and control groups.

	Control group (n: 209)	Intervention group (n: 201)	p
Age (X ± SS)	20.70 ± 1.16	20.69 ± 0.96	0.91*
Sex (n %)			
Women	152	154	0.36**
Men	57	47	
Total	209	201	

* Student's t-test.
** Pearson's Chi-square test $p < 0.05$.

Table 2
The comparison of mean scores for concept maps and CTMS and its subscales.

	Control Group (n: 209)	Experimental Group (n: 201)	t-test	p
Mean Scores for Concept Maps	12.70 ± 9.31	16.45 ± 10.91	−3.7513	0.000
CTMS subscales				
Expectancy	4.65 ± 0.74	4.49 ± 0.79	2.092	0.037
Attainment	5.50 ± 0.62	5.34 ± 0.68	2.454	0.015
Value	5.43 ± 0.78	5.34 ± 0.69	1.216	0.225
Utility	5.17 ± 0.75	4.98 ± 0.78	2.453	0.015
Cost	4.74 ± 0.87	4.58 ± 0.93	1.815	0.070

CTMS = Critical Thinking Motivational Scale.

4. Discussion

In the present study, the students receiving web-based concept mapping education got a significantly higher score for concept mapping than those not receiving this education (Table 2). Although there have not been any studies in which concept mapping education is offered through the web, there is evidence that web-based education is used in nurse education and yields positive outcomes. In an experimental study in Taiwan ($n = 147$), the second-year nursing students getting web-based education had significantly higher scores for information and skills about intramuscular injections (Lu et al., 2009). In a study by Gerdprasert et al., the students offered web-based education about intrapartum nursing care got a significantly higher score for theoretical information and practical skills than those not offered this education (Gerdprasert et al., 2011).

In a study with clinical nurses, web-based education significantly improved information and skills about monitoring respiration and heart rate and evaluating, managing and reporting clinical impairment (Liaw et al., 2017). McCrow et al. revealed that web-based education about delirium offered to nurses was an effective and satisfactory method for learning (McCrow et al., 2014). It is thought that with developing technology, increased use of web-based education in nursing will facilitate learning.

In the current study, the students given web-based concept mapping education had a significantly higher score for expectancy, attainment

and utility subscales of CTMS (Table 2). This was attributed to increased information and awareness of these students about concept maps. In an experimental study by Atay and Karabacak (2012), the students given concept mapping education got a significantly higher score for critical thinking disposition. In Sinatra-Wilhelm's study comparing effects of concept mapping and making care plans on critical thinking skills, the students using concept maps got a significantly higher score for critical thinking skills (Sinatra-Wilhelm, 2012).

In a systematic review about use of concept maps in nursing education in Iran, it was stated that concept maps had an important effect on improvement of critical thinking skills of nursing students (Ghojazadeh et al., 2014). In an experimental study using concept maps as educational tools in students taking internal diseases and surgical nursing courses in Taiwan, the students taught concept maps got a higher score for critical thinking (Chen et al., 2011). There is evidence in many studies that concept mapping has positive effects on critical thinking skills of students (Chen et al., 2011; Maneval et al., 2011; Lee et al., 2013; Kaddoura et al., 2016). The results of the present study are comparable with those reported in the literature.

Responses of the students to questions in the structured questionnaire revealed that concept mapping allowed the students to adopt a whole person approach, to make nursing diagnoses by making associations and to associate diagnoses with each other. In addition, the students reported that concept mapping shortened duration of decision making and facilitated understanding things by encouraging learning. They facilitated planning nursing interventions and putting these plans into practice by supporting more concrete information about patients and presenting it as a whole. In a qualitative study, concept maps were considered as an educational tool which would help students to create a visual representation of what is to be learned (Harrison and Gibbons, 2013). In a meta-analysis conducted by Schroeder et al., concept mapping was found to be an effective learning method (Schroeder et al., 2018). Results of Ghanbari et al.'s study also support effectiveness of concept maps in the learning processes of students (Ghanbari et al., 2010). It is recommended that concept maps should be utilized as tools to motivate students to learn, actively participate in classes and improve their creativity (Chan, 2017; Dil and Öz, 2014).

In the present study, although the students emphasized that concept maps were helpful in learning, they mentioned that concept mapping took a lot of time and that they were difficult to do for each patient. In a study by Atay and Karabacak (2010) about nursing students' opinions on concept maps, the students reported that while concept mapping was fun and helped learning, it took time. In a qualitative study, it was emphasized that concept maps facilitated learning visually, but required time and an aesthetic point of view (Harrison and Gibbons, 2013). In the current study, the students' idea that concept mapping took a lot of time might have been due to the fact that they had to create more than one concept map since they attended practicums in clinics with high patient turnover.

4.1. Limitations

Although the results of this study showed that concept maps were effective learning tools, the study had some limitations. Because of inability to request expert opinions about the content of the concept mapping education, to access evidence for validity and reliability of the concept map evaluation tool and to keep interactions between the students during practicums under control, the students were likely to influence each other while creating concept maps. In addition, since concept mapping education is not used in other nursing faculties in Turkey, the results of the study cannot be generalized to all nursing students.

5. Conclusion

In the present study, web-based concept mapping education enhanced the students' concept mapping and motivation for critical thinking. Therefore, it could be suggested that concept maps can facilitate nursing students' understanding and planning nursing care for the surgical process and putting these plans into practice. Web-based concept mapping education could be utilized as a way to improve nursing students' concept mapping and critical thinking skills. In addition, web-based education could be more commonly used in nurse education in parallel with technological developments. Nurse educators could help students to overcome difficulty in concept mapping by asking questions which provide guidance and by directing them to appropriate sources of information.

Financial disclosure

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Ethical approval

The ethical approval has taken from the Dokuz Eylul University Non-Invasive Clinical Researches Assessment Commission (Approval no. 3269-GOA/2017/10–11; Approval date: 04.05.2017) in order to conduct the research.

Declaration of competing interest

No conflict of interest was declared by the authors.

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