THE ROLE OF CONCEPT MAPPING IN THE DEVELOPMENT OF CRITICAL THINKING SKILLS IN STUDENT AND NOVICE NURSES: A QUANTITATIVE META-ANALYSIS

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Abstract

Background: Critical thinking has been identified as a skill that many nursing students struggle with. Concept mapping is one teaching method that has been purported to enhance critical thinking.

Aim: To interpret and synthesize the evidence related to the use of concept mapping as a method of developing critical thinking in nursing students and novice nurses, and to present an overview of methodological and reporting aspects of the studies. The goal of this meta-analysis was to determine the magnitude of the effect concept mapping has on critical thinking skills in order to guide our profession in how we teach student nurses.

Methods: A search of Web of Science, PubMED, Cochrane Library and EBSCOhost, which includes Academic Search Complete, CINAHL, ERIC, MEDLINE, and PsycINFO databases was performed. The criteria used for inclusion for this thesis were articles published in English, from peer-reviewed journals, participants were registered nurses or nursing students, and quantitative primary studies published since 2002. Four full text peer-reviewed articles were reviewed independently by two researchers. Data were extracted based on the inclusion criteria. A quantitative meta-analysis was conducted with Review Manager 5.3 software.

Results: Four journal articles published between 2003 and 2014 that reported results from controlled intervention quantitative studies were included in the analysis. The results were not conclusive and did not provide statistically significant evidence in support of concept mapping affecting critical thinking skills in nursing students and novice nurses.

Conclusion: This study does not support the application of concept maps as a teaching and learning strategy to promote the development of critical thinking skills in nurses. Further studies and data collection is suggested using a nurse specific measurement tool for critical thinking skills and a larger sample size.

Preface

I was responsible for identifying the topic of interest for this thesis and through the help of my committee, specifically Dr. Sabrina Wong, was able to chose the correct research design and analysis approach for the research data. Dr. Sabrina Wong was my thesis supervisor and Dr. Victoria Bungay and Joanne Ricci were part of my thesis committee. Wong, S. was responsible for helping me screen all of the research to find the necessary articles for this analysis. All three co-authors on my committee were responsible for helping me draft my thesis and contributed throughout the writing process. I conducted the analysis, using Review Manager 5.3 software, and wrote the majority of the manuscript on my own, with the inclusion of some comments and feedback from my committee.

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CHAPTER 1: INTRODUCTION

Critical thinking is a crucial component of nursing care, especially in acute care settings. In the tertiary care setting where patients have higher acuity, the environment is fast paced and the patients' health status can change rapidly. The type of care nurses are responsible for providing is becoming more complex and acute, requiring high-levels of cognitive thinking, problem solving and critical thinking capabilities (Huang, Chen, Yeh, & Chung, 2012). Nurses are expected to perform competently within their scope of practice in a wide range of situations, from assessing patients with co-morbidities to handling life and death scenarios. Their ability to think critically and problem solve is the basis of what enables them to manage the situations and provide optimal patient care. Nurses working in hospitals are expected to function successfully in multiple different surgical and medical services, working with a variety of patients of all ages and health backgrounds, and most of whom they have never met until they are providing care. As the scope of practice for nurses continues to evolve and expand, those who employ critical thinking will be able to progress and meet the healthcare needs of complex and acutely ill patients, opposed to nurses who apply memorization of information and protocols to inform their nursing practice (Senita, 2008).

Critical thinking, the methods and techniques for processing information, enable nurses to understand and apply an array of standards and guidelines to a variety of situations and specialty areas (Richardson-Tench and Martens, 2005). Chao (2004) found that the "development of critical thinking is not only the basis of life-long learning but also the cornerstone of professional growth" (Tseng, Chou, Wang, Ko, Jian & Weng, 2011, p.42). If nurses can think critically through complex situations they can provide optimal nursing care and succeed in solving clinical problems (Hoffman, Duffield, and Donoghue, 2004).

Problem Statement

Critical thinking is a process of purposeful judgment that uses "interpretation, analysis, inference, evaluation, explanation, and reflective reasoning to consider the evidence from all angles" before deciding how to think or act (Wheeler & Collins, 2003, p.339). Critical thinking skills allow nurses to comprehend and apply theoretical content, actively analyze pathophysiology, anatomy, and the disease process, and guide them in creating and applying appropriate nursing interventions and care plans (Daley, 1996). The literature reveals that we expect our nursing graduates to come into the profession with the ability to think critically. Despite the importance of critical thinking as an essential skill required for nurses to practice competently and effectively in the clinical environment, evidence indicates that novice nurses are lacking in critical thinking abilities (Welk, 2002). Although "critical thinking was consistently listed as one of the most important entry-level competencies, it was also consistently ranked among the lowest observed competencies" (King, Smith, and Glenn, 2003, p.181). Gillespie and Paterson (2009) found that "decision-making among novice nurses tends to be linear, based on limited knowledge and experience in the profession, and focused on single tasks or problems" (p. 164). As novice nurses make decisions, they focus on performing tasks proficiently instead of thinking and reflecting on their actions, looking at the bigger picture or the patient as a whole (Benner, 1984; Benner, Tanner & Chesla, 1992).

Unfortunately, these novice nurses are often faced with challenging patient care situations that require immediate and multifaceted decisions be made, and with minimal clinical experience or exposure to similar scenarios, clinical decision-making and critical thinking skills are often their only hope of successfully handling the situation. Therefore it is vital that educators learn how to foster the development of critical thinking capacities in student and new nurses so they can incorporate this skill into their practice resulting in better patient care. Potgieter (2012)

suggests that if "educators fail to stimulate critical thinking, they produce habits, rather than skill" (p. 4).

Concept mapping has been suggested as tool that can be utilized to help improve critical thinking abilities in students and have a positive effect on overall academic performance (Wheeler & Collins, 2003; Daley et. al., 1999; Senita, 2008). Research has demonstrated that both students and educators find concept mapping to be useful in visualizing concepts, integrating them into the nursing process, linking theory and practice, and improving critical thinking abilities in students (Atay & Karabacak, 2012). Whether in a clinical setting or classroom, concept mapping has been established as a useful learning and teaching method for students to develop their critical thinking abilities (All & Havens, 1997; Daley et. al., 1999). Some research has been published in nursing education that explores the relationship between concept mapping and critical thinking in student and novice nurses, but no meta-analysis has been conducted in order to aggregate the data in order to provide higher statistical power for the measure of the intervention.

Purpose

The purpose of this thesis is to examine how the use of concept mapping influences the development of critical thinking skills, and synthesize the current research on the subject. The analysis will be limited to controlled intervention studies including both randomized and non-randomized trials. The PICO (population, intervention, comparison, and outcome) approach was used to develop the research question for the meta-analysis. Population: nursing students and novice nurses; intervention: the use of concept mapping; comparison: alternatives to concept mapping (case studies, traditional care plan models); outcomes: development of critical thinking skills. I conducted a meta-analysis of studies that examined the relationship between using concept maps and critical thinking in nurses. This thesis was an opportunity to examine the issue

of critical thinking and provide educators with an effective tool that will help to develop and foster this challenging yet crucial skill. The results can inform how we teach and develop critical thinking skills in nurses of all experience levels, especially the novice or student nurse.

Research Questions

The following research questions guided this meta-analysis:

1 Is there a difference between control and experimental groups of nursing students and novice nurses on posttest critical thinking scores using the California Critical Thinking Skills Test (CCTST)?

2 Is there a difference between control and experimental groups of nursing students and novice nurses on posttest critical thinking scores using the California Critical Thinking Disposition Inventory (CCTDI)?

Theoretical Framework

The concept of critical thinking, and how to foster the development of critical thinking capabilities in nurses, is a large concept that can be approached from many different angles. The fundamental elements behind learning to think and how to teach critical thinking are overlapping; therefore both will be addressed from a theoretical standpoint.

Critical thinking is embedded in almost all aspects of the clinical education process related to nursing. The application of theory to practice involves elements of critical thinking that enables nurses to use theories they've learned in the classroom setting to guide their thinking in how they are related or influence their practice in the clinical setting. Wheeler and Collins state, "concept mapping works. It works from the perspective of the educator trying to develop and measure critical thinking skills, and it works from the perspective of the student trying to master a very complex field" (2003, p. 345). Educators cannot teach nurses how to think critically if they do not take it upon themselves to actively engage in learning and applying their knowledge. From

a theoretical standpoint, there is a lot of overlap between a learner and educator perspective in the use of concept mapping in developing critical thinking in nurses. Both the learner and educator must work together to use concept mapping to promote and develop critical thinking skills, it is not a one sided educational tool. So for the purpose of this thesis Constructionist Theoretical (CT) Perspective will be discussed in relation to a learner and Situated Clinical Decision-making (SCDM) Framework will be discussed from an educator perspective, and both will be used to help interpret the findings. The CT Perspective and the SCDM Framework support the fact that concept mapping is positively related to the development of critical thinking in student and novice nurses. Additionally, Ausubel's Meaningful Learning Theory (AML) will be applied to this study in order to understand the results. Concept mapping has been mentioned as an educational strategy for developing meaningful learning and critical thinking abilities in learners.

Constructionist Theoretical Perspective. The basis of concept mapping aligns with a Constructionist Theoretical (CT) Perspective in that it all must begin with an active learner. According to the CT perspective, learning is an active process that is based on existing knowledge and through this process students construct knowledge; the foundation for the learning process is based on the learner's previous constructs of knowledge and experience (Brandon & All, 2010). Therefore, the learner develops knowledge through the integration of new information with their past knowledge and experience to create a process for meaningful learning (Phelps, 2009). Constructionist Theory advocates the principles of active learning and emphasizes that "learners must be the creators of their own education through dialogue, discovering of principles, experiments, problem-solving, and collaborative learning (Potgieter, 2012). Learning in the nursing profession can be described as an active process in which nurses construct new knowledge based on what they already know, building upon previous experiences and information to form the base for their learning (Brandon & All, 2010). A challenge when

applying a Constructivist approach to teaching nursing students or working with novice nurses, is shifting the center of control from clinical instructor or educator to the nurse and helping to change passive students into active and independent learners (Potgieter, 2012). Constructivist theory is related to how nurses should approach learning, suggesting that an active approach opposed to passively waiting to be taught, can develop their critical thinking skills in the process (Potgieter, 2012). For that reason our first step as educators, looking to develop the critical thinking abilities in student and novice nurses, is to encourage an active approach to learning and shape the way we teach around the promotion of actively applying knowledge.

Situated Clinical Decision-Making Framework. From an educational perspective, the concept map serves as a tool for educators to analyze the problem solving, decision-making approach, and critical thinking abilities of novice nurses and students. Once we are able to get our students to adopt an active learning style, we as educators can use the Situated Clinical Decision-Making (SCDM) framework, which is more applicable in facilitating the development of critical thinking skills amongst nursing students and novice nurses. The components of the SCDM framework incorporate thinking processes, decision-making processes, foundational knowledge, and context. Gillespie (2010) found that this framework "provides a structured approach to analyzing nursing students' and novice nurses' decision-making in clinical nursing practice, assists educators in identifying specific issues within nurses' clinical decision-making, and guides selection of relevant strategies to support development of clinical decision-making" (p. 333). The use of this theoretical model by nursing educators assists them in evaluating the decision-making skills of their student nurses. Based on the outcome of the evaluations, educators can choose the most pertinent learning strategies to provide nurses with opportunities to work on their clinical decision-making and critical thinking capabilities. Similar to the Constructivist theory, the SCDM framework combines foundational knowledge of both learner and educator with context,

cognitive thinking, and problem solving abilities. Therefore the issue of development of critical thinking in relation to nursing students and the educators involved is best supported through the application of both Constructivist theory and Situated Clinical Decision-Making framework.

Meaningful Learning Theory. Knowledge acquisition can be divided into different categories of learning: receptive, discovery, rote, and meaningful learning (Ausubel, 1968). In receptive learning information is presented in a formal manner and is internalized through rote or meaningful learning. Discovery learning is where the learner is discovering the information as it occurs and internalizing it through rote or meaningful learning. Rote learning is memorizing information without processing the content, which can fade away if the learner does not frequently go over the information. Meaningful learning is when the learner assimilates new information and concepts with their existing knowledge and experiences (Ausubel, 1968). Meaningful learning has been found to be a necessity in the development of knowledge, problem-solving, and critical thinking skills (Wheeler & Collins, 2003). Researchers found that a student's ability to organize, relate, and then process information will determine how they will be able to problem solve and think critically in a professional setting (Tanner, Benner, Chelsa & Gordon, 1993). Ausubel (1968) introduced a method of cognitive organization, which must be in place for meaningful learning to occur. Ausubel's cognitive organization consists of three components: progressive differentiation, subsumption and integrative reconciliation. This study will help highlight how concept mapping helps develop this cognitive organizational process, which in turn, improves critical thinking.

Nurse educators have used certain techniques and methods to foster critical thinking that touch on all four categories of learning. Case studies, care plans, problem-based learning, and concept mapping are all examples. Although all four types of learning are beneficial to nurses and serve different purposes, meaningful learning was found to best promote critical thinking

skills (Wheeler & Collins, 2003). Concept mapping has been identified as a key educational method for fostering meaningful learning and critical thinking abilities.

Summary

It is essential that nurses have the ability to think critically in order to function, adapt, and provide optimal care to their patients, especially in our constantly evolving and highly complex healthcare system. Therefore it is our professional responsibility to ensure our new nurses in the workforce our prepared for the demands, by ensuring we do our best to develop their ability to think critically. For that reason, this meta-analysis on the use of concept maps in the development of critical thinking ability, will serve to further explore and strengthen the effect of this educational strategy.

CHAPTER 2: LITERATURE REVIEW

This chapter delves into the literature that served as the basis for this thesis. The key concepts and terms in this study are reviewed and defined. Additionally, the literature related to the teaching methodology of concept mapping in nursing education and its association with critical thinking is discussed.

Critical Thinking Defined

The majority of critical thinking definitions include cognitive skills such as problem solving, knowledge, reasoning and logical thought processes (Jones, 2010). Seifert (2010) uses a "less formal and more skeptical definition of critical thinking: deciding what to do and when, where, why, and how to do it" (p. 197). Staib (2003) states critical thinking is an evolving process of reasoning, knowledge, attitudes, reflection, and application. For the purposes of this thesis, critical thinking within nursing can be described as effective problem solving and outcome-directed thought processes, which originate from a research driven process and are based on the individual patient's needs and required interventions. This knowledge is used to analyze and organize patient information, building upon pre-existing knowledge, to prioritize the plan of care by holistically viewing the patient, or looking at the bigger picture (Oermann, 1997; Alfaro-Lefevre, 1999; Tyler, 2004).

In the clinical setting, nursing students and novice nurses are presented with large quantities of detailed information, in short periods of time, and expected to access and act on that knowledge in complex and demanding situations. According to Benner's (1984) Novice to Expert Theory, student and novice nurses are able to demonstrate minimal competencies and task-related skills, and are underdeveloped in the areas of critical thinking and decision-making, therefore they require continuing education and support. Benner and colleagues (1996) also point out the acquisition of necessary knowledge, cognitive thinking processes and clinical experience

are needed in order to develop critical thinking and clinical decision-making skills; therefore the nursing profession has a responsibility to create supportive opportunities to help students and novice nurses acquire and improve these skills. “Educational theorists and researchers have found that strategies that promote active processing of concepts and participation in the learning process are more likely to lead to the development of critical thinking skills” (Wheeler & Collins, 2003, p.340). As a result, a nurse who utilizes cognitive skills and critical thinking within the clinical environment will have the clinical competence to practice successfully in this demanding setting.

Critical Thinking Tools to Promote Active Processing of Concepts

Nurses’ scope of practice is constantly expanding and changing, the expectations placed upon them regarding knowledge and patient care, and the ability to make complex decisions that affect patient outcomes and the quality of care they provide. Critical thinking is often the basis of these decisions, therefore it is our professional responsibility to ensure our nurses have appropriate and effective methods to learn and develop this crucial skill throughout their education, training, and career. Nurses learn concepts, theory, and principles in school and in order to transition that into clinical practice they have to understand the rationale, relationships, and correlations amongst the information they are presented with (Kathol, Geiger & Hartig, 1998). Actively processing concepts or learning in a meaningful way must also continue to evolve with our nurses, and methods for enhancing critical thinking that were thought to once work may not be the best practice currently. This section will review care plans, case studies, problem based learning, and concept maps, which are some key methods used in nursing to promote active learning and enhance critical thinking.

Care Plans. Traditionally, the nursing care plan has been the method of choice for developing students’ ability to use the nursing process and their existing knowledge as a framework for learning how to critically think and problem solve through clinical situations

(Wheeler & Collins, 2003). Care plans within nursing are used as a tool to outline patient-specific goals for their health requirements (Atay & Karabacak, 2012). They are based on the clinical judgment of the nurse and data they collect from their assessment of the individual. A nursing care plan is then composed of a nursing diagnosis, with patient-specific defining characteristics both subjective and objective to support the diagnosis, other related factors or risks, appropriate nursing interventions, and expected outcomes or goals for the patient (Nursing care plan, 2013).

The challenge with care plans are their linearity and uni-dimensionality, with limited effectiveness in developing the critical thinking abilities of students (Kathol, Geiger & Hartig, 1998). Researchers found that learning in a linear fashion can be difficult for students creating care plans as they can easily become overwhelmed by the isolated facts and data they spend so long gathering and recording about their patient (Kathol, Geiger & Hartig, 1998). They realized that students had difficulty formulating and understanding the relationships between the collected data and how the components correlated or affected each other. Additionally, they realized this teaching method did not assist students in their ability to plan or make appropriate decisions pertaining to the care of their patient. Furthermore it was difficult for educators to evaluate a student's understanding of a patient's situation and level of knowledge based on a nursing care plan (Kathol, Geiger & Hartig, 1998). Care plans can be a great way for nurses to focus on patient-specific interventions and goals, however they don't enhance or promote critical thinking skills like other teaching methods do.

Case Studies. A case study is a description of an actual situation, problem, or issue that provokes critical thinking, how to think professionally, and how to incorporate theoretical concepts to highlight a practical problem (Dowd & Davidhizar, 1999). Case studies are based on real life situations, have supporting data and documents provided to be analyzed, with an open-ended question or problem presented as a possible solution (Popil, 2004). Case studies are used to

help facilitate the synthesis of content knowledge and the ability to manage problematic situations (DeSanto-Madeya, 2007). By providing a specific example, case studies remain in the learner's memory so that that information can be drawn upon or easily recalled when needed.

Researchers found that case studies are a useful strategy for creative teaching and active learning and the application of clinical information to real-life situations to promote critical thinking (Ciesielka, 2003; Kim et. al., 2006; Popil, 2011). Previous research has highlighted case studies as an "effective method of connecting theoretical critical thinking, problem solving, and decision-making skills to clinical situations, thereby facilitating improvements to clinical decisions, interpretations of patient information, and nurse-patient encounters" (Campbell, 2004; Hofsten et. al., 2010; Mayo, 2004, Huang et. al. 2012, p. 748). Popil (2004) found that case studies engage the learner and enable them to apply theory to practice, view the scenario from different viewpoints, participate in data analysis, practice decision making skills and synthesis material. Popil (2004) discussed how case studies are beneficial for active learning because they incorporate ideas of experimental learning by providing student centered education and opportunities to motivate students through active involvement.

Case studies have been a popular and advantageous teaching strategy used all throughout academia, including the discipline of nursing. Despite its regular usage, little evidence is out there to support its hospital-based ability to promote critical thinking (Huang et. al., 2012). Research suggests in addition to case studies, concept maps are an effective supplementary teaching strategy for promoting and developing critical thinking from a clinical perspective (Huang et. al., 2012; Castellino & Schuster, 2002; Desimone, 2006.

Problem Based Learning. Problem based learning is a "teaching and learning method that empowers students to work through a process of actively participating in the learning process, working with peers in small groups to identify learning goals, engaging in self-study,

discussing and applying new learning, and finally, integrating a variety of knowledge (Cooke & Moyle, 2002; Ozturk et. al., 2008). Learners are presented with a problem or situation to apply previous knowledge and build upon their existing knowledge throughout the process, which consists of five key steps: analysis of problems, establishment of learning objectives, collection of information, summarizing, and reflection (Lin et. al., 2010). With problem based learning the students have to decide amongst themselves what information they need to identify within the problem or issue as relevant, try and comprehend the information they are presented with, discuss it within the group, and create a solution to the problem (Yuan et. al., 2008). Problem based learning provides meaningful learning for students and promotes the development of critical thinking skills (Kammanee, 2008).

There have been mixed findings regarding the use of problem based learning as a teaching and learning method to enhance critical thinking skills. Some studies have demonstrated the clear benefits of problem based learning in students such as increased communication, problem solving, autonomous learning, and critical thinking (Cooke & Moyle, 2002; Morales-Mann & Kaitell, 2001). When compared with traditional lecturing methods, some research has indicated problem based learning does not enhance critical thinking (Choi, 2004; Lyons, 2006), however other researchers found that problem based learning is more effective in fostering critical thinking skills in nursing students (Dehkordi & Heydarbejad, 2008; Jones, 2008; Ozturk et. al., 2008; Tiwari et. al., 2006; Wang, 2009).

Concept Mapping. Concept mapping uses a metacognitive approach to promote meaningful learning, pattern recognition, and develop cognitive and critical thinking skills (Irvine, 1995: Novak & Gowin, 1984). Concept mapping, in particular, is a useful strategy for nursing education because it acts as a tool for nurses to re-organize and re-visit the large quantity of theory and knowledge they have accumulated and display it in a way that helps them critically

think through a scenario and treat patients with a holistic approach. Concept mapping was developed in order to help students "understand the placement of concepts in a hierarchy of concepts and to perceive the relationships between them" (Atay & Karabacak, 2012, p. 234). They found that by learning how to use concept mapping, it facilitated long-term memory retention of the information that was easy to access in the future.

Novak and Gowin's Concept Mapping

Concept mapping, developed by Novak and Gowin (1984), is based on Ausubel's assimilation theory of cognitive learning in which learning was theorized as method of assimilating new information. They found that the use of concept mapping creates an opportunity to learn meaningfully, which allows students to incorporate new knowledge and build upon what they already know, allowing them to apply that knowledge to situations in a critical manner opposed to memorizing or repeating without understanding (Novak, 1998). Furthermore, concept mapping used specifically in the clinical environment fosters the development of communication (O'Donnell, Dansereau, & Hall, 2002), teamwork (Dabbagh, 2001), group dynamics, critical thinking (Wheeler & Collins, 2003), and decision making skills (Wilgis & McConnell, 2008). Concept mapping generates a chance for students to actively learn and apply their knowledge, in the process, developing their critical thinking skills.

According to Novak and Gowin (1984) concept mapping organizes concepts hierarchically into a schematic device with the most general concepts at the top followed by more specific concepts underneath, and relationships between concepts are linked. When learners propose linkages between concepts, "learners assimilate new concepts into their existing cognitive structure" and integrate those new concepts into their knowledge base, resulting in meaningful learning (Lee, Chiang, Liao, Lee, Chen & Liang, 2013, p.1219). Consequently, research has shown that concept mapping not only promotes the development of nursing

students' critical thinking abilities (Daley, Shaw, Balistrieri, Glasenapp & Piacentine, 1999) it also "enhances students' ability to interpret evidence from clinical practice, conceptualize patients' problems, and make decisions based on purposeful judgments and their performance in clinical practice" (Tseng et. al., 2011, p.42; Baugh & Mellott, 1998; Wilgis & McConnell, 2008). The application of concept mapping to developing critical thinking is not restricted to the nursing profession but can be applied to many other teaching scenarios and professional fields, acting as a "meta-cognitive learning strategy" for improving and promoting the development of critical thinking abilities in learners (Abel & Freeze, 2006; Baugh & Mellott, 1998; Wilgis & McConnell, 2008).

Concept Mapping in Education

One strategy educators use as an active teaching strategy to help develop critical thinking skills in nurses is through the use of concept mapping. The nursing profession has only just begun to use concept mapping as a teaching strategy over the last 15 years, and that was originally primarily for clinical settings (Beitz, 1998). Concept mapping is a strategy used to teach science; since nursing uses science concepts, it was only logical for educators to adopt this tool to develop nurses' ability to conceptualize which helps enhances critical thinking abilities (All & Havens, 1997; Castellino & Schuster, 2002; Daley, 1996; Daley et. al., 1999).

This method can be used as an educational strategy to help nurses synthesize, organize, and prioritize information and knowledge into a logical sequence that they can apply to clinical situations (Wilgis & McConnell, 2008). Concept mapping allows nurses to organize their knowledge in a visual manner that promotes critical and analytical thinking, giving them the opportunity to make connections and apply their knowledge to actual patient situations (Gerdeman, Lux, & Jacko, 2013). Critical thinking develops both through the organization of knowledge nurses currently have and also in situations where it become apparent there is a lack

of knowledge. Through the use of concept maps, undergraduate nursing students could "identify new concepts and relationships, while recognizing areas that may require additional research or elaboration (Gerdeman, Lux, & Jacko, 2013). Nursing students must use their cognitive skills of analysis, critical reasoning, and evaluation when creating diagrams on concept maps, therefore it has been found to be a beneficial tool for promoting the development of critical thinking skills (All & Havens, 1997). When an educator or class discusses a student's concept map, knowledge gaps can be highlighted and discussions can lead to further identifying areas that require more thought or research. Some evidence suggests that concept mapping is an effective teaching and learning method for instructors and students to examine their existing knowledge and learn how to critically analyze a complex situation in a non-linear manner (Gul & Bowman, 2006).

Concept mapping has its advantages and disadvantages as an educational strategy used to help learners understand how concepts relate, problem solve, and incorporate new knowledge. Glendon and Ulrich (2004) found that concept mapping encourages learners to think creatively through situations, promotes critical thinking, exemplifies concepts from simple to complex, and provides an educational activity that can be completed individually or in a group. Additionally, concept maps decrease anxiety in the learner and promote greater achievement (Luckowski, 2003). The drawbacks of using concept mapping is that it is a time consuming process for both the educator and the learner and it is not an effective learning strategy for linear thinkers, who may have difficulty navigating through the relationships of a concept map (Beitz, 1998; Luckowski, 2003).

Nursing Research on Concept Mapping and Critical Thinking

The majority of research, when it comes to the relationship between concept mapping and critical thinking, has been done in less acute areas of healthcare such as medical and surgical wards or with novice nurses for the most part. Critical thinking skills are vital regardless of which

area in healthcare nurses work, however little research has been done, in terms of concept mapping and critical thinking, in acute areas such as the intensive care unit, emergency room, or the operating rooms which heavily rely on their nurses to have and utilize these skills. The patient population nurses care for in these acute areas is highly complex and constantly changing, therefore they are often in situations they have never dealt with before, where critical thinking may be the only skill they can rely on. Researchers have reported on the effectiveness of using concept maps to develop critical thinking, however the data are limited and the outcomes differ across studies; therefore a meta-analysis will help measure the effect of the intervention.

Summary

In summary, there are different critical thinking tools that can be used to promote active processes of concepts, including care plans, case studies, problem based learning, and concept mapping. Care plans promote the use of the nursing process and existing knowledge to work through clinical situations, however they are insufficient in developing critical thinking because learning occurs in a linear manner. Therefore, students often have difficulty understanding the relationships between the isolated facts and may not strengthen their clinical decision making skills or critical thinking through the use of this learning tool. Although both case studies and problem based learning have been shown as teaching tools that affect critical thinking, neither one acting alone is enough to promote the development of critical thinking to the level we hope to see in our student and novice nurses, to ensure they are prepared for their careers.

There have been no quantitative meta-analyses of intervention studies examining the relationship between concept mapping and the development of critical thinking skills in nurses. Therefore by conducting a meta-analysis of different studies I will be able to identify patterns among the results, amalgamate the data to create a statistically higher power to represent the results, as opposed to the statistics from one single study. This meta-analysis will contribute to nursing

research because it will be able to provide more precise and accurate results for the relationship between concept mapping and critical thinking and can be used to foster the ever-challenging critical thinking capabilities of student and novice nurses.

CHAPTER 3: METHODOLOGY

This chapter discusses the methodology used for this analysis. Search strategies, databases and key words, and screening are discussed. How the data was extracted, the type of statistical analysis, effect sizes, tests of significance, the statistical model used, and the publication bias are all explained. Lastly, the benefits of conducting a statistical meta-analysis of the data used in this study, is highlighted.

Search Strategy

A comprehensive search of the literature was conducted to locate research studies that addressed the relationship between the use of concept mapping and the development of critical thinking in nurses. A number of criteria were used in conducting the search. The first inclusion criterion specified that the outcome variable of critical thinking or aspects of critical thinking, including problem solving, clinical decision-making skills, and reasoning must be measured and reported statistically. Measurement methods could include self-report, direct observation, assessments, and/or written and oral examinations such as case studies or exams, as long as it is quantifiable. Measurement instruments were limited to one of two types in order to maintain methodological heterogeneity; the California Critical Thinking Skill Test (CCTST) and the California Critical Thinking Disposition Inventory (CCTDI). The second criterion was that the study had to address the impact of concept mapping on the critical thinking skills of registered nurses new to the profession or nursing students. The third criterion was that only quantitative research studies, with a controlled intervention, were included that were published in scholarly peer-reviewed journals since 2002, to keep the meta-analysis current, in the English language. The final criterion required that a relationship, whether direct or indirect, be reported between the use of concept maps and critical thinking skills in nurses.

Database and Key Words

A comprehensive search of the electronic databases for this meta-analysis were PubMED, Cochrane Library, Web of Science and EBSCOhost, which included Academic Search Complete, CINAHL, ERIC, MEDLINE, and PsycINFO. Search terms included: "nurs*", AND "concept map*", AND "critical thinking". Additionally, manual searches of the references lists of retrieved publications and reviews were performed. In order to ensure all relevant studies were captured, citations from the bibliographies of relevant articles for the analysis were used to find additional references.

Screening

A list of 164 articles was created and 66 duplicates were removed. Next, the list of articles was stored for independent review using RefWorks, which is "a web-based bibliography and database manager that allows you to create your own personal database by importing references from text files or online databases and other various sources" (RefWorks). Articles were independently screened by LR and supervisor SW using two steps. First, we examined their title (98 titles screened) and if that met the inclusion criteria, abstracts (50) were also independently reviewed. Of the 50 abstracts reviewed, only 4 met the inclusion criteria and were selected for the analysis. See Appendix A for the screening of articles.

Inclusion Criteria. Studies needed to meet the following criteria in order for full review: (1) used concept mapping as an educational approach in the intervention group, (2) included nursing students are novice registered nurses, (3) evaluated critical thinking as an outcome, (4) used one of two instruments to measure critical thinking (CCTST and CCTDI), (5) published in English in scholarly journals, and (6) reported the results in quantitative measures.

Exclusion Criteria. Studies were excluded if they: (1) had incomplete documentation of the outcome or results, (2) used subjects other than nursing students or registered nurses, (3)

utilized other interventions than concept mapping, and (4) did not evaluate critical thinking.

Data Extraction

Data were extracted by two independent reviewers, LR and SW. For each of the four studies selected, the following information was extracted: first author, publication year, country of origin, sample size (intervention and control group), characteristics of participants, intervention method, teaching method in the control group, measurement tools and duration of intervention, and outcomes (effect size). The extracted data was put into Microsoft Excel to provide an overview of each article. Of the extracted data, the sample size, measurement tool, and outcomes (effect sizes) were used to conduct the analysis. This information is attached in Appendix B.

Statistical Analysis

The data collected from the four studies was entered into Review Manager 5.3 to test heterogeneity and complete the meta-analysis. Review Manager is a software program that performs meta-analyses and produces quantitative systematic reviews. Critical thinking scores of the concept mapping group are analyzed and compared to the control group or to pre-test scores. Since continuous data from different scales were extracted, the standardized mean difference (SMD) was calculated for effect size based on sample size (Cohen, 1988) and 95% confidence intervals (CIs) for each study, and for the pooled studies using variance analysis. Weighted mean difference (WMD) and 95% confidence intervals (CIs) were calculated for continuous data from the same scale. Given the evidence presented in the theoretical approach and the literature review, concept mapping should have a positive influence on critical thinking amongst student and novice nurses, therefore a one-sided P value less than 0.05 will be regarded as significant for all analyses.

There are two models of meta-analysis. The fixed effect model was used to pool data

where there was no heterogeneity, otherwise the random effects model was used. Heterogeneity was considered significant for P value of Cochran's Q statistic < 0.10 and I 2 > 50% (Higgins and Thompson, 2002; Higgins et al., 2003). I^2 was the percentage of variation attributed to heterogeneity and was easily interpreted. I^2 statistic of 25– 50% was considered low, 50–75% was considered moderate, and 75% was considered high. In finding a substantial amount of heterogeneity, we conducted a sensitivity analysis to assess if this significantly altered the results of the meta-analysis. A sensitivity analysis was performed by excluding each one of these studies and then recalculating the pooled estimates for the remaining studies, which did not significantly alter the results.

Specification of Effect Size Calculation

Effect size was calculated in order to demonstrate the mean difference between groups in standard score form, the ratio of the difference between the means to the standard deviation will be highlighted (Yu, 2015). Only one effect size per study was calculated to avoid overrepresentation of individual studies that used multiple critical thinking ability measures or multiple follow up tests. This thesis followed the same rules Rehse and Pukrop (2003) applied to their meta-analysis. If several instruments were used to measure critical thinking within one study, the instrument with superior psychometric properties was selected and the results based on other instruments were excluded. Second, if multidimensional critical thinking tests were administered to subjects, only the effect on the total score or the average effect was used. Third, if critical thinking was measured on multiple occasions, only the first time after the implementation of the intervention of concept mapping was selected. Fourth, "if several treatment conditions [are] realized, effect sizes [will be] averaged over all comparisons with the control group" (Rehse & Pukrop, 2003, p.181).

Tests of Significance

The population effect size for the purpose of this thesis will be the quantitative measure of the strength of the correlation between the use of concept mapping and the development of critical thinking. There is no definitive test that can be used to determine whether a population effect size differs significantly from zero. However there are a couple ways to address this issue. Hunter and Schmidt (1990) suggest using the 95% confidence interval to estimate the potential variation of the population effect size and that at least 75% of the observed variance in effect sizes should be attributable to sample error. In addition, the "population effect size should be at least twice as high as the residual standard deviation" (Rehse & Pukrop, 2003, p.181). And finally, the absolute amount of residual variance should not exceed 25% of the population effect size (Stoffelmayr, Dillavou, & Hunter, 1983). The standard error (SE) of effect-size is important when combining multiple studies with different effect sizes and will be used to weight the effect sizes from the individual studies.

Type of Statistical Model

The effect size measure that will be used for the meta-analysis will be Cohen's *d* (1988). This measure was selected because it is a "standardized form of the covariance between two variables and is a measure of the strength of a relationship between two continuous variables" (Field & Gillett, 2010, p.668). A random-effects meta-analytical technique will be applied to the data so that the results can be generalized beyond the studies directly included in this thesis and inferences can be extended to other populations. Additionally, random effects models account for any variance caused by differences among subjects and between studies. Review Manager 5.3 software utilizes the random-effects technique, based on the DerSimonian Laird statistic, along with assessments of heterogeneity. The forest plots will display the estimates and standard errors.

Publication Bias

The effect of a publication bias, specifically in meta-analyses, is that reviews may overestimate population effects if they only include published studies because the effect sizes in unpublished studies, with equivalent methodological quality, will be smaller (McLeod & Weisz, 2004). Only published research was included for the analysis, as one of the inclusion criteria was published English peer-reviewed studies, therefore nothing will be done to control for or correct the publication bias which may skew the results from the meta-analysis. This however will be addressed as a limitation in Chapter 5.

Benefits of Conducting a Statistical Meta-Analysis

Single studies have been done that look at the relationship between the use of concept mapping and the development of critical thinking, but no meta-analysis has been done to this date. When the results from numerous studies are combined, the statistical power increases and the precision of estimation can be substantially improved (Yu, 2015). Additionally, if conflicting results are found in previous research, a meta-analysis will focus on the bigger picture and the sum of all results as a whole to highlight the relationship.

CHAPTER 4: RESULTS

The purpose of this meta-analysis, using a pretest-posttest experimental and control design, was to examine whether concept mapping improved critical thinking based on the exam scores. The studies used in this analysis looked at the effect of concept mapping, used as a teaching strategy, on critical thinking skills in student nurses and novice registered nurses. The findings of these studies are presented in this chapter.

The studies looked at two different measurement instruments for testing critical thinking and the California Critical Thinking Skills Test (CCTST) and the California Critical Thinking Disposition Inventory (CCTDI). This meta-analysis used continuous outcome variables, therefore the individual study findings were presented as N - the total number of participants in the experimental or control group, and mean SD - the arithmetic mean and standard deviation (SD) of the outcome measure in the experimental or control group.

The mean scores and standard deviations from each study were used to compare the control and experimental groups pretest and posttest scores. Data was inputted into the Review Manager 5.3 software for the analysis. The continuous outcome measures, critical thinking scores, were expressed as weighted mean difference (WMD). Heterogeneity (I^2), measures the diversity between the studies, giving an indication for how comparable the studies in this meta-analysis are.

Comparison of Experimental and Control Groups Pretest Critical Thinking Scores

Pretest mean scores for the CCTST and CCTDI were computed for the control and experimental groups across the studies.

1. The control group's pretest total CCTST mean score for Boyadjian-Samawi (2006) was 12.2 (SD = 5.99), for Huang et. al. (2012) was 10.98 (SD = 4.72), and Wheeler and Collins (2003) was 17.34 (SD = 3.66). The experimental group's pretest total

CCTST mean score for Boyadjian-Samawi (2006) was 12.88 (SD = 4.66), for Huang et. al. (2012) was 10.88 (SD = 3.49), and Wheeler and Collins (2003) was 16.93 (SD = 4.37). The weighted mean difference (WMD) between the control and experimental groups in all three studies was -0.00.

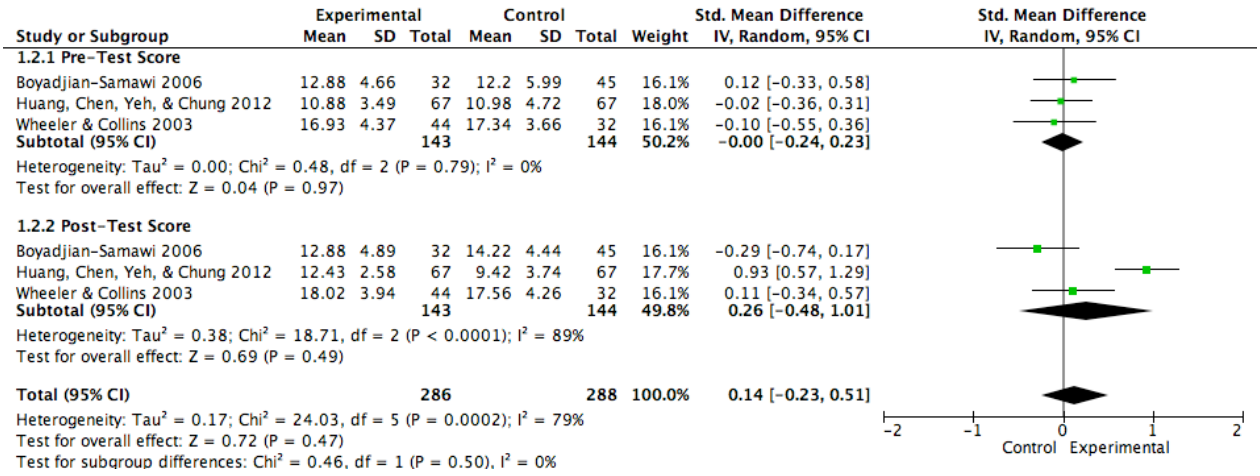
2. The control group's pretest total CCTDI mean score for Atay and Karabacak (2012) was 221 (SD = 19), for Boyadjian-Samawi (2006) was 310.16 (SD = 27.99), and Huang et. al. (2012) was 232.38 (SD = 18.28). The experimental group's pretest total CCTDI mean score for Atay and Karabacak (2012) was 220 (SD = 17.7), for Boyadjian-Samawi (2006) was 314.06 (SD = 34.81), and Huang et. al. (2012) was 240.67 (SD = 21.92). The WMD between the control and experimental groups in all three studies was 0.19.

Research Questions

Research Question 1. Is there a difference between control and experimental groups of nursing students and novice nurses on posttest critical thinking scores using the California Critical Thinking Skills Test (CCTST)?

The mean scores for the control and experimental group's posttest scores on the CCTST were used to compute the Test for Overall Effect. Heterogeneity (I^2) of variance was tested for and due to the statistically significant difference (89%), heterogeneity was deemed very high, therefore a random effect model was used. The Test for Overall Effect yielded no statistically significant difference in group means for the experimental and control groups on posttest critical thinking. However, the Total Test for Overall Effect, looking at pretest and posttest scores in the experimental and control groups, showed a statistically significant difference between groups (P = 0.04). Results from the meta-analysis are shown in Table 1.

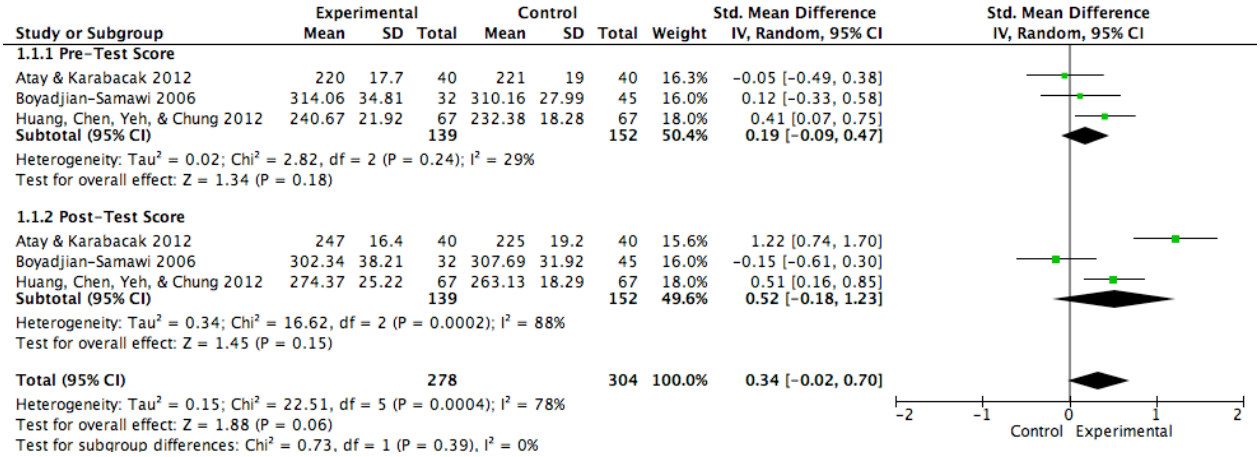
Table 1 – Comparison of Experimental and Control Groups Means and Standard Deviations for CCTST Scores, Pretest and Posttest.



Research Question 2. Is there a difference between control and experimental groups of nursing students and novice nurses on posttest critical thinking scores using the California Critical Thinking Disposition Inventory (CCTDI)?

The mean scores for the control and experimental group's posttest scores on the CCTST were used to compute the Test for Overall Effect. Heterogeneity (I^2) of variance was tested for and due to the statistically significant difference (88%), heterogeneity was deemed very high, therefore a random effect model was used. The Test for Overall Effect yielded no statistically significant difference in group means for the experimental and control groups on posttest critical thinking. Results from the meta-analysis are shown in Table 2.

Table 2 – Comparison of Experimental and Control Groups Means and Standard Deviations for CCTDI Scores, Pretest and Posttest.



Sensitivity Analysis

The "One-at-a-time" approach was used for the sensitivity analysis, where one study was omitted at a time and the others kept at their baseline to see what effect it produced in the results. This approach was selected so that any observed change in the results was due to the single variable, or study, that was removed. Additionally by only removing one study at a time, and keeping all other studies fixed, it increases the comparability of the results and decreases the chances of program error, which is more common when several variables are changed at the same time (Sacks et. al., 1989). When conducting a sensitivity analysis in a meta-analysis such as this study, it tested whether the results were sensitive to restrictions on the data, therefore determining whether the results were consistent in providing stronger evidence of an effect and of the generalizability of the results. The sensitivity analysis for this study showed that the overall results were not affected; therefore the results of the meta-analysis can be regarded with a higher degree of certainty. The sensitivity analysis remains robust, meaning they are similar to the results from the primary analysis.

Population Effect Size

The population effect size for this thesis was the quantitative measure of the strength of the correlation between the use of concept mapping and the development of critical thinking. A standardized measure of effect, in this case Cohen's *d*, was used to calculate the effect size because the variables in this study do not have intrinsic meaning, are combined from multiple studies, and to demonstrate the size of the effect relative to the variability in the population. Cohen (1988) suggests $r = 0.10$ is a small effect, accounting for 1% of the total variance; $r = 0.30$ is a medium effect, accounting for 9% of the total variance; and $r = 0.50$ is a large effect accounting, for 25% of the total variance. In meta-analyses, such as this one, standardized effect sizes were calculated for different studies and combined to show the overall effect. The California Critical Thinking Skills Test (CCTST) pretest Cohen's *d* is 0.013 and effect size *r* is 0.006, the posttest Cohen's *d* is 0.44 and effect size *r* is 0.21. The California Critical Thinking Disposition Inventory (CCTDI) pretest Cohen's *d* is 0.159 and effect size *r* is 0.079, the posttest Cohen's *d* is 0.37 and effect size *r* is 0.18. Therefore the population effect size for this study, the quantitative measure of the strength of the correlation between the use of concept mapping and the development of critical thinking skills, was on the smaller side, accounting for very little of the total variance.

The 95% confidence interval (CI) was used to estimate the potential variation of the population effect size, and as Hunter and Schmidt (1990) suggested, 75% of the observed variance in effect sizes was attributed to sampling error. The CCTST had a 0.34 95% CI when comparing pre and posttest scores from the experimental and control group. The CCTDI had a 0.70 95% CI when comparing pre and posttest scores from the experimental and control group

Summary

This chapter presented the findings of this meta-analysis. The means and standard

deviations were looked at to analyze the differences in pretest and posttest scores between the experimental and control groups, using one of two critical thinking measurement instruments (CCTST and CCTDI). Overall there was no statistically significant difference between the pretest and posttest results from the CCTST and CCTDI amongst the experimental and control groups. The sensitivity analysis for this study remained robust, therefore the overall results were not affected and were similar to the results from the primary analysis. The population effect size for this study accounted for very little of the total variance. The findings of the research questions are discussed in depth in Chapter 5.

CHAPTER 5:

DISCUSSION, LIMITATIONS, IMPLICATIONS, RECOMMENDATIONS, AND CONCLUSION

The purpose of this quantitative meta-analysis using a pretest – posttest experimental and control group was to explore the effect of concept mapping as a teaching strategy in the development of critical thinking skills. This chapter will begin by discussing the results more in depth and relating them back to the supporting theories from the literature review. Next, the study limitations and implications for nursing will be presented and finally future recommendations will be discussed.

Discussion

The two research questions asked whether there was a difference between control and experimental groups of nursing students and novice nurses on posttest critical thinking scores using either the California Critical Thinking Skills Test (CCTST) or the California Critical Thinking Disposition Inventory (CCTDI). The results of the meta-analysis for both research questions revealed that there were no statistically significant differences in the means between the experimental and control groups on posttest critical thinking scores with the intervention of concept mapping. However, of the four studies used for this meta-analysis, individually two of them showed statistically significant differences between the experimental and control groups in posttest critical thinking scores.

There are several factors that may explain the findings of this analysis such as small sample size, publication bias, type and reliability of instrumentation, timing of the introduction of the intervention, and individual participant characteristics. Each of these factors will be discussed.

The findings of this study may be related to the small sample size used for the analysis,

only four studies, and the uncontrolled publication bias. Sampling error increased because the sample size of participants, from the four studies that met the inclusion requirements, may not have been adequate. Despite half of the studies individually demonstrating a statistically significant difference between experimental and control groups, due to the small sample size the effect demonstrated by the meta-analysis may have been masked by the randomness of the samples (Polit and Beck, 2012). As mentioned previously in this study, the publication bias was not controlled for due to limiting resources for this master's level thesis. Only published articles were sourced for this meta-analysis, therefore the publication bias was not controlled for, which may have skewed the results.

One of the major factors that contributed to the findings of this analysis was the type of instrumentation used. During the literature review portion of this analysis, two main critical thinking instruments were commonly seen in the research; CCTST and CCTDI. Therefore, those two were selected as the type of instrumentation that would be part of the inclusion criteria for this study. The instruments selected are not specific to critical thinking in nursing and can be applied across many subjects and fields. The CCTST and CCTDI were initially developed for a wide variety of students, with a reported acceptable reliability rating (Leppa, 1997). The findings from this analysis, supported by Wheeler and Collins (2003) and Boyadjian-Samawi (2006), indicate the importance of ongoing evaluation of the reliability of instruments such as the CCTST and the CCTDI. It may be reaching beyond the results, however all four studies used for the meta-analysis demonstrated some benefits of using concept mapping to enhance critical thinking skills in nurses, whether it was reflected in the posttest scores or not, it was discussed in each study. Therefore, the results from this analysis suggest CCTST and CCTDI may not be the most suitable instrument to measure the effect of concept mapping on nurses' critical thinking skills. The literature search revealed a few studies are beginning to use The National League for

Nursing (NLN) Critical Thinking in Clinical Nursing Practice/PN Examination (NLNCT) is an instrument, which is specifically designed for nurses. More studies should be conducted that utilize this approach in order to give a better understanding as to whether concept mapping actually improves critical thinking skills in nurses.

In addition to the type of instrument selected, the reliability of the instrument is just as crucial in its affect on the findings. The use of the CCTST has not proven to be an accurate method as a standardized test, for measuring critical thinking skills in nurses (Boyadjian-Samawi, 2006; Leppa, 1997; Toth, 1996; Wheeler & Collins, 2003). Research found that nursing students did not demonstrate significant improvements in their ability to think critically during their nursing program, when measured using the CCTST. In fact, Leppa (1997) reported a decrease in critical thinking scores throughout the nursing program, therefore suggesting students were negatively affected or not affected at all by the learning strategies implemented. Leppa suggested the reliability of instruments should be retested with every research study.

Another possible explanation for the findings of this study is related to when the intervention of concept mapping was introduced to the nurses. The literature review revealed that the most beneficial time for introducing concept mapping to nursing students is early on in the program, before they have firmly established their preferred studying methods (Kinchin & Hay, 2000). Furthermore, Daley et al. (1999) found that second semester nursing students were less receptive to learning a new strategy, and when asked about the effectiveness of concept mapping as a tool to develop critical thinking skills, nursing students recommended incorporating it earlier into the curriculum. The participants used in this analysis were nursing students who ranged from freshmen and sophomore level in Atay and Karabacak's (2012) study, sophomore level in Wheeler and Collin's (2003) study, junior and senior level in Boyadjian-Samawai's (2006) study, and novice registered nurses new to a hospital orientation program in Huang et al. (2012) study.

Further research is needed to look at how concept mapping affects critical thinking skill development when introduced to student nurses in their first semester or first year of the program, in order for the intervention to actually work to its full potential.

The findings from this study might be related to the fact that critical thinking skills could differ amongst groups and across studies. The study design, participants' age, work experience, gender, point of entrance into the nursing program, and many other contributing factors already predispose certain participants to have higher levels of critical thinking abilities than others. This is a factor that cannot be controlled for when creating experimental and control groups, but will play a role in the results of the study.

Application of the Constructionist Theoretical Perspective. As suggested earlier, the use of concept mapping as a strategy to develop critical thinking in nurses, begins with the Constructionist Theoretical Perspective (CTP), where active learning is the foundation. According to CTP, learning is an active process based on existing knowledge and the groundwork for the whole learning process is based on the learner's previous constructs of knowledge and experience (Brandon & All, 2010). This perspective applies to concept mapping in that the learner must take an active approach to their learning and when creating concept maps they rely on their pervious knowledge, experiences, and information to actively build the map. In applying the CTP to whether concept mapping increases critical thinking, in theory it would appear that concept mapping should be linked to improved critical thinking, however the findings from this study did not support the use of concept mapping for the purpose of developing critical thinking skills in nurses. Despite the insignificant results from this study, I would argue that applying the CTP to learning in nurses is still a beneficial strategy for encouraging an active approach to learning for nurses, whether it improves critical thinking skills or not, it still assists learners in increasing their knowledge base.

Application of the Situated Clinical Decision-Making Framework. Concept mapping can be used as a tool for educators to help analyze the problem solving and decision-making abilities of nurses; the Situated Clinical Decision-Making framework (SCDM) can be utilized by educators in order to facilitate the development of these skills. The SCDM framework provides a structured approach for educators to evaluate learner's decision-making and problem solving skills and help guide them in choosing supportive strategies to promote the development of these abilities (Gillespie, 2010). In applying this framework to the use of concept mapping as a tool to develop critical thinking, it encourages educators to evaluate decision-making skills of the learners when it comes to creating concept maps and help support them throughout that process. Although the results from this study were insignificant in demonstrating a relationship between concept mapping and improved critical thinking skills, it still remains a beneficial framework for educators to apply as a strategy for teaching problem solving and decision making skills.

Application of the Meaningful Learning Theory. Ausubel's (1968) meaningful learning theory supports the idea that the basis of thinking is understanding concepts in a meaningful way and being able to identify the relationship between them. When nursing students learn in a meaningful way, they assimilate previously acquired concepts with new concepts they learn. Meaningful learning is crucial for the development of knowledge and this occurs when the new knowledge incorporated into the preexisting conceptual framework of the learner (Novak & Gowin, 1984). This application of meaningful learning provides a greater understanding of the concept as a whole, and a new understanding of the relationships between concepts. The research has shown that concept mapping is one strategy that creates an opportunity for students to meaningfully learn.

As suggested earlier in this study, Ausubel's cognitive organizational method for the process of meaningful learning is highlighted through the use of concept maps as a learning

strategy. The three components for the cognitive organization are: progressive differentiation, subsumption and integrative reconciliation (Ausubel, 1968). Progressive differentiation can be seen when earlier concept maps are compared to later ones, where the quantity and complexity of linkages are evident which are presented in a more hierarchical organization. Subsumption is demonstrated in the studies of this analysis, as the concept maps created by participants had an increase in new concepts and were linked higher up in the hierarchy then initially. Finally, integrative reconciliation was evident by the fact that concept maps produced by nurses, over time, increased the linkages between new ideas and prior knowledge.

The results from this study did not support the use of concept mapping as a teaching strategy to improve critical thinking skills in nurses. Existing research discusses the benefit of concept mapping as a teaching strategy to be used in higher education, that acts as a metacognitive tool that can enhance students' understanding and ability to conceptualize, unfortunately the findings from this study were insignificant in demonstrating that (Daley et al., 1999; Wheeler & Collins, 2003).

Limitations

One of the major limitations to this study is its generalizability, which is limited due to the sample populations of the studies used for the analysis. For the purpose of this analysis, due to time and resource constraints, only four studies were found that match the inclusion criteria and used. Additionally the samples of participants from each study vary from first semester freshman nursing students, to sophomores, to novice nurses new to a healthcare facility, in the United States of America, Turkey and Taiwan. Ideally this study would have been conducted using participants who were all in the same first semester of nursing school so that clinical experience from previous semesters and knowledge or learning strategies accumulated throughout nursing school did not play a role in the outcome. Also, the study designs of the

articles used for the analysis were fairly weak in that there was no random selection or assignment, convenience sampling was used for all the studies. Furthermore, the inclusion criteria limited the results to published English peer-reviewed studies, therefore the publication bias acts as a limitation to this study. Due to the sample populations, lack of random selection, and diverse sample of nursing students and novice nurses, and the publication bias, the findings from this study cannot be generalized. With that being said, the results still have beneficial implications for the profession of nursing and will be discussed in the next section.

Another limitation that may have contributed to the results, that was briefly mentioned, is that the intervention of concept mapping was introduced at different points during the nurses' education and careers. Developing critical thinking skills is a complex conceptual activity that is ongoing throughout nursing school and a nurse's professional career. The intervention of concept mapping introduced in the first semester of nursing school will produce different results than if introduced later in nursing school, as students often have developed learning strategies by that point that work best for them and may be less receptive to trying new techniques. Kinchin and Hay (2000) found that the best time to introduce concept mapping to nursing students is early on in their education, before they develop study habits. Students who learn concept mapping in their first semester will be more likely to utilize throughout their education, which will have a greater impact on the development of critical thinking with the use of concept mapping.

Another limitation, related to the time when concept mapping is introduced, is the time interval between the pre and posttest measurements. The period between pre and post testing will affect the results in that the longer students have to work with concept maps and utilize them in their learning the greater the results will be. The studies used in this analysis had a time interval between pre and post testing that ranged from 4-12 months. One semester, especially at the beginning of a nurse's education, may not be a sufficient time to measure the development of a

complex skill such as critical thinking ability, especially if done during the first year of nursing school. A longitudinal study that uses concept mapping throughout the whole nursing program curriculum, not just one course, with a pretest – posttest design at the beginning of the program and the end would be a more effective measure of the actual effect of concept mapping on student nurses' critical thinking skills over time.

Implications

This study looked at the effects of concept mapping on the critical thinking abilities of student and novice registered nurses. Despite the results from the analysis showing no statistically significant differences between the experimental and control groups in improved critical thinking scores with the use of concept maps, there are several implications for nursing education and research.

Education. These results show that concept mapping does not increase critical thinking skills. Teaching student nurses how to think critically or develop their critical thinking skills is a challenging area for nurse educators. The research reveals that nurse educators, both in the classroom setting and clinical practice, are struggling with the teaching and evaluation of the critical thinking skills (King & Shell, 2002). Welk (2002) found that novice nurses' lack necessary critical thinking skills, which are an essential skill required for nurses to practice competently. Researchers have indicated that critical thinking skills are consistently ranked amongst the lowest observed competencies in student and novice nurses, despite coming out on the top of most important entry-level competencies (King, Smith, & Glenn, 2003). Despite the acknowledgment from nurse educators that critical thinking is a crucial skill that needs to be developed in nursing school, attempts at developing this skill are still proving to be unsuccessful and an area that they are struggling to teach. Although the results from this analysis have no statistical significance, it could be that concept maps might help students actively learn in a

meaningful way, and made them more cognizant of their critical thinking abilities. However, more research is needed in order to understand whether concept mapping is related to meaningful learning.

Research. The findings from this study, and the individual studies used in the analysis, reveal the implications of the instrumentation used to measure critical thinking. As mentioned in the discussion, the reliability of the instruments, the CCTST and the CCTDI, have not proven to be entirely accurate as a standardized test to measure critical thinking in nurses (Boyadjian-Samawi, 2006; Leppa, 1997; Toth, 1996; Wheeler & Collins, 2003). Future research should address the reliability of the instruments used to measure critical thinking in nurses and alternative instruments should be explored such as the National League for Nursing Critical Thinking exam, which is specifically designed for nurses.

This analysis contributes to nursing research, as it is the first meta-analysis looking at the relationship between concept mapping and critical thinking skills in nursing students and novice nurses. Despite concept mapping being identified in the literature as a metacognitive intervention to facilitate meaningful learning and critical thinking, there is limited empirical evidence that supports its effectiveness (Beitz, 1998; Daley, 1996; Wheeler & Collins, 2003). Although this analysis did not produce statistically significant results in support of concept mapping as a metacognitive strategy that can be used to develop critical thinking, it did discuss some benefits of the intervention that could be focused on in future research. The results of this meta-analysis contributed to nursing research in the areas of the student learning process, the critical thinking process, and how critical thinking is taught and measured.

Recommendations

Based on the findings of this study, the following recommendations are proposed for future nursing education and research. This study should be replicated with a larger sample size,

and randomly selected from multiple different nursing schools, in order to provide a more accurate representation of nursing students. Random selection and assignment to control and experimental groups would strengthen the design of the study. More research needs to be done, looking at the relationship between concept mapping and critical thinking skills, using an instrument specifically designed for measuring critical thinking in nurses. Since critical thinking is a skill that needs time and experience to develop, a longitudinal design that evaluates the effectiveness of concept mapping on critical thinking should be used from first year nursing students to graduation. Future analyses that look at this topic should include more studies to better control for variability, increase generalizability and meet the required power analysis to highlight if there is a relationship between concept mapping and critical thinking.

Conclusion

This meta-analysis looked at the effect concept mapping has on critical thinking skills in nursing students and novice nurses, by comparing posttest scores in the control and experimental groups. The Constructionist Theoretical Perspective, Situated Clinical Decision-Making Framework, and Ausubel's Meaningful Learning Theory were discussed and their relevance to critical thinking highlighted. The results of this analysis do not support the existing research in that concept mapping can be used as a teaching tool in nursing, and act as an effective learning strategy that may help nursing students learn concepts in a meaningful way and promote the development of critical thinking skills.

The total sample of nursing students and novice nurses included in this analysis was 501, coming from 4 different studies that met the inclusion criteria. The intervention looked at in this meta-analysis was concept mapping and critical thinking was measured using the CCTST or the CCTDI. Posttest scores from the control and experimental groups were compared using Review Manager 5.3 software. The statistics presented from the data analysis included the heterogeneity

of variance and the test for overall effect.

A meta-analysis was conducted to see if by pooling the current data involving this relationship, an effect would be highlighted, therefore strengthening the individual studies pertaining to this topic.The findings from this analysis did not support the effectiveness of concept mapping on nurses' critical thinking skills. There were no statistically significant differences between the critical thinking scores of student and novice nurses on the posttest scores in the experimental and control groups. Studies have demonstrated how concept mapping enhances students' critical thinking abilities, and although this analysis revealed an improvement in scores in the experimental group, unfortunately the results were not of statistical significance (Boyadjian-Samawi, 2006; Wheeler & Collins, 2003).

Critical thinking is not only the foundation of life-long learning but also the basis of professional growth (Chao, 2004). As mentioned throughout this analysis, critical thinking ability is one of the most commonly identified deficits nurses and nurse educators report. The nursing profession requires nurses to be skilled in critical thinking in order to practice proficiently and to correctly apply and adapt the nursing process to every situation. Nursing educators report critical thinking is required for nurses to provide competent care and function safely in all environments, and at all levels throughout the nursing program and a nurse's career (King & Shell, 2002). Critical thinking is a crucial skill that will always be required in our nurses therefore nurse educators must continue to experiment with and explore different interactive and innovative teaching and learning strategies that will help develop critical thinking in all aspects of nursing education.

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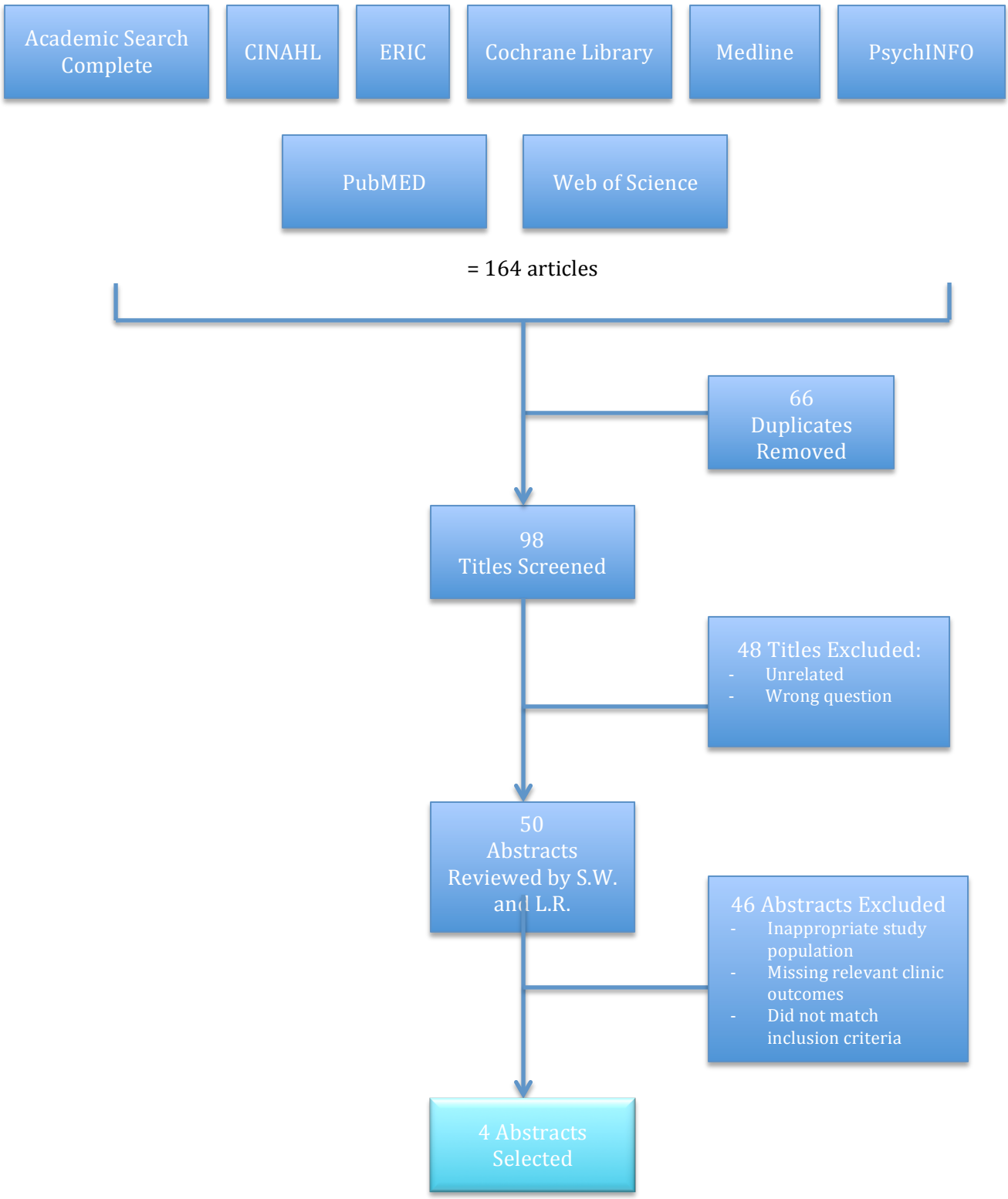
Appendices

Appendix A: Flow Chart of Literature Selection Process



Appendix B: Data Extraction Matrix

Authors, Year, Title, Journal	Country	Purpose	Study Design	Sample Characteris-tics	Data Analysis	Findings
Atay & Karabacak. (2012) Care plans using concept maps and their effects on the critical thinking dispositions of nursing students. *International Journal of Nursing Practice.*	Turkey	This study examined how using concept maps in creating care plans effects the critical thinking dispositions in nursing students. Research questions: 1. Are there any differences between the students who prepared a care plan using concept mapping and those who prepared the plan using column format? 2. Is there any relationship between concept map care plan	A **longitudinal prospective cohort** study conducted during the Spring semester academic year of 2008-2009. The students in the experimental group received training on how to prepare a concept map care plan in three sessions (each session was 3-4 hours long). Students in the control group received no additional training and prepared their care plans in the traditional	**N=80** freshman and sophomore nursing students from X School. **Control group N = 40** 25 were freshman and 35 were female. **Experimental group N = 40** 21 were freshman and 34 were female. No significant differences in the average group age or grade point average were found between the control and experiment groups. **Recruitment:** Convenience sampling of freshman and sophomore nursing students in the spring semester. Simple random sampling was used to split the	Statistical analysis of the **California Critical Thinking Disposition Inventory (CCTDI)** scores from each of the sub-scales and the total scores was done with SPSS software. Scores between the control and experimental groups were compared using a t-test. The reliability coefficient among the participants was: $r = 0.98$ $p < 0.001$	**Pre-test Mean score control group 221±19.0 Mean score experimental group 220.0±17.7** There were no statistically significant differences found between the pre-test mean scores of the two groups for critical thinking disposition ($t = 0.37$, $p > 0.05$). **Post-test Mean score control group 225±19.2 Mean score experimental group 247±16.4**

Authors, Year, Title, Journal	Country	Purpose	Study Design	Sample Characteris-tics	Data Analysis	Findings
		evaluation criteria mean scores of the experiment al students?	column format.	students into the control and experimental groups.		There was a statistically significant difference found between the post-test mean scores of the two groups for critical thinking disposition ($t = 5.37$, $p < 0.05$, $f = 90.73$).
Boyadjia n-Samawi. (2006) Critical thinking skills and dispositio ns of junior and senior baccalaur eate nursing students.	USA	The purpose of this study was to: 1. Explore the effect of concept mapping, as a metacogniti ve teaching strategy on the critical thinking skills and dispositions of junior and senior level baccalaurea te nursing students. 2. Evaluate	**Quasi-experiment al, non-equivalent control group, longitudina l design.** Pre-test/post-test design. Participants were enrolled in a generic baccalaureat e nursing program. Students in the control group	**N=77 Control=45 Experimental= 32** The pre-test scores of the two groups did not differ significantly. A convenience sample of junior and senior level students, all voluntary. Mean age= 26.58 (SD=7.72) Little	The **California Critical Thinking Skill Test (CCTST)** and the **California Critical Thinking Dispositio n Inventory (CCTDI)** were used to measure critical thinking skills and critical thinking disposition.	**CCTST Pre-test Mean score control group: 12.20±5.99 Mean score experiment al group: 12.88±4.66 Post-test Mean score control group: 14.22±4.44 Mean score experiment al group: 12.88±4.89**

Authors, Year, Title, Journal	Country	Purpose	Study Design	Sample Characteris-tics	Data Analysis	Findings
		the changes in students' concept mapping skills over time.	received lecture only and the experimental group used concept maps as an instructional method over the course of a full academic semester.	variability between groups.	Data analysis included descriptive, correlational and comparative statistics. Paired t-tests and independent t-tests were used.	**CCTDI** **Pre-test** **Mean score control group: 310.16±27.99** **Mean score experimental group: 314.06±34.81** **Post-test** **Mean score control group: 307.69±31.92** **Mean score experimental group: 302.34±38.21**
Huang, Chen, Yeh, & Chung. (2012) Case studies combined with or without concept	Taiwan	This study aimed to evaluate the effects of a program of case studies, alone (CS) or combined with	**Randomized controlled trial.** The experimental group participated in a 16-week	**N=134 Control=67 Experiment=67** Nurses were recruited from a 392-nurse, 14-ward, 500-bed, medical teaching	Data were collected before and after the program using the **California Critical Thinking Skill Test (CCTST)**	**CCTST** **Pre-test** **Mean score control group: 10.98±4.72** **Mean score experimental group:**

Authors, Year, Title, Journal	Country	Purpose	Study Design	Sample Characteris-tics	Data Analysis	Findings
maps improve critical thinking in hospital-based nurses: A randomized-controlled trial. *International Journal of Nursing Studies.*		concept maps (CSCM), on improving critical thinking (CT) in clinical nurses. Research question: 1. Are there significant differences in CT cognitive skills and affective dispositions toward CT between the two groups who participated in the CSCM and the CS groups?	CSCM program. The control group participated in a CS program of equal duration. A multistage randomization process was used to select and to assign participants, ultimately resulting in 67 nurses in each group.	hospital in Hualien, Taiwan. The participants were working in a medical, surgical, obstetrics and gynecology, pediatric, long-term care, or intensive care unit, and providing direct patient care. Average age of participants was 27.04±3.88 years; average years of nursing work experience was 5.21±3.95. No significant differences in age, educational levels, and years of nursing work experience between the two groups.	and the **California Critical Thinking Disposition Inventory (CCTDI).** **CCTST** The internal consistency reliability, as demonstrated by the Kuder-Richardson -20 test, ranged from 0.69 to 0.74 and was 0.34-0.53 in this study. **CCTDI** The content validity index ranged from 0.50-0.80 for the subscales and was 0.85 overall. The Cronbach alpha	**10.88±3.49** **Post-test** **Mean score control group: 9.42±3.74** **Mean score experimental group: 12.43±2.58** **CCTDI** **Pre-test** **Mean score control group: 232.38±18.28** **Mean score experimental group: 240.67±21.92** **Post-test** **Mean score control group: 263.13±18.29** **Mean score experimental group: 274.37±25.22**

Authors, Year, Title, Journal	Country	Purpose	Study Design	Sample Characteris-tics	Data Analysis	Findings
					values ranged from 0.34-0.73, with an overall value of 0.71 and were 0.66-0.75 with an overall value of 0.73 in this study.	
Wheeler & Collins. (2003) The influence of concept mapping on critical thinking in baccalaureate nursing students.	USA	The purpose of this study was to evaluate the effectiveness of concept mapping in developing critical thinking skills in baccalaureate nursing students. This study examined whether using concept mapping instead of the traditional nursing care plan to prepare for	**Quasi-experimental longitudinal design.** Pre-test/post-test design with a control group to determine whether nursing students who used concept mapping to prepare for clinical experiences during the fall semester of their junior year would show greater	**N=76 Control=32 Experimental=44** Participation was voluntary and all eligible students participated. The pre-test scores of the two groups did not differ significantly.	The **California Critical Thinking Skill Test (CCTST)** was used to measure critical thinking skills. ANCOVA was used to analyze the covariance on the mean difference between pre and post-test scores.	**Pre-test Mean score control group: 17.34±3.66 Mean score experimental group: 16.93±4.37** **Post-test Mean score control group: 17.56±4.26 Mean score experimental group: 18.02±3.94**

Authors, Year, Title, Journal	Country	Purpose	Study Design	Sample Characteris-tics	Data Analysis	Findings
		clinical experiences would help baccalaurea te nursing students become better critical thinkers.	improvemen t in critical thinking skills than those who did not. A convenience sample of sophomore nursing students were randomly assigned to one of four courses (Adult Health, Pediatric Nursing, Maternity, or Psychiatric Nursing) for the first 7.5 weeks of the fall semester. Concept mapping was introduced to the Adult Health students and one third of the students in the Pediatric Nursing			

Authors, Year, Title, Journal	Country	Purpose	Study Design	Sample Characteris-tics	Data Analysis	Findings
			course. The remaining students used traditional nursing care plans to prepare for clinical.			