Concept Maps: A Strategy to Teach and Evaluate Critical Thinking

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ABSTRACT

The purpose of this article is to describe a study that implemented concept maps as a methodology to teach and evaluate critical thinking. Students in six senior clinical groups were taught to use concept maps. Students created three concept maps over the course of the semester. Data analysis demonstrated a group mean score of 40.38 on the first concept map and 135.55 on the final concept map, for a difference of 98.16. The paired t value comparing the first concept map to the final concept map was -5.69. The data indicated a statistically significant difference between the first and final maps. This difference is indicative of the students' increase in conceptual and critical thinking.

In the preceding quote, Addie Norton refers to a special type of learning. This type of learning is defined as one that requires an active process of thinking, learning, and drawing relationships.

The questions nurse educators face are: Do we teach students to think and learn in this fashion? Do we help students develop the critical-thinking skills that will facilitate a lifelong ability to “dig it out of the mud?”

The purpose of this article is to describe a study that implemented concept maps as a methodology to teach and evaluate critical thinking. As nursing education has shifted to an emphasis on outcomes-oriented education, the issue of teaching and evaluating critical thinking has come to the forefront. The National League for Nursing (NLN) now requires the demonstration of critical thinking in graduates of all nursing programs in the United States (NLN, 1996).

One of the major issues in the teaching and evaluation of critical thinking is the development and use of tools and instruments that both foster the teaching, as well as the measurement, of critical thinking, specific to the context in which learning occurs. Instruments exist that measure general aspects of critical thinking (e.g., California Critical Thinking Skills Test [Facione, 1992]; Watson-Glaser Critical Thinking Appraisal [Watson & Glaser, 1980]; The Cornell Critical Thinking Test [Ennis, Millman, & Tomko, 1985]), but these instruments do not possess a connection to the context of nursing practice. This issue of the measurement of critical thinking within a particular context is important because if nurse educators teach students to think critically and then evaluate their performance using unconnected, general measures we in essence have failed to demonstrate validity in our measurement of the concept of critical thinking.

Critical Thinking Defined

Following a Delphi research project, the American Philosophical Association (APA) (1990), published a consensus definition of critical thinking based on the views of 46 published critical-thinking theorists from numerous disciplines. This definition states:

"Critical thinking is the process of purposeful, self-regulatory judgment. This process gives reasoned consideration to evidence, contexts, conceptualizations, methods, and criteria (APA, 1990, p. 2).

Facione (1995) states:

Like many other descriptions of higher order thinking, the original Delphi authors conceptualized a simultaneous, metacognitive, self-appraisal of one’s thinking process (that is, thinking about and evaluating one’s thinking while engaged in the process of purposeful judgment)" (p. 2).

Concept maps, the teaching and evaluation tools used in this study, link directly to the APA (1990) definition of critical thinking. Concept maps are metacognitive tools that assist learners to develop a self-appraisal of their own individual thinking processes. The maps foster a careful consideration of evidence drawn from clinical practice. Through use of concept maps, learners develop the ability to consider the context of nursing practice in their conceptualization of client problems. Finally, purposeful judgments are made regarding

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interventions based on how methods and criteria are linked to the conceptualization of the problems.

**Conceptual Framework**

Ausubel, Novak, and Hanesian's (1986) assimilation theory of learning served as the conceptual framework for this study. Within this theoretical framework, Ausubel et al. (1986) advocate that learners shift away from behavioral learning strategies to cognitive learning strategies. Ausubel et al. (1986) believes learners do not learn by memorizing, rather they learn by organizing, relating, and subsuming concepts into their cognitive structures. When learning in a meaningful fashion, concepts are linked and assimilated so learners create unique and idiosyncratic meanings and organization of information. This unique meaning includes concepts of new material, concepts of what the learners already know, and concepts from the context in which the learners are engaging in the learning. Ausubel et al. (1986) differentiated the concepts of meaningful learning and rote learning. In their terms, rote learning is a form of memorizing in which learners create and construct knowledge by linking concepts together in unique ways. Through the process of meaningful learning, learners demonstrate that the knowledge being created has a particular meaning and organization. The process of constructing a knowledge base allows instructors and learners to develop a shared meaning through discussion of the conceptual relationships.

**Learning With Concepts.** According to Ausubel et al. (1986), concept learning occurs in three ways. First, the learners subsume lower-order concepts under higher-order concepts in a hierarchical fashion. This process of subsumption involves rearranging and reordering conceptual understanding and meanings. Learners first may learn the higher-order concept and then subsume the lower-order concepts, or learners may learn the lower-order concepts and then relate them to the higher-order one. Learners essentially are using a process of both inductive and deductive thinking to develop a conceptual hierarchy and organization that facilitates learning and remembering concepts. For example, students may develop an
Scoring Criteria for Concept Maps

**Propositions:** Is the meaning relationship between two concepts indicated by the connecting line and linking word(s)? Is the relationship valid? For each meaningful, valid proposition show, score 1 point.

**Hierarchy:** Does the map show hierarchy? Is each subordinate concept more specific and less general than the concept drawn above it (in the context of the material being mapped)? Score 5 points for each valid level of the hierarchy.

**Cross Links:** Does the map show meaningful connections between one segment of the concept hierarchy and another segment? Is the relationship shown significant and valid? Score 10 points for each cross link that is both valid and significant, and 2 points for each cross link that is valid but does not illustrate a synthesis between sets of related concepts or propositions. Cross links can indicate creative ability and special care should be given to identifying and rewarding its expression. Unique or creative cross links might receive special recognition, or extra points.

**Examples:** Specific events or objects that are valid instances of those designated by the concept label can be scored 1 point each. (These are not circled because they are not concepts.)


understanding of the concept of communication in one course and subsume it under the concept of family history-taking in a subsequent course.

Second, the learners progressively differentiate concepts in the cognitive structure. This progressive differentiation involves an analytical process where learners break down the newly learned concepts into component parts. For example, beginning nursing students may progressively differentiate the concept of vital signs into the components of temperature, respiration, blood pressure, and pulse.

Third, the learners learn through a process of integrative reconciliation. Integrative reconciliation is a synthesis process in which learners take the concepts that have been differentiated and seek connections between different concepts. For example, students may demonstrate integrative reconciliation when they begin to make connections between clients' vital signs, medical status, and assessment data.

**Concept Mapping: What Is It?**

Based on the work of Ausubel et al. (1986), Novak and Gowin (1984) operationalized meaningful learning and assimilation theory by creating concept maps. "A concept map is a schematic device for representing a set of concept meanings embedded in a framework of propositions" (Novak & Gowin, 1984, p. 15). Concept maps are created with the broader, more inclusive concepts at the top of the hierarchy, connecting through linking words with other concepts that can be subsumed. This tool facilitates understanding of conceptual relationships and the structure of knowledge. "Concept maps...are a representation of meaning or ideational frameworks specific to a domain of knowledge, for a given context of meaning" (Novak, 1990, p. 29). Figure 1 depicts a concept map demonstrating the essential ingredients of concept maps. Note the maps are developed to represent Ausubel et al.'s (1986) assimilation theory of learning and foster a process of meaningful learning. Concept maps have concept labels depicting the relationships among new and previous knowledge. The concepts labels are linked to form propositions stored in the learners' cognitive structures. Concept maps have some type of hierarchy that is often dependent on the context of the learning. Concept maps facilitate students' understanding of conceptual relationships and the structure of knowledge. When used as a strategy to facilitate learning, concept maps allow instructors and students to share information, discuss conceptual relationships, and correct misperceptions in the learned information.

**Research Questions**

The following research questions guided this inquiry:

- Will concept maps measure changes in students' critical-thinking abilities over the course of a semester?
- How do faculty and students evaluate the use of concept maps in nursing education?

**Methodology**

Faculty within the culminating clinical course in a baccalaureate nursing program elected to use concept maps to foster the links between the theoretical and clinical components of the course. Course and clinical faculty invested time in learning to use concept maps. Six senior clinical groups (n = 54) were taught to use concept maps as a learning strategy. During the first week of class, students were taught how to create concept maps (see Sidebar on page 43). After this introductory session, students completed concept maps on the scenario given to them in class. This map was used to demonstrate their understanding of mapping, and they discussed the maps in their clinical groups. Permission to conduct the study was obtained, and each student provided written consent to have components of their work evaluated and incorporated in publications. Additionally, students completed evaluation forms requesting their opinion of concept mapping as a learning strategy.

Over the course of the semester in the clinical setting, students created three concept maps depicting relationships among the clients, pathophysiologic factors, pharmacologic factors, and therapeutic nursing interventions. These maps were used in postconferences as discussion tools to foster links between theoretical course material and clients for which the students were providing care.

For the purposes of this study, the work of three students from each of the six clinical groups (n = 18) was randomly selected for data analysis and scoring. The first and final concept maps of the semester were scored. Points were awarded for the hierarchical organization of the maps, the progressive differentiation of concepts, and the integrative reconciliation of the concepts. The Sidebar on this page depicts the scoring formula used in this study. Based on assimilation theory, the scoring formula awarded points for the students' ability to create proposi-
Antidiabetic Agent
specifically
70/30
Increases glucose transport
to
Decrease blood glucose
and
for
IDDIM

Insulin
includes
taken by
which is related to
that
NSG DX
24 U
IM
25 MG
50 MG
NSG DX
DOSE
ROUTE
ORALLY
IM
24 U
IM
AM
PAIN R/T ARTHRITIS CONDITION
PRODUCES ANTI INFLAMMATORY ANALGESIC AND ANTIPYRETIC EFFECTS

Indomethacin
related to
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HR FOR INJURY R/T CNS ADVERSE REACTIONS

Knowledge Deficit
and
are
are
are
are
are
ANEMIA
HEADACHES
DIZZINESS
Knowledge Deficit

Uticaria

Hyperglycemia
N & V

Insulin-Induced Hypoglycemia
and

Altered Nutrition More Than Requirements

Adverse Reactions

Figure 2: First map developed by a student participating in study.

Results
Map Scoring. Data analysis (Table) demonstrated a group mean score of 40.38 on the first concept map and 135.55 on the final concept map, for a difference of 98.16. The t value comparing the first concept map to the final concept map was -5.69 (p = .001). The data indicated a statistically significant difference between the first and final map. This difference is indicative of the students' increase in conceptual and critical thinking.

Student Evaluation. Student comments and evaluation of the process of concept mapping showed mixed reviews. Students indicated the maps required in-depth preparation and often, in the process of creating the maps, they felt "lost." This lost feeling was described not in relation to the nursing content being mapped but in trying to demonstrate the concepts and relationships on paper. Students reported the creation of the maps was very time consuming. The following comment was a typical evaluation:

They [concept maps] are useful in learning to understand how many aspects of a patient may interact. I think I learned a lot by doing them but they are very time consuming.

A major concern of students was the timing or introduction of concept mapping as a learning strategy. Students expressed concern that the maps were introduced as a learning strategy in the final semester of
their baccalaureate program. One student commented:

I believe that concept maps should be taught earlier in the nursing curriculum. Concept mapping is very beneficial, and I wish I learned it much earlier in my nursing program. It was hard to make the switch this late in the game.

Another student responded, "If introduced at an earlier date, I think concept maps would not be viewed [as being] so tedious."

It appears that being asked to change learning strategies at the end of their nursing education program was difficult for students. They had learned to be successful in their educational program by using certain learning strategies and resisted the idea of changing those strategies so close to graduation. Students expressed the idea that the introduction of mapping earlier in their educational process would have fostered their learning.

**Faculty Evaluation.** Faculty articulated that concept maps as a learning strategy were beneficial in demonstrating the knowledge students had gained over the semester. Faculty indicated they could see the development of students' thinking processes. Two additional comments warrant discussion. First, faculty indicated that the maps helped them assess which students were safe practitioners in the clinical experience. Faculty felt the maps demonstrated both students' knowledge of and plans for particular clients. Faculty indicated that often the quiet students, who may not verbally demonstrate their knowledge, could do so in a concept map, and the clinical instructor could tell if they were prepared and safe. Alternatively, the more verbal students, whom faculty thought understood the information, demonstrated on their concept maps misperceptions and lack of fully developed knowledge bases.

Second, faculty felt the maps allowed them to correct student misperceptions when the maps were discussed in postconferences. Faculty indicated that some of the misperceptions were subtle enough that students could have progressed through their entire nursing program, and if the misperception was never addressed in an examination question, it never would have been corrected.

**Implications for Nursing Education**

This study demonstrated concept maps do improve students' critical-thinking abilities. The maps served the purpose of providing "reasoned consideration to evidence, contexts, conceptualizations, meth-
ods, and criteria" (APA, 1990, p. 2). The study also demonstrated critical-thinking ability can change over the course of a semester.

Additionally, concept maps served both as an education method and evaluation strategy in this study. The authors feel this is an important consideration. In teaching critical-thinking abilities, the validity of the measurement and outcomes of the learning are important. Concept maps served as a tool that fostered both the learning of critical thinking and the measurement of those thinking abilities within the context of nursing practice. The authors believe the students demonstrated a dramatic increase in concept map scores over one semester because the maps tied together the teaching and evaluating of critical thinking.

The authors consider this a preliminary study and would suggest replication and further research in the area of using concept maps in nursing education. Future research studies need to include larger, cross-institutional samples; comparison of concept mapping as a strategy for teaching critical thinking with other critical-thinking strategies; and correlation of concept mapping as a measurement of critical thinking with other existing critical-thinking measures.

Finally, the researchers suggest construct validity of concept maps as a measurement of critical thinking be established. This construct validity could be assessed using the multitrait-multimethod matrix (Campbell & Fiske, 1959). This procedure would help determine if convergence and discriminability (Campbell & Fiske, 1959) exist between concept maps and critical-thinking abilities.

### Conclusion

This study demonstrated that concept maps, as a metacognitive learning strategy, can significantly improve students' critical-thinking abilities. Additionally, when used in the clinical setting, the maps serve as a strategy to assist students in drawing complex conceptual relationships regarding the care of their clients. Concept maps served as an outcome measure of critical thinking. Finally, when using concept maps as a teaching strategy, careful consideration needs to be given to the most beneficial time to introduce this technique in the nursing curriculum.

### References


