

A qualitative evaluation of medical student learning with concept maps

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Abstract

Purpose and Aims: The purpose of this study was to investigate the ways in which the use of concept maps influenced the learning processes of third year internal medicine students in the context of medical education. Reported here are the qualitative results of this study.

Methods: One-hundred thirty four medical students were taught to use concept mapping as a learning strategy at the beginning of their internal medicine rotations. Upon completion of the internal medicine rotation students were asked to evaluate how concept maps fostered the process of linking theoretical information to clinical practice. Additionally, students described how concept maps impacted their learning.

Results: In this study, concept maps fostered a positive connection between theory and practice. Additionally, students described three major themes impacting their learning: concept mapping as a facilitator of knowledge integration and critical thinking, as a teaching methodology and finally, as a learning method.

Conclusions: This study suggests concept maps may be an instructional method to foster the learning and thinking process of medical students.

Introduction

Concept mapping is a visual representation of how knowledge is organized and represented in the human memory. Therefore, concept maps are diagrams that depict the student's understanding of the interrelationships between concepts in a particular knowledge domain (Novak & Gowin 1984; Roberts 1999). Many literature sources support the utilization of concept mapping as a beneficial learning method (Novak 1990; Pinto & Zeitz 1997). Irvine (1995) recognizes concept mapping as a means to promote meaningful learning and as a meta-cognitive strategy. Daley et al. (1999) demonstrated that concept maps can facilitate critical thinking. Concept maps demonstrate a student's mastery of a topic's attributes, relationships and for a greater development of holistic understanding (Plotnick 2001; Marchand et al. 2002).

As Novak & Gowin (1984) indicate, "A concept map is a schematic device for representing a set of concept meanings in a framework of propositions" (p. 15). Concept maps are pictures or graphic representations that learners draw to depict their understanding of the meaning of a set of concepts. Learners use the maps to link new learning to what they already know. In this way, the maps offer learners and instructors an opportunity to share, discuss, and revise their understanding of concepts, propositions, and the relationships between new and existing knowledge. Concept maps can be used to foster conceptual learning, critical thinking, analysis, synthesis, and the development of shared meaning.

Practice points

- This study suggests that concept maps have the ability to assist students with knowledge integration and critical thinking. The maps can serve as a tool to assess medical students' thinking, understanding of the topic they mapped and any misconceptions they may hold.
- Concept mapping seems to foster pattern recognition and may help facilitate differential diagnosis. Using maps to create this type of thinking is an exciting development in medical education.

Constructing a concept map begins by defining a problem or issue that the concept map should address (Novak & Cañas 2006). Next, learners identify and list the key concepts that apply to the knowledge domain of the map. Learners then rank order these concepts from the most general, inclusive concept for the problem or situation to the most specific, least general concept. Learners then start building a preliminary concept map. As the concept map is built, learners tie the concepts together with linking words in some fashion that makes sense to them. After the preliminary map is constructed, cross-linkages between the different segments or domains of knowledge are established, illustrating how these domains are related to one another. Finally, instructors and learners can discuss, share, and revise the maps, understanding that

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a concept map is never really finished. A concept map created by a student is depicted in Figure 1.

In recent years, concept maps have been incorporated on a small scale as teaching and learning tools in graduate (West et al. 2000) and undergraduate (McGaghie et al. 2000; Farrand et al. 2002; Rendas 2006) medical education. However, little is known about the perceptions of medical students using concept maps during a clinical rotation. Research has not been completed assessing medical students' ability to link theoretical material to clinical practice, nor has research examined how medical students view concept maps as learning tool. Furthermore research has also shown that factors such as motivation (Farrand et al. 2002) or other academic competing assignments (Santhanam et al. 1998) may represent a negative influence on students' perceptions of a new learning method such as concept maps. Thus, it is important for educators, who seek to introduce critical thinking in their courses, to evaluate students' perceptions of innovative learning approaches in the clinical setting.

As a result, the following questions were advanced to guide this inquiry: 1. How do students perceive the role of concept maps in fostering linkages between theory and clinical practice? 2. What are medical students' reactions to using concept maps as a learning tool?

The purpose of this manuscript is to report the qualitative results of students' perceptions of how concept maps helped them link theoretical information to clinical practice. Additionally, student views of concept maps as a learning tool were reported as well as potential barriers to their use.

Because concept maps constitute a learning tool aimed at supporting meaningful learning, critical thinking and reflection, it is important for medical educators to develop a better understanding of medical students' perspectives of concept mapping. As Brookfield (1995) indicates, educators need to "get inside students' heads" (p. 92) to understand their unique experiences of learning.

Methods

The purpose of this study was to explore medical students' perceptions following learning with concept maps. A qualitative interpretivist approach (Guba E, Lincoln Y, 1989) was used to analyse the research questions advanced for this study. An interpretivist approach was selected because narrative answers were determined to be the most appropriate approach for determining what students were thinking about the learning strategy of concept map.

Study population and setting

Participants were 136 third-year medical students, rotating through a required eight week internal medicine rotation at the Medical College of Wisconsin, from July 2005 to December 2005. The course structure provided students with the option to spend eight weeks in the inpatient setting or half of that time in the ambulatory setting and the remaining time inpatient. Students were taught the concept mapping process by the course director at the beginning of the rotation based on a previously described method (Novak & Gowin 1984) and

through the course of each student created a minimum of three concept maps. Students were told that when creating their maps they could select any clinical topic of interest within the area of internal medicine. All students were provided with a link via email to access a computerized concept mapping software program (<http://www.ihmc.us/>). They were given the option of completing the maps by hand or by using computer based software. Upon completion of their first map students were provided by the course director with general comments about their map. These comments (based on Novak & Gowin (1984)) encouraged the students to subsume lower order concepts under higher order concepts; to continue to differentiate the concepts into more discrete components; and to look for connections between concepts on the left side of the map and the right side of the map. Upon completion of the clerkship rotation students were surveyed about their perceptions of concept maps as a learning tool.

Data collection

A six-item questionnaire was developed by the course director and other faculty involved in medical students' teaching and completed by students at the end of the rotation. Participants were queried with open ended questions such as: How do you view the use of concept maps as a learning tool? How do you view the use of concept map as a tool to help you link theoretical information to clinical practice? What were major barriers to using concept maps? Students were then asked demographic information (age, gender), type of clinical setting (inpatient vs. outpatient), and if they had ever used concept maps before. The survey was pre-tested among a group of ten third-year medical students for item clarity and consistency. A brief group discussion was also performed after the pretest by two of the questionnaire developers to probe respondents for potential problems related to the format as well as the reading, understanding and answering of the questions.

Data analysis

Data were analysed in two ways. First, descriptive statistics were used to calculate mean frequencies of age, gender, type of rotation, previous use of concept maps, and use of computer software. Second, an inductive analysis (Creswell 1998) was completed to identify overall themes and patterns of how students viewed concept maps as a learning tool. To conduct this type of qualitative analysis student comments were reviewed multiple times and coded into categories. The category system was refined and revised continually as more and more data were included. Then the codes and categories were reduced to three overall themes identified by students. Quality control was maintained with two independent researchers coding the data, verifying codes and developing the category system.

Results

Response rate was 98% (134/136). The mean age of participants was 27, and 55% were males. Ninety-five percent of students used the computerized Cmap tool,

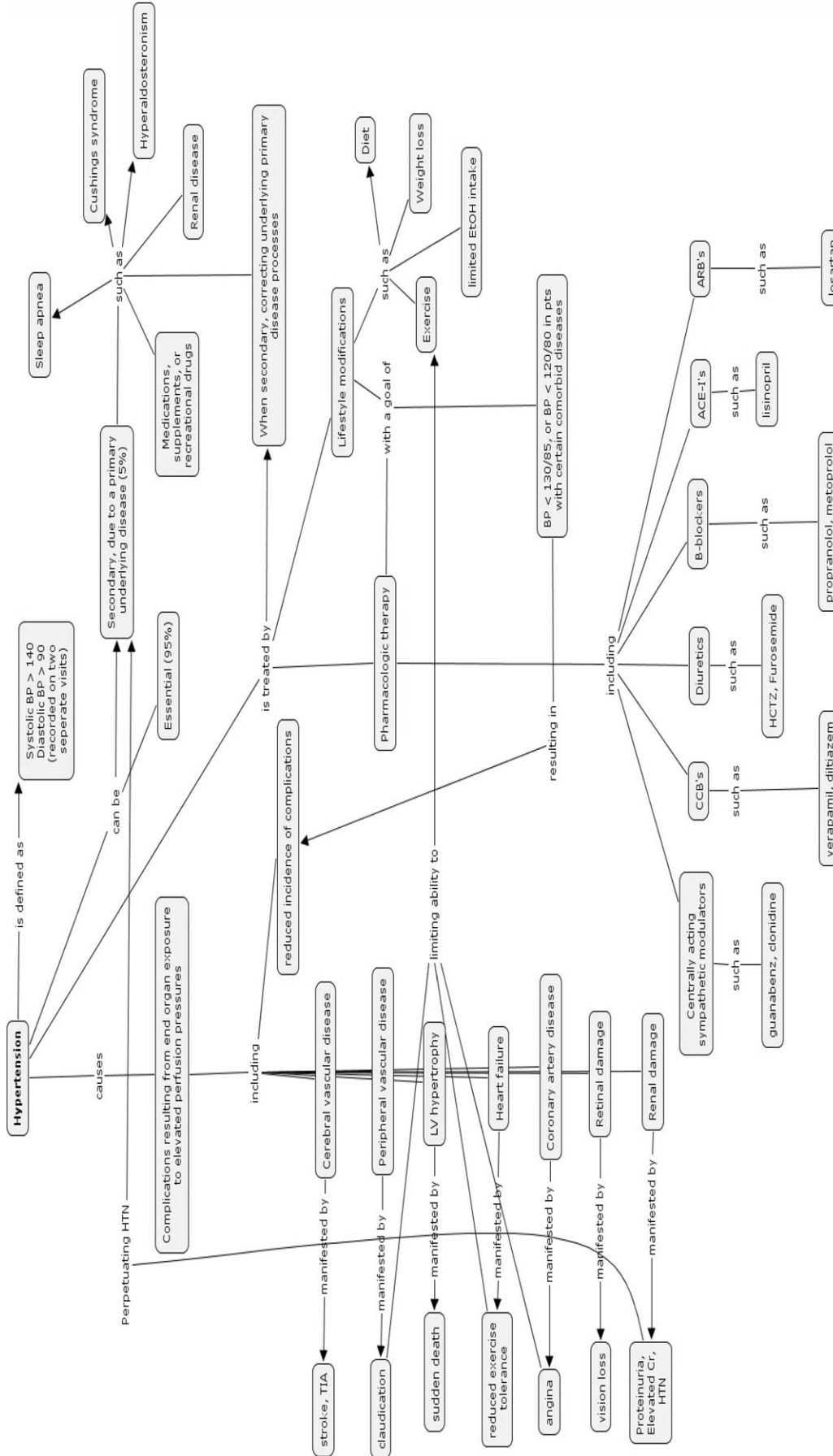


Figure 1. Sample student generated concept map.

and 60% spent the entire length of the rotation (8 weeks) in the inpatient setting. No students had previous experience with concept maps. Overall, findings from this study indicate that students did feel concept maps assisted in the process of linking theoretical information to clinical practice. Additionally, student articulated that the maps were an effective learning tool and fostered their thinking in new ways. Finally, students indicated that the major drawback, in their minds, to using maps was the time it took to create them.

Three major themes emerged from the analysis; concept mapping as a facilitator of knowledge integration and critical thinking, as a teaching methodology and finally, as a learning method.

Concept Mapping as a facilitator of knowledge integration and critical thinking

Students reported that concept maps helped them to organize ideas and to map (conceptually and on paper) their thought processes. Students' comments indicated: "Great way to get ideas and thought processes out onto paper" "Help me to organize my ideas" "They helped me to map out my thought processes".

Concept maps also foster students' ability to organize new concepts thus creating a high capability of student problem solving and holistic thinking.

Some students acknowledged that concept mapping facilitated critical or in-depth thinking through connecting topics that the students (before the concept mapping assignment) did not correlate. One student stated, "They helped to coordinate in-depth thinking about a particular topic and how it can relate to many other topics that I might not have thought were related before I did the map." Other students indicated: "Good way to connect points that you don't normally connect" "Helps me with critical thinking and in linking several concepts that I had not previously thought about" "I enjoyed developing concept maps and found it useful in drawing connections between isolated nuggets of information to form a more coherent and integrated understanding of a topic" "I felt that this was a helpful method to develop a more in-depth perspective of a topic" "It's a good way to link the various aspects of a specific problem."

Students reported the concept maps allowed for creativity by developing a system of thinking that included pattern recognition, the ability to think broadly on topics and finally, allowed for knowledge integration. One student stated, "The maps help you think outside the box and give you a broad perspective on how medicine is intertwined". Another stated, "Just making the map was a helpful exercise, forced me to think in a new way and understand previously confusing material". Other student comments indicated: "Helps develop a system of thinking about common symptoms or broad disease categories" "They were very helpful to me to learn about differential diagnoses and pattern recognition" "Helped me keep broad differential diagnosis in mind" "They were good to expand on common medicine topics" "Concept maps are good for showing that there may be multiple processes in one patient contributing to one symptom"

In this study, students reported that concept mapping allowed them to link and integrate ideas together through an active thinking process. One student stated, "Cross-linking brought information together." Another stated, "For me, to think about how about how multiple problems are linked was a major change." Overall the following comments were representative of student sentiments about concept maps ability to foster changes in thinking: "They require active thinking rather than passive thinking" "The maps help to link many ideas together" "It is a way to integrate ideas".

Concept mapping as a teaching methodology

In this study, students' noted that in order to develop the skills necessary to create concept maps, (instructor) feedback is essential. Student's stated, "Feedback is necessary to developing skills in creating concept maps" "Sometimes it wasn't very clear what amount of detail was required for the assignment."

Students in this study reported that although concept maps could be used as an additional study tool, comprehensive instruction should be provided at the beginning of course instruction. Students stated: "*A bit more instruction to the organization/logic/theory/rules of concept map making would have been useful in the beginning of the course*" "*I might pull it out from time to time as an aid*" "*Serve as a good study tool*".

In this study, learner self-regulators (such as motivation) were noted by the students as contributing to their success. One student stated that, "*Concept mapping can be effective if the appropriate effort is given.*" Other students indicated that, "*You get out what you put in*" or "*If the student puts in enough time it can be valuable*". Finally some students expressed that motivation and time were an issue in completing the maps. Consider the student who indicated: "*I can understand that it may be a useful tool for some people. But I could have made better use of the time by reviewing practice questions or reading journal articles. It turned out to be 'busy work' for me personally and I don't think it should be a requirement, although I appreciate the sincere desire for us to learn that motivates it*".

Several students reported concept mapping was beneficial to learning key concepts or one topic. One student suggested that to "*Require narrow topics and keep the maps relatively simple*" may be helpful in the development of student concept maps. Another stated, "*I think it is valuable in relating the concepts associated with a specific clinical problem. It makes relationships more apparent.*" It was also interesting that some students, despite the time involved in creating the maps, felt they fostered learning for very specific difficult topics. A typical student comment was, "*Helpful, if you are struggling on a specific concept, but not as much so to use as a primary study tool. I learned the most when focusing on subjects I had trouble with but too time consuming to do for most things.*"

Students in this study seemed to have mixed views on the issue of the time involved to create concept maps. Some students did note that developing the concept maps, "*took a lot of time*". However, one student acknowledged that even though the maps were time consuming, particularly in relationship to other course work, "*I did recognize the value in them.*" In agreement, another student mentioned, "*Great!*"

Time consuming – but, definitely a worthwhile learning tool.” A different student expressed, “*It was a bit difficult to learn how to use the CMAP tools program at first. By the second map, I found it quite easy to use and very useful so it did not take as much time.*” Many students recognized the time commitment in creating that maps and felt that it was beneficial. They stated, “*Time consuming to produce, but once they were made, helpful study tools.*” Accordingly, one stated, “*I enjoy making the concept maps when I have time to sit down and focus on them.*” However, some students felt the opposite, that the time invested in the map was not advantageous. One student stated, “*I think they are very useful but maybe not very high yield use of time since it seems like I spent more time trying to figure out how to connect things than actually learning them.*”

Furthermore, the concept maps encouraged verbalization of questions, answers and assumptions allowing peers to communicate incorrect connections or links, creating a co-construction of meaningful learning. In this study a few comments related to collaborative learning principles. Some students expressed an interest in integrating concept maps for group discussions including the comment, “*good for bringing key points together... especially when teaching each other.*”. Additionally students indicated, “*I would continue to use them in group discussions, with faculty supervision/input*”

Concept Mapping as a Learning Method

In this study, the majority of the students claimed that concept mapping was a good learning tool and that concept mapping was very helpful. Students stated that, “*Learning from them was helpful.*” “*I found them very helpful and was surprised that I enjoyed making them.*” “*Good exercise. It was a new way to learn for me, and I enjoyed it. It should be continued in the future.*” “*I think it’s very effective and worth promoting.*”. Over and over again, students expressed that the maps helped them learn. What was also interesting was how many students expressed surprise at the value of the maps as a different way to learn.

Students, in this study, also commented on a possible relationship between concept mapping and learning style. Many noted that concept maps as a learning strategy may be beneficial to some learners and not to others. Students reported, “*It can be helpful on an individual level*” “*They work for some people and not for others.*”. “*I think for some people they are a good tool, particularly for visual learners*” “*Let the students use it as they see fit for their own learning style*” One student statement seemed to sum up the perceptions of the study participants, “*Some people learn via maps, some people don’t. I understand why we made them, however I think that people should be able to organize a certain topic in whichever way they learn best (map, outline, etc) I was creating concept maps to learn pathology – I think that it is a good idea for medicine also, although I think it doesn’t work for everyone*”

Finally, a few students indicated that concept maps did not enhance their learning process. Most of these students indicated that the time required to shift their learning processes and to create the maps was just too great. Students also

indicated that timing (in relationship to student year and integration into the curriculum) of the concept maps also appeared to be an important aspect for many students who appeared to struggle for “time” to complete the concept maps during a busy clerkship. As one student stated, “*I think that concept maps may be a useful tool to many students, however, I think that having them assigned during the clerkship made it a task that I approached as another thing to get done rather than a learning/study tool.*” Other students indicated: “*I already know how I need to study in order to succeed and this exercise did not help me. It only took from the time I could have been studying more productively*” “*I felt that my time would have been better spent reading my textbook than trying to figure out how to set up a concept map on the computer program*” “*It may help a few students but I do not think that they are the best way for most students on a busy medicine rotation to learn what they need in the limited time that they have*” “*This time might have been more useful doing questions or study*”.

Discussion

Students indicated that the maps helped organize ideas and thought processes, as well as facilitate in-depth thinking and the connections of concepts. This is consistent with other research on concept maps and it is a very encouraging finding that students see the value of concept mapping in medical education.

What is most important to the field of medicine, from this study, is that students reported that the maps facilitated pattern recognition and fostered a greater understanding of differential diagnosis. In other words, students recognized how the maps functioned in linking theoretical information to clinical practice. But, these results demonstrate that students went even further than just linking theory to practice. What students expressed was that the maps helped them learn to “think” like a physician. This is a critical finding, as it has the potential to facilitate the development of bridges between medical school and actual practice. What students in this study were describing was a change in how they thought holistically about patients. They were able to see multiple aspects of patient care that were interrelated that they had not recognized previously. It appears that the students began to understand the complexities of patient care in new ways, ultimately leading to great recognition of clinical patterns and hopefully more accuracy in creating differential diagnosis. Obviously, further research is needed in this area, but these initial findings are encouraging.

From a student’s perspective, concept mapping encourages them to think independently, produces more self-confidence and provides an increased awareness of finding connections between different areas. Teachers reported that concept mapping assisted students to become active learners and organize theoretical knowledge in an integrative manner or conceptual framework (Boxtel et al. 2002; Harpaz et al. 2004). Finally, concept mapping allow the learner the ability to connect and represent main concepts of an area of knowledge in their own (the learners’) understanding (Harpaz et al. 2004). Concept maps assist in the process of knowledge creation and

therefore, it is not only the final creation that is of importance in concept mapping, it is the authentic process of creating the concept map that is also of importance (Coffey et al. 2003). It is the construction of the map that facilitates the organization of knowledge and assists in the understating of the content. Thus, knowledge is created not discovered (Kinchin & Hay 2000).

However, two issues surfaced as students described concept maps as a learning tool. First, students described the issue of time. Students were clear that the mapping process was time intensive for them and some students reject the idea of mapping based on the amount of time they needed to invest in the maps. This is often a common issue when students begin mapping (Daley et al. 1999). Most students have learned how to be successful in the educational system through using strategies of memorization and recall. The maps ask the student to focus on learning in a different way and it is not uncommon for students to resist changing learning methods that have fostered success for them in the past. In addressing this issue it is often helpful to assist the students to understand the different learning process in which they are engaging. It can also be helpful to analyze the best places within the medical school curriculum to use maps. It is not necessary for every faculty member to incorporate mapping as a strategy and when placed strategically (based on the student need to learn to integrate clinical knowledge) there seems to be less student resistance. Second, students identified the need to introduce the maps earlier in the curriculum.

Several limitations of this study should be considered: first, the participants were 3rd year medical student from one medical school. Senior level medical students from other medical institutions may not share the same views. Second; it was not within the scope of our study and our findings do not demonstrate whether concept maps support and/or facilitate enhancement of student clinical performance in the inpatient or outpatient setting. Third; an analysis of the connection with other knowledge or clinical skills measurements such as US Medical Licensing Board Examinations (USMLE) or Objective Structured Clinical Examinations (OSCEs) was not ascertained and could be ground for future studies.

Conclusions

Through an analysis of medical students' evaluation of using concept maps, this study suggests that student's view concept maps as having the ability to assist them with knowledge integration and critical thinking. Additionally, the maps were identified as a teaching and learning tool that may well have applicability and implications for medical education. As student comments indicate, mapping seems to foster pattern recognition and may help facilitate differential diagnosis. Using maps to create this type of thinking is an exciting development in medical education.

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References

- Benner P. 1982. From novice to expert. *Am J Nurs* 82:402–407.
- Benner P. 1984. *From Novice to Expert: Excellence and Power in Clinical Nursing Practice* (Menlo Park, California, Addison-Wesley Publishing Company).
- Benner P, Tanner C. 1987. Clinical Judgment: How Expert Nurses use Intuition. *Am J Nurs* 87:23–31.
- Boxtel CV, Linden JV, Roelofs E, Erkens G. 2002. Collaborative concept mapping: Provoking and supporting meaningful discourse. *Theory Pract* 41:40–46.
- Brookfield S. 1995. *Becoming a Critically Reflective Teacher* (San Francisco, CA, Jossey Bass, Inc.).
- Coffey JW, Carnot MJ, Feltovich PJ, Hoffman RR, Canas AJ. 2003. *A summary of literature pertaining to the use of concept mapping techniques and technologies for education and performance support (No. Technical Report submitted to the US Navy Chief of Naval Education and Training)* (Pensacola, FL, Institute for Human and Machine Cognition).
- Creswell JW. 1998. *Qualitative Inquiry and Research Design: Choosing among Five Traditions* (Newbury Park, Sage Publications).
- Daley B, Shaw C, Balistrieri T, Glasenapp K, Piacentine L. 1999. Concept maps: A strategy to teach and evaluate critical thinking. *J Nurs Educ* 38:1–6.
- Farrand P, Hussain F, Hennessy E. 2002. The efficacy of the 'concept map' study technique. *Med Educ* 36:426–431.
- Guba E, Lincoln Y. 1989. *Fourth Generation Evaluation* (Newbury Park, Sage Publications).
- Harpaz I, Balik C, Ehrenfeld M. 2004. Concept mapping: An educational strategy for advanced nursing education. *Nurs Forum* 39:27–30, 36.
- Irvine LM. 1995. Can concept mapping be used to promote meaningful learning in nurse education? *J Adv Nurs* 21:1175–1179.
- Kinchin IM, Hay DB. 2000. How a qualitative approach to concept map analysis can be used to aid learning by illustrating patterns of conceptual development. *Educ Res* 42:43–57.
- Laight DW 2006. Attitudes to concept maps as a teaching/learning activity in undergraduate health professional education: influence of preferred approach to learning. *Med Teach* 28:e64–e67.
- Marchand C, D'Ivernois JF, Assal JP, Slama G, Hivon R. 2002. An analysis, using concept mapping, of diabetic patients' knowledge, before and after patient education. *Med Teach* 24:90–99.
- McGaghie DR, McCrimmon DR, Mitchell G, Thompson JA, Ravitch MM. 2000. Quantitative concept mapping in pulmonary physiology: comparison of student and faculty knowledge structures. *Adv Physiol Educ* 23:72–81.
- Novak JD. 1990. Concept maps and Vee diagrams: Two meta-cognitive tools to facilitate meaningful learning. *Instr Sci* 19:1–25.
- Novak JD, Gowin DB. 1984. *Learning How to Learn* (New York, Cambridge University Press).
- Novak JD, Cañas AJ. (2006). *The Theory Underlying Concept Maps and How to Construct Them*, Technical Report IHMC CmapTools 2006-01, Florida Institute for Human and Machine Cognition. Available at: <http://cmap.ihmc.us/Publications/ResearchPapers/TheoryUnderlyingConceptMaps.pdf> (accessed July 2006).
- Pinto AJ, Zeitz HJ. 1997. Concept mapping: A strategy for promoting meaningful learning in medical education. *Med Teach* 19:114–122.
- Plotnick E. 2001. A graphical system for understanding the relationship between concepts. *Teach Librarian* 28:42–45.

- Roberts L. 1999. Using concept maps to measure statistical understanding. *Int J Math Educ Sci Technol* 30:707–717.
- Rendas AB, Fonseca M, Pinto PR. 2006. Toward meaningful learning in undergraduate medical education using concept maps in a PBL pathophysiology course. *Adv Physiol Educ* 30:23–29.
- Santhanam B, Leach C, Dawson C. 1998. Concept mapping: how should it be introduced, and is there a long term benefit? *High Educ* 35:317–328.
- West DC, Pomeroy JR, Park JK, Gerstenberger EA, Sandoval J. 2000. Critical thinking in graduate medical education: A role for concept mapping assessment? *JAMA* 284:1105–1110.