Serial Concept Maps: Tools for Concept Analysis

Anita C. All, PhD, RN; and LaRae I. Huycke, MS, APRN, BC

ABSTRACT

Nursing theory challenges students to think abstractly and is often a difficult introduction to graduate study. Traditionally, concept analysis is useful in facilitating this abstract thinking. Concept maps are a way to visualize an individual's knowledge about a specific topic. *Serial* concept maps express the sequential evolution of a student's perceptions of a selected concept. Maps reveal individual differences in learning and perceptions, as well as progress in understanding the concept. Relationships are assessed and suggestions are made during serial mapping, which actively engages the students and faculty in dialogue that leads to increased understanding of the link between nursing theory and practice. Serial concept mapping lends itself well to both online and traditional classroom environments.

During graduate school, nursing students typically take a course focusing on the development of nursing theory. Currently, most theory courses are taught with the goal of students learning to evaluate and analyze a variety of theories, rather than a specific theory or theorist. Students examine a range of theories from nursing and related disciplines, and ultimately, each student selects a single concept to analyze its antecedents, attributes, empirical referents, and consequences.

Learning to think in new and abstract ways in graduate courses is challenging for many students. Concept analysis, concept maps, and more recently, *serial* concept maps are tools to help students as they navigate the complexities of theory development and analysis. Concept maps are visual representations of an individual's understanding of selected phenomena, in this case a concept. The term *serial concept maps* is used to denote a series of evolving maps created about a single concept over a specified time period. Serial concept maps can be used to assess and evaluate a student's understanding of a selected concept and the associations (links) between the concept and the elements of concept analysis. Cross-links identify the interrelatedness of the elements and depict multiple associations among all elements. Serial maps demonstrate the evolution of an individual's understanding of a concept throughout the process and culminate in the student's final concept map and formal analysis paper.

This article describes how a series of maps is used as a learning strategy and evaluation tool. An example of a series of maps on a single concept is included with faculty comments. Finally, implications for nursing education are explored.

CRITICAL THINKING AND STUDENT LEARNING

Nurse educators focus on promoting meaningful learning and developing critical thinking skills. Kinchin and Hay (2005), Hsu (2004), and Luckowski (2003) reported that critical thinking is a necessary skill for nurses and that meaningful learning occurs if individuals take personal responsibility for learning by consciously and ex-

Received: January 13, 2005

Accepted: February 15, 2006

Dr. All is Wachovia Endowed Professor and Director, Joint MSN Program, Auburn University and Auburn University Montgomery, Auburn, Alabama; and Ms. Huycke is a doctoral student, University of Tennessee, Memphis, Tennessee.

The authors thank Dr. Betty Kupperschmidt for her editorial assistance, Carolyn Lau for her help with illustrations, and all of the graduate students who created serial concept maps for course assignments and allowed the use of them in this article.

Address correspondence to Anita C. All, PhD, RN, Wachovia Endowed Professor and Director, Joint MSN Program, Auburn University, 213 Miller Hall, Auburn, AL 36849-5505; e-mail: aca0001@auburn.edu.

plicitly relating new data to existing data. This process of relating prior knowledge to new knowledge promotes habits of self-learning (Kinchin & Hay, 2005; West, Pomeroy, Park, Gerstenberger, & Sandoval, 2000) and, with a solid knowledge base, leads to meaningful professional growth. Storage of information is so crucial to learning that educators continually strive to find methods and processes that promote remembering and understanding. Strategies and processes that attach meaning to facts and relationships facilitate the cognitive process of remembering. Understanding how individuals learn is paramount in the process of creating and facilitating an environment conducive to education (Daley, Shaw, Balistrieri, Glasenapp, & Piacentine, 1999; Hsu, 2004; Schuster, 2000).

Historically, educators have taught and measured learning on the basis of students' rote memorization of facts, with little attention given to broader concepts. Recently, the teaching of broader concepts has been recognized as providing the greatest potential for meaningful learning and appropriate decision making (Hsu, 2004; Kinchin & Hay, 2005; Luckowski, 2003; West et al., 2000). New information and concepts are best learned when actively integrated into the students' existing knowledge base (All & Havens, 1997; All, Huycke, & Fisher, 2003; Dobbin, 2001; Kinchin & Hay, 2005; Schuster, 2000). A shift from instructor characteristics to the qualities of students, along with changes in traditional classroom instruction, have generated a need for tools that support meaningful learning, while providing a means for faculty evaluation (Dobbin, 2001; Hsu, 2004; Luckowski, 2003). Serial mapping is one tool that allows educators to perceive a topic from the students' perspective, document students' current understanding, and glimpse how students learn over time.

The idea of serializing concept mapping may be a way of exemplifying Ausubel's principle of advanced organizers (Ausubel, 1963, 1978; Ausubel, Novak, & Hanesian, 1978; Carroll & Timpson, 2002; Van Zele, Lenaerts, & Wieme, 2004), in which a form of introductory material is designed to provide a bridge to new information. In the case of serial mapping, students' previous maps provide a conceptual preview to link prior knowledge to the new evolving lesson.

CONCEPT ANALYSIS AND CONCEPT MAPS

Concept Analysis

Analysis of concepts is a vital step in understanding theory development. Concept analysis demands that students distinguish between critical and extraneous attributes. This level of analysis must be rigorous and precise, although the final product remains tentative. Tentativeness stems from multiple means by which concepts and attributes can be perceived (Walker & Avant, 2005). For example, a nurse caring for healthy children who explores the concept of death may settle on attributes that are decidedly different from a list created by a pediatric hospice nurse. Each list, however, offers unique insights into that nurse's perspective of death and suggests a knowledge base that can be simultaneously similar (based on education) and different (based on experience), depending on the context. Concept mapping can help in this rigorous and precise examination of a concept.

Concept Maps

Concept maps are tools for organizing and visualizing an individual's knowledge on a particular subject (Akinsanya & Williams, 2004; Luckowski, 2003). Within a concept analysis map, a concept is identified, its attributes listed, a hierarchical order established, and relationships among the elements of the concept depicted. Propositions are constructed and developed into meaningful statements about the concept using a simplified concept map. Although these examinations can be complex and demand the use of inductive and deductive reasoning, concept mapping facilitates navigation through the literature and demands the organization of knowledge (Hsu, 2004).

The theoretical framework for concept mapping is based on constructivist learning theory, cognitive continuum theory, and experiential learning theory. These theories suggest that meaningful learning occurs when new information is assimilated into a preexisting knowledge schema and that judgment and decision making are tasks related to cognition (Sewchuk, 2005; Tosteson, 1990). Because individuals acquire a framework of concepts on the basis of their unique experiences and knowledge (All et al., 2003; Dobbin, 2001), new information is integrated in a variety of ways. This explains, at least in part, why no two maps are ever alike. Similarly, student maps uniquely change, or evolve, as meaningful learning occurs.

Constructivist learning theory stresses the importance of challenging students to actively participate in and accept personal responsibility for learning (Novak, 1998). In the case of serial mapping, the students' previous maps provide a conceptual preview to link prior knowledge to the new evolving information. These individual student maps offer insight into the student's perspective of the concept.

Kinds of Concept Maps

Four basic and three specialized concept maps have been described in the literature (All et al., 2003; Ferrario, 2004; Glendon & Ulrich, 2004). Although all seven kinds of maps offer a visual representation of a student's perspective of a particular concept, each also has advantages and limitations.

A basic map, termed *hierarchical,* identifies the concept and attributes in a hierarchical pattern. This is typically constructed in descending order of importance. Hierarchy maps require a student to identify relationships between a concept and its attributes, as well as among those elements. Hierarchical maps can incorrectly become algorithms if careful attention is not given as the series of maps evolves over time. *Spider* maps require students to devise ways to depict both the hierarchical order and interrelatedness of elements in the maps. *Flowchart* maps are two-

dimensional, hierarchical, linear diagrams, in which a student must demonstrate the dynamic process of meaningful learning versus static cause-and-effect relationships. *Systems* concept maps include inputs and outputs that illustrate a student's understanding of the concept and its attributes. The linear construction of flowchart or systems maps may be of greater value than maps constructed vertically, as students may have a greater recall of information when relationships are represented by lateral links.

Three specialized maps have also been described in the literature (All et al., 2003; Ferrario, 2004; Glendon & Ulrich, 2004): *pictorial* or *landscape, multidimensional,* and *Mandal/Mandala.* These maps use drawings or pictures, multiple shapes and colors, and puzzles or interlinking shapes, respectively, to represent knowledge and understanding. These maps can be limited by a student's computer or artistic ability. Map alterations can also be extremely time consuming as changes are made in the series.

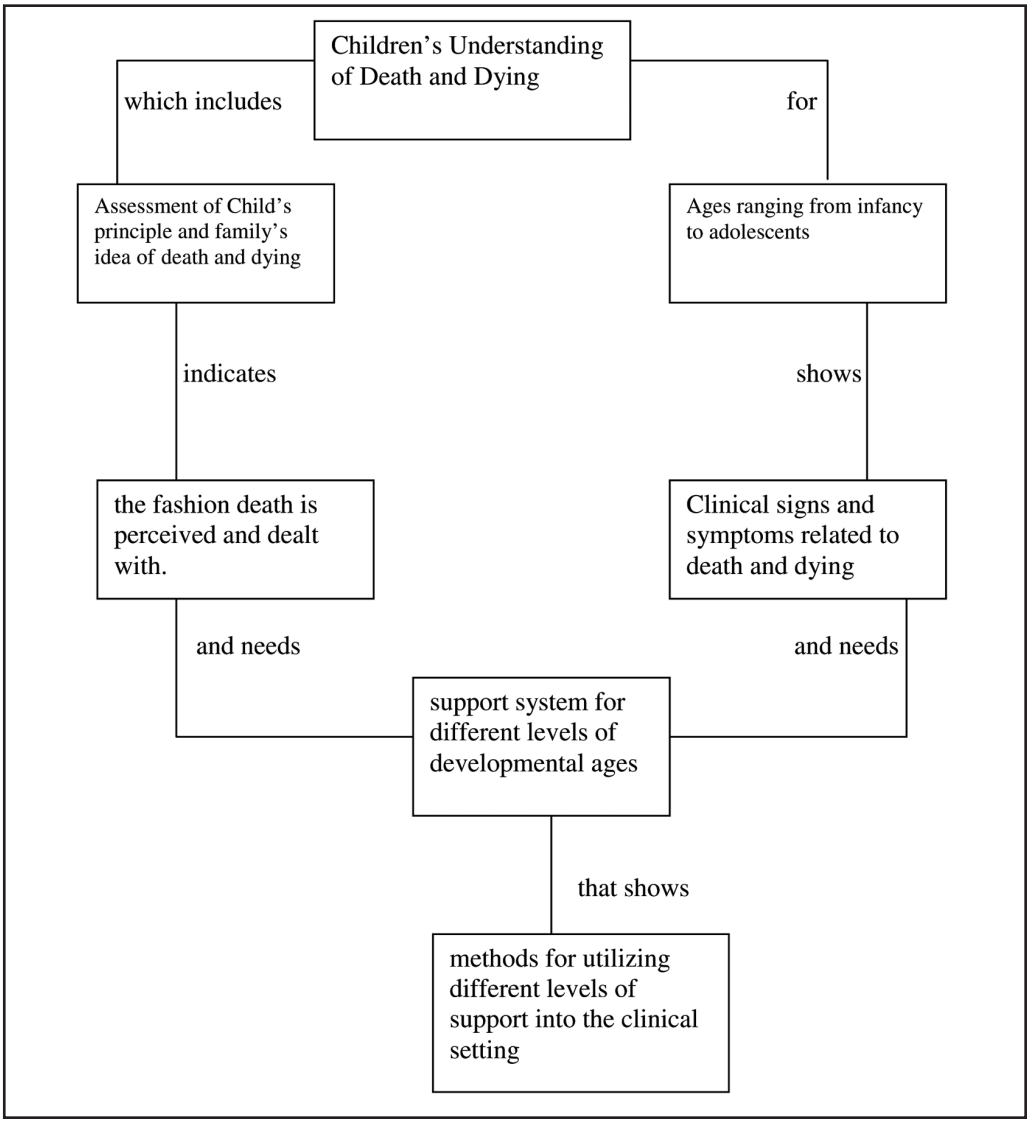

Figure 1. The student's first concept map. No concept was identified, so faculty initiated dialogue with the student to help identify a concept appropriate for analysis.

Map Use and Evaluation

Regardless of the kind of map used, maps created by students become a visual representation of their unique perspective of a concept. In evaluating maps, faculty must consider what is included in a map's content, as well as what is not included. The absence of specific knowledge establishes a learning need. When links and cross-links are incorrectly used or absent, faculty should explore potential causes. Students may not have assimilated new data correctly or may lack the skills to communicate their perceptions. Concept mapping provides students with an opportunity to reflect on what they do and do not know and offers a method for faculty evaluation. Because a concept map is a visual representation of what and how students think, it can be used in variety of settings to assess and evaluate knowledge of a topic (All et al., 2003; King & Shell, 2002).

SERIAL CONCEPT MAPS

Serial concept maps can be used as a way to intermittently monitor student progress in an online theory course, as a method of engaging students in meaningful learning, as a graded evaluation strategy, and ultimately, as a guide to writing a formal concept analysis paper. As students acquire an understanding of a concept, their maps become more detailed, integrated, and comprehensive as they evolve over time. Serial concept maps offer advantages for both students and educators. Larger class sizes, fewer faculty, and online education necessitate the creation of new methods for instruction and evaluation. Students using serial concept maps can communicate their understanding of complex topics on a single sheet of paper. Faculty, after gaining experience with concept maps, can quickly evaluate students' progress, identify strengths and weaknesses

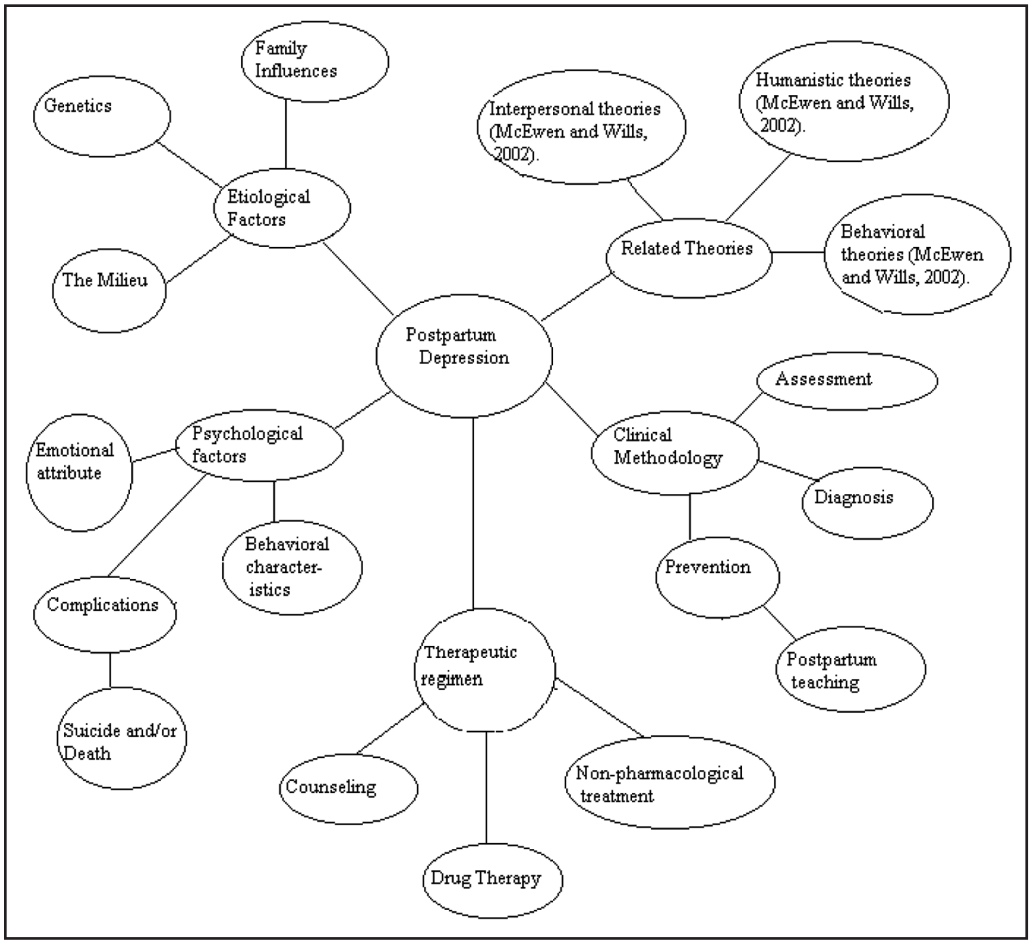

Figure 2. The student's second concept map. Postpartum depression was identified as the concept. However, this map demonstrates the student's misunderstanding of the concept and inability to identify attributes or accurately depict relationships between the concept and its attributes. The faculty again clarified the concept with the student and reviewed the instructions regarding the elements of concept analysis and their inclusion in the map.

in knowledge, and evaluate inductive and deductive reasoning. Through serial mapping, students are encouraged to reflect on what they currently know and the perceptions they have formed while assimilating new data. During serial mapping, old and new knowledge is integrated, while critical thinking and organizational boundaries are demonstrated. At the completion of the serial mapping assignments, students are more prepared to write the formal paper on the topic.

Application

The authors of this article began using serial mapping in a graduate-level, online theory development course due to increased enrollments and a need to evaluate understanding during the course of a 16-week semester. During the first week of class, students meet for a face-to-face course orientation; another face-to-face class is scheduled mid-semester for students to share their concept maps. A faculty-created lecture introducing concept mapping is provided via a link in the first course module. This lecture describes the underlying principles of concept mapping, kinds of maps, and steps in creating the first map. Four separate map assignments are included in the course activities, with the first map being due the third week of the semester.

First Concept Map. Starting the mapping assignments early in the semester encourages students to select a concept and allows them sufficient time to complete the other assignments and still author a concept analysis paper. Students who are unable to generate computer maps make other individual arrangements with the faculty for constructing and submitting their maps. Monitoring student progress throughout the semester allows the faculty to intervene quickly when students encounter difficulties.

During the second week of the semester, before the first serial map is due, an online brainstorming session is held, and the myriad possible concepts are open for discussion. Students discuss the kind of map they think might work best for their learning style and their concept. Using the framework of Walker and Avant (2005), students are encouraged to focus their attention on the identification and depiction of a specific concept. This brainstorming corresponds with Walker and Avant's (2005) first step, selecting a concept. The students' first map is due at the end of the third week of the course. Written feedback is provided within 1 week of submission of the first map. If a student fails to correctly identify a concept, e-mail correspondence, telephone conversations, or office appointments are conducted until the student identifies a concept. For example, one student chose to analyze the co-bedding of premature twins. After tentative exploration of the literature and discussion with the faculty, the student realized co-bedding was an intervention. Interdependence was identified as the concept driving the use of this intervention. While they are waiting for feedback on their first maps, students are reminded to continue to review the literature and consider how new

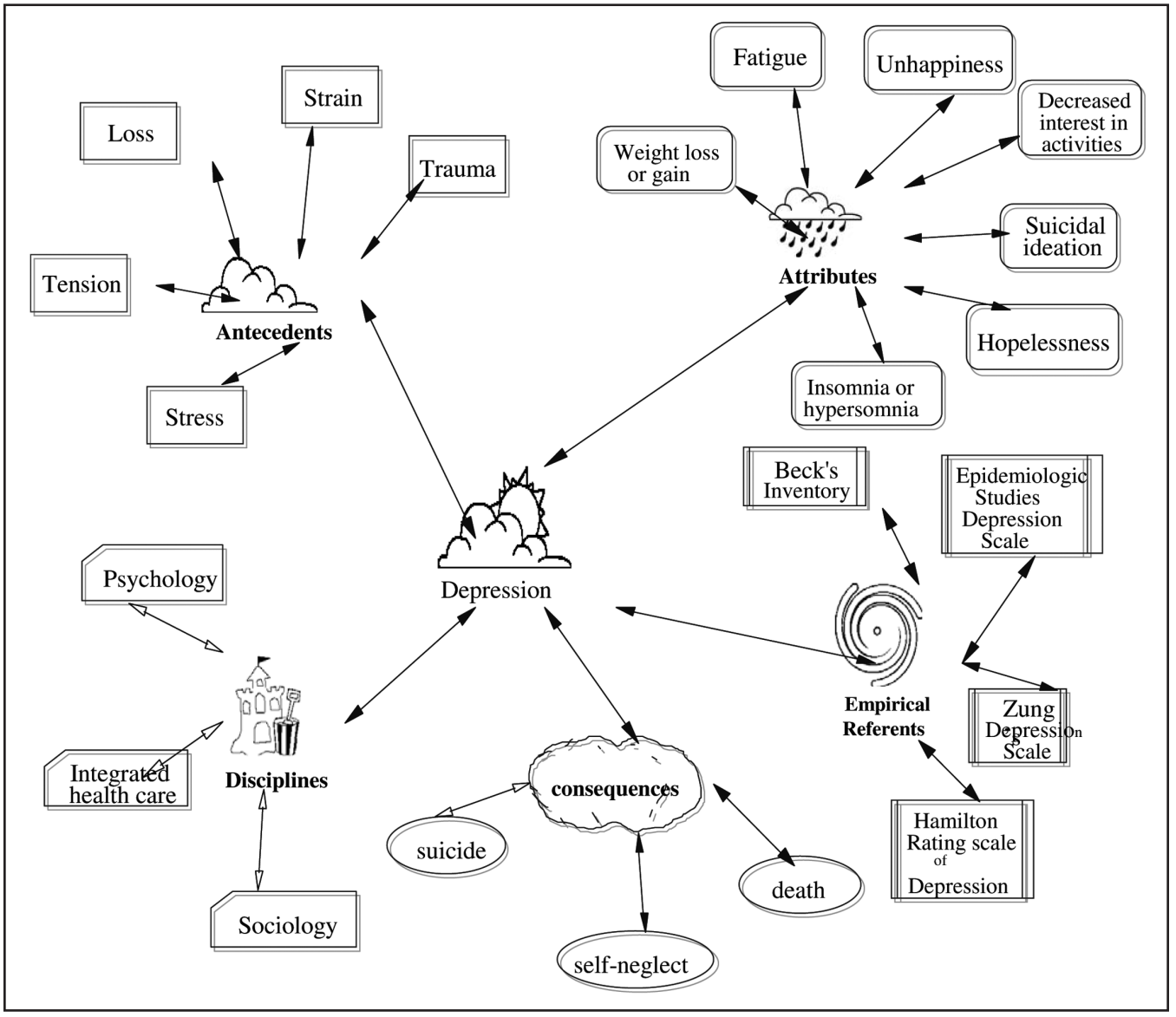

Figure 3. The student's third concept map. This map demonstrates the student's beginning understanding of the concept (depression) and the relationship among the elements of the analysis. The student received positive feedback, but the faculty discussed whether all of the relationships should be depicted as bi-directional.

information might fit in with their current knowledge of the concept.

Second Concept Map. The second map in the series is due during the seventh week of the semester, and it is used to evaluate the students' progress related to:

- Determining the purpose of the analysis.
- Making progress in selecting three academic disciplines to provide different perspectives on the concept.
- Developing the antecedents and attributes of the concept.

This second map corresponds with Walker and Avant's (2005) steps two through four: determining the aim or purpose, identifying uses of the concept, and determining attributes. Interestingly, students frequently do not place the concept within their knowledge schema, choosing instead to depict the concept as the central idea devoid of any previous knowledge. Often, the concept is attached by straight lines to three other nodes, each depicting a different discipline. Inclusion of attributes is often haphazard and frequently demonstrates little overlap among the disciplines. Students also often, at this point, do not see the direction or strength of some of the relationships.

Third Concept Map. A traditional classroom meeting is held prior to the due date of the third concept map (week 8 or mid-semester) and provides the opportunity for students to share maps and receive feedback from student colleagues. As expected, other students bring new perspectives and insights into the concepts. Students openly

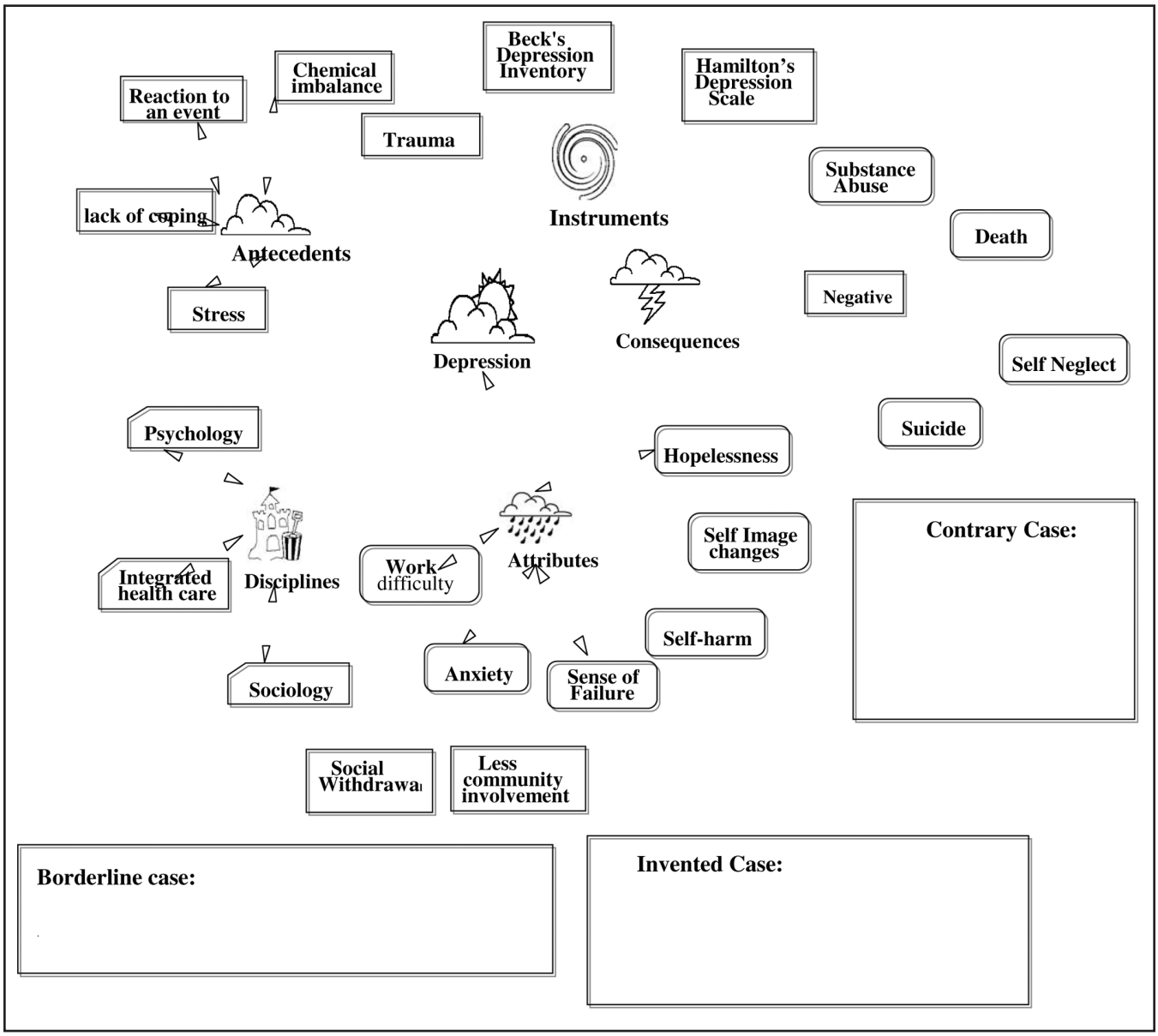

Figure 4. The student's fourth concept map. All of the elements of the concept analysis are depicted; however, there are large white spaces and the arrows do not always connect elements. The student explained that this was a result of lack of computer skill.

share information about the development of their maps and offer tips on computer generation of a map. Students become teachers as concepts are probed in a collaborative setting. This collaborative meeting helps students move into their third serial map. Students are instructed that the third map should contain most of the elements and the relationships for the concept analysis paper and are asked to begin developing case illustrations. The third map requires students to provide all of the steps determined by Walker and Avant (2005), except the construction of case illustrations.

Fourth Concept Map. The fourth and final map of the series is due at the end of the twelfth week. In this assignment, students are asked to include all of the elements of Walker and Avant's (2005) technique of concept analysis, plus the case illustrations. Students are expected to analyze their concept by identifying its antecedents, consequences, defining or critical attributes, and empirical referents. Equally important in evaluating the final map is the identification of relationships and strengths or weaknesses of the relationships among the elements in the fourth map. The fourth map is returned with faculty feedback 2 weeks before the formal concept analysis paper is due.

An interesting occurrence is that when students felt uncertain about the appropriateness of their case illustra-

tions, they turned in the case illustration attached to the map in a narrative format. This allowed for interaction between the student and faculty and increased the student's confidence in his or her knowledge. Students are encouraged to incorporate any faculty feedback they receive on the fourth map in their final paper and to use the map within the text of the paper to illustrate the relationships and their understanding of them.

Evaluation

Although the concept maps are graded, a punitive effect is avoided. The first map is given a score of 100 if the student identifies a concept. If no concept is identified, the map receives a score of 50. As noted above, each serial map is to contain specific elements of the analysis, and 5 points are subtracted for each expected element that is missing. The direction and strength or weakness of the relationships are discussed with students and are used to improve their understanding of the concept; they are not used as a grading criteria.

EXAMPLES AND OUTCOMES OF SERIAL MAPPING

To illustrate the progression of serial mapping, a sample of one student's maps is presented with faculty feedback in **Figures 1 through 4.** Each student chose a concept of interest, and no one kind of map was suggested. **Figure 1** shows the student's first attempt at a concept map, which failed to include a concept.

After the first map was reviewed, the student met with the faculty, and an open dialogue was initiated about the student's area of interest—childhood depression. Ultimately, the student decided to analyze the concept of depression and concentrate on children in the application section of the paper. After the dialogue, the student appeared to have a clearer understanding of selecting a concept and its appropriateness for a concept analysis.

Figure 2 depicts the second concept map in this student's series. This map demonstrates the student's misunderstanding of the concept and inability to identify attributes or accurately depict relationships between the concept and its attributes. With this map it became clear that the concept was no longer childhood depression but instead had evolved into postpartum depression. This was not the content the faculty had expected after the dialogue session with the student. Faculty feedback consisted of e-mail correspondence, with the faculty adding directional arrows to the submitted map to illustrate potential relationships. Methods the student might use to demonstrate the strength or weaknesses of relationships, such as varying colors and the size of lines and arrows, were explored. The student again stated that the concept of interest was depression and was then reminded that depression needed to be analyzed broadly before a particular kind of depression could be explored in the paper's application and implications section. Instructions regarding the elements of concept analysis and their inclusion in the map (e.g., antecedents, defining or critical attributes) were reviewed. Finally, the student was asked to select three academic disciplines for inclusion in the final paper and was instructed to include them in the next map.

Figure 3 depicts the third map in this student's series and demonstrates the student's beginning understanding of the concept and the relationship among the elements of the analysis. Positive feedback was given on this map, and it was noted that not all of the relationships were bi-directional. Directional arrows were added by the faculty, and for several relationships, the student was asked to consider the validity of the relationships (e.g., the bi-directionality of the consequences and the concept). After discussion with the student, the faculty discovered that the student understood the directionality of the elements but was having trouble generating single-direction arrows on the computer.

The student's final map (**Figure 4**) contained all of the elements required by Walker and Avant (2005) for the detailed analysis of a concept. Feedback on **Figure 4** included that large white spaces existed and the arrows did not always connect elements. The student again explained it was due to lack of skill in using the computer drawing program and the need to invest time in the final paper and not the actual computer generation of the map.

Additional feedback to the student on the fourth map included discussion of the bi-directionality of relationships and methods for improving the case illustrations. It was noted in reviewing the series of maps that as the student gained confidence, the maps became more creative. After the second map, the student added pictures and shapes to represent certain elements of the map. More important, the sequence of antecedents preceding the concept, the presence and measurement of concept attributes, and the consequences of concept events are clearly demonstrated.

SUMMARY

Efficient methods that streamline the delivery of education must ensure quality in learning. Larger class sizes and online courses necessitate new learning strategies, and serial concept mapping is one of these. Serial concept mapping promotes positive role modeling for students, offers prompt feedback, and demonstrates students' unique processes of learning and critical thinking. The nature of serial concept mapping lends itself to the sophisticated exploration of theories, concepts, and other key issues in graduate education. Electronic representations allow faculty to provide feedback in ways other than text and help faculty assess students' perceptions formatively during the semester. Serial maps lead to customized feedback and increase active learning. The use of serial concept maps in concept analysis is a visual method that helps students and faculty identify and clarify faulty relationships, thus leading to more meaningful learning.

REFERENCES

Akinsanya, C., & Williams, M. (2004). Concept mapping for meaningful learning. *Nurse Education Today, 24,* 41-46.

All, A.C., & Havens, R.L. (1997). Cognitive/concept mapping: A teaching strategy for nursing. *Journal of Advanced Nursing, 25,* 1210-1219.

All, A.C., Huycke, L.I., & Fisher, M.J. (2003). Instruction tools for nursing education: Concept maps. *Nursing Education Perspectives, 24,* 311-317.

Ausubel, D.P. (1963). *The psychology of meaningful verbal learning.* New York: Grune & Stratton.

Ausubel, D.P. (1978). In defense of advanced organizers: A reply to the critics. *Review of Educational Research, 48,* 251-257.

Ausubel, D.P., Novak, J.D., & Hanesian, H. (1978). *Education psychology: A cognitive view* (2nd ed.). New York: Holt, Rinehart & Winston.

Carroll, J.B., & Timpson, W.M. (2002). Concept mapping: A tool for teaching, training, and technical assistance. *Journal of Adult Education, 31*(1), 1-7.

Daley, B.J., Shaw, C.R., Balistrieri, T., Glasenapp, K., & Piacentine, L. (1999). Concept maps: A strategy to teach and evaluate critical thinking. *Journal of Nursing Education, 38,* 42-47.

Dobbin, K.R. (2001). Applying learning theories to develop teaching strategies for the critical care nurse. *Critical Care Nursing Clinics of North America, 13,* 1-11.

Ferrario, C.G. (2004). Developing clinical reasoning strategies: Cognitive shortcuts. *Journal for Nurses in Staff Development, 20,* 229-235.

Glendon, K., & Ulrich, D. (2004). Dear Florence: Tips and strategies for faculty. *Nurse Educator, 29,* 175-178.

Hsu, L.L. (2004). Developing concept maps from problem-based learning scenario discussions. *Journal of Advanced Nursing, 48,* 510-518.

Kinchin, K., & Hay, D. (2005). Using concept maps to optimize the composition of a collaborative student groups: A pilot study. *Journal of Advanced Nursing, 51,* 182-187.

King, M., & Shell, R. (2002). Critical thinking strategies. Teaching and evaluating critical thinking with concept maps. *Nurse Educator, 27,* 214-216.

Luckowski, A. (2003). Concept mapping as a critical thinking tool for nurse educators. *Journal for Nurses in Staff Development, 19,* 228-233.

Novak, J.D. (1998). *Learning, creating, and using knowledge: Concept maps as facilitative tools in schools and corporations.* Mahwah, NJ: Erlbaum.

Schuster, P.M. (2000). Concept mapping: Reducing clinical care plan paperwork and increasing learning. *Nurse Educator, 25,* 76-81.

Sewchuk, D.H. (2005). Experiential learning: A theoretical framework for perioperative education. *AORN Journal, 81,* 1311-1318.

Tosteson, D.C. (1990). New pathways in general medical education. *New England Journal of Medicine, 322,* 234-238.

Van Zele, E., Lenaerts, J., & Wieme, W. (2004). Improving the usefulness of concept maps as a research tool for science education. *International Journal of Science Education, 26,* 1043-1064.

Walker, L.O., & Avant, K.C. (2005). *Strategies for theory construction in nursing* (4th ed.). Upper Saddle River, NJ: Pearson/Prentice Hall.

West, D., Pomeroy, J.R., Park, J.K., Gerstenberger, E.A., & Sandoval, J. (2000). Critical thinking in graduate medical education. A role for concept mapping assessment? *Journal of the American Medical Association, 284,* 1105-1110.