Handbook of Research on Collaborative Learning Using Concept Mapping

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Chapter 9
Teaching Critical Thinking and Team Based Concept Mapping

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INTRODUCTION

Collaborative learning is necessary to help students move beyond assimilative learning to become, as described by Mezirow (1991, p. 167), ñ é critically aware of how and why our assumptions have come to constrain the way we perceive, understand, and

explanation (Facione & Facione, 1997) to reach decisions that produce a new understanding for all members. New understanding by the students, in turn, converts their ñworking memoryò into long-term memory. Thus, students participating in the process of team problem solving avoid the pitfalls of assimilative learning which simply layers new information onto old understanding. The process of using current knowledge to create new knowledge has been termed transformative learning (Boyd & Myers, 1988), and this functional transformation is accompanied by a parallel anatomical transformation occurring in the brain itself (Zull, 2002). Collaborative learning physically transforms the brain by establishing a greater number of long lasting synaptic connections through the growth of nerve cell dendrites. This physical transformation occurs in two interactive areas of the brain: 1) the temporal area and 2) the prefrontal area. The temporal area accesses existing memory and adds to that memory when new learning takes place. The prefrontal area uses knowledge from the temporal area to establish new possibilities and to make logical decisions about them. The active use of both of these areas of the brain is necessary to develop critical thinking skills thus indicating that the growth of dendrites occurs both in the area of the brain that stores memory and in the area of the brain that uses that memory for decision making (Zull, 2002; Bransford, Brown, & Cocking, 2000).

Prior to our research on team problem solving, we discovered that individual preparation for participation in team problem solving exercises is enhanced by concept mapping. This is because the construction of a concept map requires analytic reading through the constant formulation of focused questions (Cañas & Novak, 2006). The back-and-forth process of asking a question (ñWhere does this go in my map?ò) and then answering it (ñIt is connected here é and here é ò) helps the student discover how new knowledge can be organized. This facilitates, in turn, the retrieval of this knowledge during the team dialog when each student must defend their decisions to the rest of the team members. The formulation of a rationale for suggesting new possibilities, or for choosing among optional solutions, requires more than recall knowledge of factual content. Such a rationale also requires an understanding of the meaning of factual content and the construction of a concept map reveals that meaning through patterns and organization.

Concept maps are effective tools for helping students understand their individual learning style and how their preference for processing information affects their individual learning strategy, both for remembering information and for using it in problem solving. Students who are either Sensing or Intuitive personality types, as determined by the Myers-Briggs Type Indica9<004C0057-6ysolving053by

Based Learning (Michaelsen, Knight, & Fink, 2004). This learning system was developed to permit small group learning in large classrooms and utilizes multiple choice questions to not only score learning achievement, but to serve as the vehicle for dialogue in team problem solving. Although the process is highly engaging and students are able to debate and decide on their choice of answers, the discussions frequently suffer from difficulties in communication of knowledge. It occurred to us that the substitution of scored concept maps would provide a method for assessing learning while communicating knowledge more accurately and reliably. As a result, we describe

a non-preferred mental function, for example at work, they use more mental energy and tire more easily. But, like any motor skill, use of the non-preferred side can be developed and mastered. Thus, no one is limited, or compartmented, by their type; the limitation is usually a lack of awareness of type preferences and, therefore, a lack of awareness of why some aspects of thinking are more difficult than others. The available data do not support a relationship between personality type and intelligence nor a connection with any psychopathology. Each dimension of type, as described below, is exercised to different degrees by individuals of the same type preference due to the influence of other personality traits and life circumstances (Myers, McCaulley, Quenk, & Hammer, 1998).

Extraversion and Introversion Preferences

Students differ in their preference for whether their best thinking is achieved through ñtalking it outò

the skills of their opposite type. The reason for this is that, while personality type preferences are relatively constant, the development of thinking skills in the non-preferred mental functions is not restricted (Pelley & Dalley, 1997). Sensing types gain a ñbig pictureò perspective by discovering and constructing organizational and conceptual relationships and Intuitive types gain a greater grasp of the facts by attaching them to their ñbig pictureò concept map. This helps to avoid the problem of construction of primarily descriptive maps in place of the desired explanatory maps as cited by Cañas and Novak (2006). They point out that the choice of focus questions can prevent a map from serving as a classification of facts but, rather, can influence the student to construct a dynamic map that shows explanations of cause and effect.

Concept maps can be effective in facilitating the maturation of a team from a collection to a community. While a collection of students can be directed to work together, they do not achieve synergy until they trust each other as do members of a community. Team maturation has been reported to progress through four stages before students develop the trust needed for effective critical thinking skills (Tuckman, 1965). During the first two stages of team maturation, ñformingò and ñstorming,ò the dialogue that is critical to effective team learning is less efficient and thus more difficult to bring to a focus. These early stages are characterized by the uncertainty of classificatiootheized learly stages ar5Ss 2 Tm Tm [(critical)Bi800 b4079042h79K225.V1.9042h79K22etarly J E,9r

This collaborative learning method balances individual and group accountability by including both individual test performance and group test performance in the final score. The requirement for individual test performance prior to the beginning of group activities maintains the learning responsibilities that are expected of each student. This assures that group morale and team motivation don't suffer from one or more students arriving for the group activities without making an effort to prepare. However, it is not a safe assumption that students who responsibly attempt to prepare for a team exercise have done so competently. Many students study in vain, unable to comprehend critical facts or organization. Thus, this otherwise highly effective collaborative learning process is vulnerable to the effectiveness of the individual learning skills of each student. We addressed this vulnerability by merging an effective method for individual preparation, concept mapping, with a proven method for collaborative learning. Because the student uses concept maps for both individual preparation and for participation in group dialogue,

discussion and debate. At designated times, all groups are led by the teacher to simultaneously share their groups' answers with the entire class for easy comparison and immediate feedback. This stimulates an energetic total-class discussion with groups defending their answers and the teacher helping to consolidate learning as needed. Phase 3 takes from 1 – 2 hours. A complete TBL session addresses all three of the recommendations of the National Research Council that produce

Figure 1. Reproduction of an original individual concept map of a reading assignment in "ethics." The student was only able to identify three cross-links with the remaining elements of the map in a branched hierarchy. This student has sensing preferences in her learning and thus does not seek out these relationships. The scoring is discussed later in the chapter below

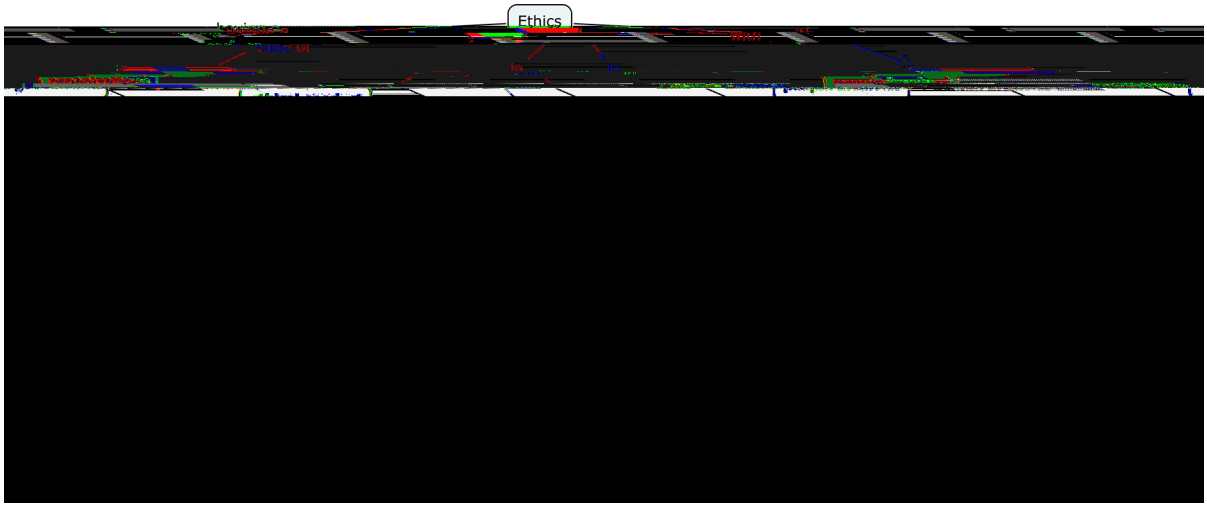

Figure 2. Reproduction of an original group concept map of a reading assignment in "ethics." Many more cross-links are present indicating a stronger input by intuitive type members of the team who tend to see relationships more readily. The scoring is discussed later in the chapter

prioritizing importance and relevance. The second map uses deductive reasoning to associate the relevant elements of the case to each answer choice. This second step is the most powerful in eliciting higher order thinking because it is a visual demonstration that, while the greatest number of links will be associated with the correct answer, other incorrect answers also have some links associated. This is of great importance to the Sensing type student that expects all answers to be either totally correct or totally incorrect.

By the end of the TBCM session, all students have had an opportunity to discuss facts and concepts with a common visual focus and to develop the greatest number of relationships within the topic area. The discovery of relationships is a thinking skill that will carry over into all future learning for each of the team members. The analysis of the relevance of different elements of a case is aided by a common visual focus to illustrate that most real world problems are not ñblack-or-white.ò

Teaching the Process of Concept Mapping

Because Intuitive types and Sensing types react differently to the process of concept mapping, it is important to include training sessions prior to conducting TBCM. This is accomplished effectively with a mock TBCM session so that the training occurs in a setting that begins training in team problem solving skills.

We teach concept mapping as a communication tool. When the student is studying alone, concept maps help authors or teachers to communicate with them through the written word. Similarly, when the student is learning in a group, concept maps help them communicate with team members through the spoken word. Communication can become very frustrating when Intuitive type students are talking about patterns and relationships that the Sensing type students missed and when Sensing type students talk about details and facts that the Intuitive type students missed. The following approach will help in training all students to become proficient with concept mapping so that each type can see what the other type is trying to say.

ñList-Group-Compareò ï Students can commit this simple phrase to memory for use during individual study. It reminds them to follow a sequence that guides reading in a way that facilitates construction of a concept map. The first step in the sequence is a reminder to survey the material and pull out terms that are more general and inclusive. Even though this appears to be a simple and obvious step, the Sensing type student will in many cases overlook that there are more general terms that are different in nature than other more specific terms. This type of student can be so focused on details and facts that all are given equal importance. This serves as an initial frustration in construction of a proper concept map. It serves as an equally powerful motivation when this type of student ñseesò the reading in a new light through concept mapping.

The grouping step involves extracting the first terms to be included in the map and beginning the organization of the map itself. This should be illustrated first by the teacher with constant reference to the list. Reassurance is important at this stage for the students to understand that the initial list will become more accurate and useful over time. Additionally, it is important for Sensing type students that the map is constructed from the top-down and not center-out. It is of no consequence to Intuitive type students where the map begins, so it gives a common ground for ecaRmcts thcr ecaRmclly

the student how to map the material, but instead asks the student about their thinking. Students can converse with each other about their maps and acquire this sense of certainty through the dialogue. Whenever a teacher shows all or part of a map, they are showing their thinking and missing what the student is thinking.

The comparing step overlaps with the grouping step as the map is completed in greater detail. At this stage students are asked to complete the map by including all subtopics within their main topic branches and to seek out comparisons, i.e. relationships, between major branches that are represented as cross-links. This is a natural step for the Intuitive type student and an extra step for the Sensing type student. Many Sensing type students never seek out relationships and rely on the teacher to point them out as additional facts to memorize. The process of seeking out relationships is taken for granted by Intuitive types, but it is a skill that can be learned by Sensing types.

Scoring Concept Maps

A simple scoring system will drive the desired behavior of seeking out integrative relationships in the learning assignment. We have used a modification of the scoring system reported by West, Pomeroy, Park, Gerstenberger, & Sandoval (2000).

1. Links (1 point). Any two concepts or facts, enclosed to form nodes of a variety of shapes, correctly connected receive one point to reward the acquisition of factual knowledge. It has a special value for the Intuitive type students who tend to overlook facts that do not contribute a ñbig picture.ò
2. Branch points, excluding convergences (5 points). Nodes that branch into two or more links receive 5 points to recognize the discovery and documentation of an indexing

teachers direct the composition of teams so that resources are distributed as evenly as possible. For example, a science course would want to distribute students who are science majors evenly among the groups followed by students with some science background and finally with those remaining students with minimal science background. This type of heterogeneity has been shown to produce the fastest and strongest team maturation.

One caveat regarding insights gained from the Myers-Briggs research is that type only indicates a preference for a mental function and does not measure the degree to which the preference is developed as a thinking skill. Just as students of the same intelligence use their intelligence differently and students with the same life or work experience have used that experience differently, so do students of the same type use their type skills differently. Thus, it is better not to use personality type to compose teams but rather, after the teams are composed, to discuss how each member can use their type best. Placing the focus on best use of type encourages personal (and thus professional) development instead of creating a stereotypical expectation.

Research shows that group size for this type of collaborative learning has a range of 5-7 students (Michaelsen, Knight, & Fink, 2004). This

3. Scoring and Evaluation of Maps

The method for scoring the content of a map appears to be simple and straightforward when provided to the students. The reality, however, is that scoring requires judgment and thus improves with experience. Students are at different stages of understanding when they construct maps and their maps reflect that thinking. The inspection of one student's map by another student is a moment of truth where learning and knowledge are exposed. In the end, scoring drives analytic reading.

The scoring process as we have implemented it in Team-Based Concept Mapping needs further study to improve accuracy and objectivity. We have found that members of the same team are naturally supportive and this eases the tensions.

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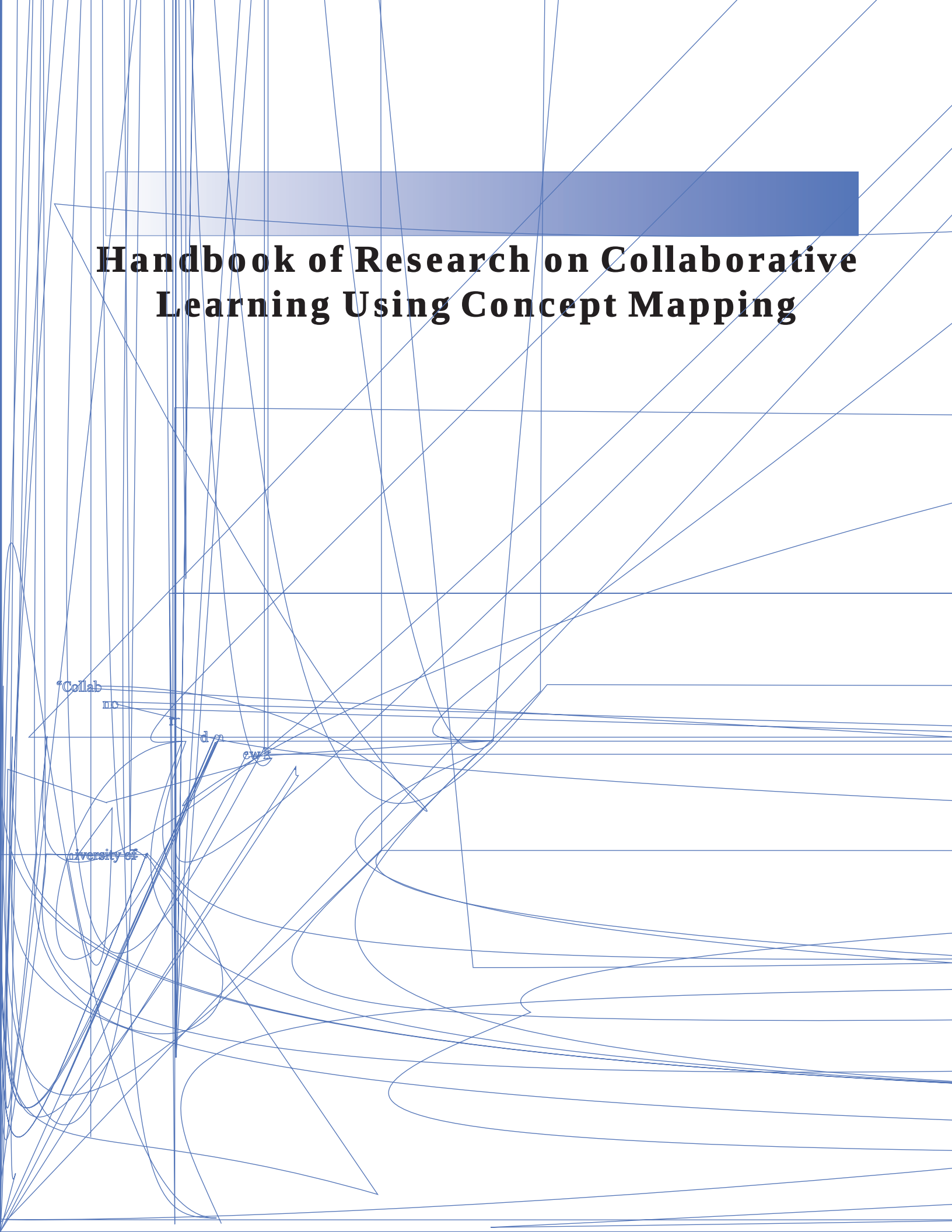

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