Supporting the Learning Process with Collaborative Concept Mapping Using Computer-Based Communication Tools and Processes

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ABSTRACT

University students are too often challenged by their limited skills in application, investigation, relational thinking, and communication of ideas. In this study, we have combined 3 tools that potentially can support and foster students’ development in the above mentioned areas through student collaboration, concept mapping, and electronic technologies. The participants in this study were 26 students in two intact classes in learning theories. In groups of 3 to 5 students, they were asked to generate 3 concept maps and accompanying prose over the term on 3 major issues in the field of learning. Through the use of interviews, questionnaires, and student generated concept maps, students reportedly enjoyed concept mapping for its organizational and relational properties but preferred sharing their concept maps and dialoguing with one another in a synchronous mode where immediate feedback and flow of thinking could be maintained when involved in constructing maps. Moreover, they did not like the redundancy offered by both prose and concept map outputs, suggesting that while concept mapping can be an arena for generating and generally structuring ideas, prose can be a means of communicating such ideas in a form that is common to most people. This is particularly important for teachers and students who have difficulty navigating through maps alone.

THE PROBLEM

It is commonly assumed that adult students are proficient in how to learn. However, it is evident that even college students have difficulty abstracting important information, discerning relationships between ideas, and integrating the information with their prior knowledge to form coherent understandings (Bransford, 1979; Bransford, Sherwood, Hasselbring, Kinzer, & Williams,

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These problems in learning are aggravated by a number of factors. One is that the primary source of information, texts, are often “inconsiderate” to students, that is, authors often do not provide links between ideas nor do they relate ideas found in the texts with the learners’ experiences. To compound this problem, university students find drawing inferences to be very difficult (Britton, van Dusen, Glynn, & Hemphill, 1990). In addition, learners may not have the prior knowledge that will help them link, anchor, and make sense of new information (Ausubel, 1963; Stewart & Dale, 1989). Furthermore, limited or inappropriate learning strategy use can hinder one’s ability to define and solve problems in a deliberate and purposeful manner.

University students seem quite adept at regurgitating memorized information, but there is ample evidence which points to the fact that they rarely retrieve such information when confronted with novel conditions that warrant its application (Bransford et al., 1990). Thus, university learners face great obstacles in their development of inquiry based skills where they are required to investigate, apply, communicate, and dialogue about their ideas to others. Being equipped with such skills allows learners to elaborate, question, and critically evaluate and revise their knowledge with peers and teachers. In other words, learners engage in active pursuit of knowledge rather than passive reception of it (Edelson, Gordin, & Pea, 1999).

THE STRATEGIES

In this study, we combined three tools that have the potential to support and foster students’ learning: collaborative learning, concept mapping, and electronic technologies. Collaborative learning is an instructional strategy that is characterized by structured group work that supports various forms of thoughtful discussion and dialogue amongst group members (Abrami, Chambers, Poulsen, De Simone, d’Apollonia, & Howden, 1995). Cooperative learning, a specific form of collaboration, has been found to enhance achievement and productivity significantly more than competitive or individual learning structures. Equally impressive is the positive impact that team learning has on student attitudes about learning, affect, and self-concept (Johnson & Johnson, 1994). Moreover, Slavin (1990) found that cooperative methods that employ group rewards are superior to other forms of reward distribution. Others add that it is the task-focused interaction among students
that enhances learning by creating conflicts, by exposing students to higher levels of thinking, and engaging them in higher level interaction (Webb, 1989). In this study, students were encouraged to engage in higher level interactions and received a group reward.

Concept mapping is a learning strategy that allows learners to externalize their thinking in a visual/verbal form to improve students’ understanding of learning (Holley & Dansereau, 1984; Novak, 1998). It allows the learner to abstract important information, relate ideas, and represent them in a structured manner. The result is a concept map where concepts are enclosed in nodes and attached by links. Much work has been done in this area investigating the effectiveness of the strategy. Generally speaking, positive results have been reported (De Simone, Oka, & Tischer, 1999; Novak, 1998; Schmid & Telaro, 1990), although findings are not consistent across the literature. To better understand why and when concept mapping facilitates learning, recent work by De Simone & Schmid (1998) began an in-depth analysis of the concept mapping process to uncover factors that could impinge upon the learner’s use of the strategy. A relationship between the use of concept mapping as a tool and the levels of cognitive processing engaged in by the learners has been identified. Three types of strategy use emerged. Some learners essentially used standard mapping procedures that resulted in basic comprehension. Others displayed more creative mapping which sometimes led to higher level processing such as relating ideas in ways other than those suggested by the text, and more active monitoring of the comprehension process. Finally, some used the tool inappropriately and thus often faltered even at the basic level of processing. Factors influencing inappropriate usage included lack of time, difficulties comprehending the material, interference from other strategies, distortion of the strategy itself.

The electronic technologies we chose to explore included both computer-mediated communication (CMC) as a student-instructor/student-student communications tool, and electronic concept mapping software. Together, these were seen as supporting relational learning and dialoguing in the following ways: (a) exchange of/access to information, encouraging both synchronous and asynchronous discussion and negotiation; (b) making physical changes or revisions in the maps, allowing for greater freedom to adjust one’s conceptual thinking and its mapped representation; (c) opportunities to represent a “conceptual gestalt” and/or details of the content (i.e., from big picture to in-depth representations) based on individual/group preferences and the task demands of the learning system; (d) the
utilization of graphic representations which serve as strategic scaffolds for learners through the concept mapping process and accompanying templates; and (e) equal participation from group members because electronic versions of concept maps enable storage of multiple drafts, therefore enabling and tracking individual’s representations as well of the evolution of group maps.

Our approach to foster learning has been to assemble tools which will provide for students the ability to externalize internal thoughts, while collaborating in a venue for exploring and discussing such externalizations. We believed these tools would enable them to flexibly manipulate and revise ideas, draw knowledge from their concept maps and on-line discussions, and keep a record allowing them to review, reflect, and revise their thinking. Suthers (1999) maintains that when such tools are used in a collaborative context, the individual is less likely to ignore discrepancies between their own thoughts and the external representation, as they must attend to its shared features. Thus, such representations are likely to have a greater effect on individual cognition when used in a social context, especially when ill-structured domains allowing for multiple perspectives are involved.

THEORETICAL ORIENTATION

The learning theory underlying this study falls under the general rubric of constructivist thinking. Constructivists make several assumptions about the learner, the context within which one learns, the learning process, and the outcomes. Learning environments are most effective when learners are actively involved in constructing their own meaning and doing so within authentic learning situations (Brown, Collins, & Duguid, 1989). In such contexts, knowledge is not abstract and out-of-context, but is presented and learned in ways that are genuine, calling upon situations and applications that allow learners to use the knowledge learned. Constructivists also purport to present learners with learning strategies, or flexible tools. Due to the nature of such constructed and authentic environments, it is assumed that complex strategies such as concept mapping can support the construction of genuine knowledge via analysis, drawing of inferences both within text and beyond the text through elaboration with prior knowledge (Pearson & Johnson, 1978), and synthesis (De Simone & Schmid, 1998; McKeachie, Pintrich, & Lin, 1985). It also assumes that authentic learning environments will encourage the learner to adopt a strategic learning orientation, (i.e., that the student utilize the
strategy which most effectively and efficiently accomplishes the learning objectives). The learner is assumed to be strategic in making use of a variety of strategies to help them reach their goal, relying upon their own prior knowledge, motivation, and available resources which influence how they approach the task. Within the constructivist framework, a role of the “teacher” is then to provide learners with flexible learning tools as opposed to routinized procedures (Duffy, 1993), and to provide the necessary scaffolds for the learners to make progress. At times these scaffolds are the teacher providing information and the necessary support; at others it is the materials and processes that act as scaffolds (Vygotsky, 1978). Finally, the evaluation system has a major impact on the students’ learning goals in constructivist’s thinking. One cannot advocate that students learn “authentically” and engage in higher order thinking such as how to relate ideas, discuss them in a reflective manner, and then assess students’ ability at only the knowledge and comprehension levels (Bloom, Englehart, Furst, Hill, & Krathwohl, 1956).

THE STUDY

In this study, the nature of the instructional objectives and the course content lent themselves to dialogue and the use of strategies such as concept mapping. The nature of the tasks was authentic in three ways. First, students in this course are expected to understand and evaluate a myriad of different theories of learning. In this case, the students’ role was to not only transcribe information from the textbook and articles into a visual-spatial form, but to develop an understanding of main ideas and how they are related across the entire course content. To this end, we encouraged learners to apply the basic principles of concept mapping and collaborative learning as well as the electronic medium to master course content in a unique instructional environment. Second, we expected students to ameliorate their own learning through the development of their own approaches to mapping, how they engage in dialogue and how they explored the electronic environment to support and foster their learning. Third, students were expected by their instructor to not only cover Learning Theories as content, but to acquire experience in learning in an electronic environment, and to experience how theories of learning apply to themselves in this new medium. In this study, students experienced extensive, first hand use of two electronic concept mapping tools, and they needed to adjust their learning and the tool use to successfully complete the task. The research was
therefore conducted in the naturalistic classroom situation. We did not and could not manipulate variables and control others but rather studied the strategies as they unfolded with respect to the learners’ understanding and the teachers’ role in the learning process.

In summary, this was an exploratory study which involved the design and implementation of a learning system that made use of electronic concept mapping to encourage higher level learning using collaborative learning structures and tasks which were of relevance and utility to the students. The questions we addressed in this study were: (1) Does collaborative concept mapping in a computer medium assist students in actively constructing ideas and do learners see the benefits of mapping? If so, when and how? If not, what is hindering their learning? (2) Does the electronic medium facilitate or suppress learning both as individual learners and when communicating ideas to others? In this study, we perceive concept mapping as being a means for externalizing internal thoughts, while collaboration is a venue for exploring and discussing such externalizations.

METHODS

Design and participants
This study involved the implementation of electronic concept mapping as an instructional strategy over two, parallel, intact sections of a one-semester, graduate level, Learning Theories course. The collection of achievement and process data of these two cases was systematically undertaken in their natural context (Gall, Borg, & Gall, 1996).

The participants included a total of 26 students, 11 in a Tuesday nighttime session and 15 in a Wednesday daytime session. The Tuesday group was comprised of nine female and two male students. The Wednesday group included eight females and six males.

The two groups did not differ with respect to experience with word processing and computer use, showing an average of 8 years experience. All participants except two (from the Wednesday group) reported having access to a computer with Internet connections at home. Both exceptions reported having easy, alternative access. All but five participants had access to an IBM platform from home. Both groups reported only occasional or little experience with visual organizers or use of learning strategies such as concept mapping. The two groups reported frequent to occasional experience with CMC, and
high, positive levels of comfort with communicating ideas and working in
groups. All participants reported the importance of individual contribution to
group work and the benefits of learning from group members.

Materials
The measures were: (1) students’ background questionnaire tapping into
demographics and Likert-type questions on computer skill and concept
mapping proficiency and attitudinal information in regard to group-learning
situations; (2) student-generated concept maps (one per group for each of
three exercises); and (3) a three part post course questionnaire: (a) about the
platform used to conduct their on-line work and concept mapping; (b) scaled
responses on issues related to frequency of task engagement, communication
problems and the group process, and (c) open ended questions on the value of
concept mapping and the electronic concept mapping tools. Focus group data
were also gathered on their mapping experiences. The post course question-
naire allowed us to obtain individual’s responses. The focus groups were
beneficial in helping us to further probe their responses as well as gather
unprompted impressions of any aspect of the study.

The course content was based on the Driscoll (2000) text *Psychology of
Learning for Instruction*, plus articles from the primary literature.

Strategy instruction

*Electronic concept mapping strategy training*

The electronic concept mapping strategy training consisted of an approxi-
mately 1-hour session describing the functions of the electronic concept
mapping tool and the concept mapping strategy per se. Training began with a
collaborative in-class exercise asking participants to graphically represent the
concept of “learning.” A discussion of their ideas of learning and how these
ideas were graphically represented followed. Then, participants moved to the
computer lab for a demonstration of the electronic concept mapping software.
They were first informed about the attributes of concept maps (i.e., they have
three basic relationship types: hierarchies, chains, and clusters) and about the
essentials of concept mapping (i.e., that it is a process which is individually
constructed by the learner and under continuous modification). Then, the
research assistant demonstrated how to construct concept maps electronically
and distributed instructional packages that were intended as self-contained
guides for creating electronic concept maps (the packages were also posted
on-line). Initially, we trained participants on PIViT due to its simplicity and sub-mapping feature that was anticipated to promote the creation of manageable sized maps. Moreover, PIViT was free of charge and available from the Internet. However, a number of problems surfaced with the software, the gravest one being cross-platform incompatibilities of the software (i.e., IBM and Macintosh). Because of insurmountable technical difficulties associated with PIViT, we turned to another concept mapping software, Inspiration. Students were provided with individual copies of Inspiration and were asked to load it on their computers. They were informed that this software contained no sub-map feature but were encouraged to create separate concept maps as sub-maps. It was emphasized that shapes, colors, and pictures as well as words could be represented with Inspiration.

Procedures
Over the course of the regular semester, the course instructor requested that students form self-selected groups of three to five members and share their information using the Intranet server, FirstClass. Students were also strongly encouraged to change group membership for each exercise. In total, the groups were to construct three concept maps and corresponding explanatory prose in response to select, integrative statements related to the contents of the course. For the first two maps, the instructor provided students with the general statements: “All learning is under the control of reinforcers” and “The motor for learning and development is motivation.” These integrative statements required the students create inferences both between various parts of the text, and with their own prior knowledge (Pearson & Johnson, 1978). Students were asked to first concept map individually to insure individual contribution. Using FirstClass they were then to share their individual representations and accompanying prose electronically with their group members so that a group map could be constructed and the ideas of the group reflected. This process was hoped to foster dialogue within groups which, given the complexity of the task, could help clarify thinking and create meaningful visual representations. For the third map, group members were required to generate their own integrative statements.

All collaboratively generated concept maps and accompanying prose were collected and feedback was provided directly on the printed concept maps by the researchers on a pre-set schedule. The instructor also evaluated the prose submissions. In all three tasks, the assignment required the abstraction of
ideas, and relating them not only to one another but also to the broader statement.

During the final class meeting, the last 30 minutes were allocated to the completion of the Post Course Questionnaire and the conduct of a focus group discussion. For the focus group, the floor was opened to the general question such as: “What was your reaction to the use of concept mapping in this course?” A participant-driven discussion ensued, lasting approximately 45 minutes with each group, with comments recorded by the animator/researcher.

Scoring procedures

Concept maps
The first two authors assessed the concept maps independently in terms of the accuracy of the content as represented by the information in the nodes and links. In addition, a more holistic approach to feedback was provided in the form of summary statements about our general impressions of each group’s map. This feedback came largely in the form of questions and observations on structure, links and the map’s effectiveness at responding to the statement. For example, “this map shows that the group can separate fact from opinion,” “it looks like this group used mapping to turn text into a graphical entity,” and “a stronger map can be made by re-arranging the map so that conceptually similar concepts can be in closer physical proximity.” Although the instructor asked the researchers to rank order the maps, students did not receive a grade from the researchers.

Questionnaires
Objective data from the questionnaires were compiled in Excel spreadsheets. Open-ended responses were summarized in tabular form, beginning with the Tuesday group. Each item was treated in order. To eliminate an order effect, participant questionnaires were randomly selected for each item. Data were subsequently grouped by emergent categories by the first two authors.

Focus groups sessions
Participant comments from each session were compiled in tabular form in order of their occurrence and then grouped into categories that emerged from
Table 1. E-CM Post Course Focus Groups.

<table>
<thead>
<tr>
<th>Training</th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td>Training too early – needed more – more spread out</td>
<td>T</td>
</tr>
<tr>
<td>Novices have problems (posting was also new experience)</td>
<td>T</td>
</tr>
<tr>
<td>Task Relevance</td>
<td>T</td>
</tr>
<tr>
<td>Questions were too general</td>
<td>T</td>
</tr>
<tr>
<td>Products were redundant (both prose and maps) irritating to do prose</td>
<td>T</td>
</tr>
<tr>
<td>Too many things at once</td>
<td>T</td>
</tr>
<tr>
<td>Feedback</td>
<td>T, W</td>
</tr>
<tr>
<td>Needed more feedback on individual maps</td>
<td>T, W</td>
</tr>
<tr>
<td>Didn’t help them make better maps</td>
<td>T, W</td>
</tr>
<tr>
<td>On-line – (neg.)</td>
<td>W</td>
</tr>
<tr>
<td>Had to get together to do maps – No one did it on-line!</td>
<td>W</td>
</tr>
<tr>
<td>On-line would have taken 6 times longer</td>
<td>T</td>
</tr>
<tr>
<td>Even synchronous was tough, but easier than asynchronous</td>
<td>T</td>
</tr>
<tr>
<td>Doesn’t benefit from body language, immediate feedback (essential for novices)</td>
<td>T, W</td>
</tr>
<tr>
<td>Doing on screen was static</td>
<td>W</td>
</tr>
<tr>
<td>On-line – (pos.)</td>
<td>W</td>
</tr>
<tr>
<td>f2f was great/dynamic/on same wavelength</td>
<td>W</td>
</tr>
<tr>
<td>One group did on-line, but via synchronous, chat (each submitted individual maps first) – Took 5 hours, but saved travel, etc.</td>
<td>W</td>
</tr>
<tr>
<td>If done on-line, needs more prep (in f2f, can come unprepared!)</td>
<td>W</td>
</tr>
<tr>
<td>On-line allows you to make full argument uninterrupted</td>
<td>W</td>
</tr>
<tr>
<td>Concept Mapping and Collaboration</td>
<td>W</td>
</tr>
<tr>
<td>Good for collaboration</td>
<td>W</td>
</tr>
<tr>
<td>Needed each other to wrestle with ideas</td>
<td>W</td>
</tr>
<tr>
<td>Good for negotiation</td>
<td>W</td>
</tr>
<tr>
<td>Good as an argument, description or proof</td>
<td>W</td>
</tr>
<tr>
<td>Organization</td>
<td>W</td>
</tr>
<tr>
<td>Good organizational tool</td>
<td>W</td>
</tr>
<tr>
<td>Forces you to organize</td>
<td>W</td>
</tr>
<tr>
<td>Focuses (when reading, you forget what you read before)</td>
<td>W</td>
</tr>
<tr>
<td>Can’t ramble on/brevity is a strength</td>
<td>W</td>
</tr>
<tr>
<td>Mismatch in Learner Preferences</td>
<td>W</td>
</tr>
<tr>
<td>Don’t see things that way</td>
<td>W</td>
</tr>
<tr>
<td>Was an additional step – already “had it”</td>
<td>W</td>
</tr>
<tr>
<td>Deeper Understanding.</td>
<td>W</td>
</tr>
<tr>
<td>Deepens understanding</td>
<td>W</td>
</tr>
<tr>
<td>Had to re-read and understand deeper/feel the context, relationships, what comes first</td>
<td>W</td>
</tr>
<tr>
<td>Prompted self-evaluation – opportunity to think twice/forces you to go back to beginning</td>
<td>W</td>
</tr>
<tr>
<td>When working on paper, focused on editing (CM did not suffer from that)</td>
<td>W</td>
</tr>
<tr>
<td>Burdensome, but in a good way</td>
<td>W</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>W</td>
</tr>
<tr>
<td>Would be great on a virtual white board</td>
<td>W</td>
</tr>
<tr>
<td>Good for retention/easier to see</td>
<td>W</td>
</tr>
<tr>
<td>Hated PIViT</td>
<td>T</td>
</tr>
<tr>
<td>Challenged by deadlines, multiple assignments, all graded</td>
<td>T</td>
</tr>
</tbody>
</table>

Note. T = Tuesday group; W = Wednesday group.
the data (e.g., training, feedback, technical, etc.). The categories and specific responses are represented in Table 1.

RESULTS

Concept maps
Not surprisingly, the groups’ maps differed significantly in the structure (or organization) of their representations, replicating the findings of De Simone and Schmid (1998). Some had the more traditional appearance of hierarchical maps, while others included more cyclical patterns. Also, given that the Inspiration software allowed for the representation of pictures and symbols (e.g., clipart), some groups availed themselves of such features, while others used the typical verbal mode in the form of notes.

Groups also varied in their ability to represent the text-based knowledge accurately, though overall they were successful at analyzing the relevant content (i.e., identifying main ideas, grouping them across several chapters) Where they were less successful was that they had a difficult time using the map to support their integrative statements (i.e., they failed to create an “argument” which elaborated upon the statement such that they could represent evidence for or against it).

Pre- and post-course questionnaire: likert type items
Nine participants of the Tuesday evening course and 14 members of the Wednesday section submitted their completed questionnaire. In response to the question: “How much experience do you have using visual organizers (e.g., flowcharts) for learning academic content,” both groups reported a low level of knowledge ($M = 3.7$, 5 being “none”). To the question “How much experience do you have concept mapping, in particular,” both groups reported similar, low levels of knowledge ($M = 3.9$).

The Wednesday group reported more on-line participation than the Tuesday group. Both groups reported experiencing technical difficulties “occasionally” and conceptual difficulties “a few times,” derived primarily from their early, PIViT experiences. Four questions were posed in both the Pre- and Posttests. Regarding group-based activities, both groups reported high levels of enjoyment prior to the course. Their enjoyment level remained high after the course. Both groups reported a small decrease in inclination to “take charge” of group activities from pre to post. While both
groups remained steadfast in their conviction that individual contribution is important to group success, the Wednesday group was nearly unanimous. Finally, while both groups strongly agreed that they learned from each other, there was a half point drift toward the negative direction for both groups.

**Post course questionnaire: part c-opened questions**

Questions 12–19 solicited participants’ actions and reactions to the use of electronic concept mapping (CMing) as of the last day of the course. As qualitative data, the following summaries present the gist of all the comments. Overall, the preponderance of comments was positive and constructive. Only one participant outright rejected the CM strategy. Furthermore, all respondents answered every question (except one, who left the concept mapping “liked least” question blank – a good sign). However, the richness and variety of answers waned with the later questions, or became redundant.

As we compiled the responses, the nature of the participants’ comments were such that they could be framed around three aspects of their experience: **Input** – what the learner/instructional system brings to the process (e.g., prior knowledge of the content and strategy, task demands, access to and quality of tools); **Process** – actual strategy use in the learning of content; and **Output** (the role of the actual map as an iterative and final product). Following are the questions and comments.

**Question 12: Did concept mapping per se help you learn the material?**

Except for two participants, the majority of them responded “yes” to this question. With respect to **Input** issues, participants included: that one must be familiar with the content and that it must match with individual preference for learning (though most liked it, several said it did not match their learning preference “I don’t see things graphically”).

**Process** issues that emerged from the data fell under two subheadings: **content** and **strategy** use: Content-wise, participants reported that concept mapping: simplified; made more manageable; related ideas which led to in-depth, higher-level understanding; helped one “see” connections; enabled comparing/contrasting of theories; and clarified relationships. With respect to strategy use, participants claimed that it was: easy to use; forces one to “think differently” (e.g., think twice, examine process underlying material, forces one to focus on key ideas, organizes/structures/summarizes, encourages self-reflection/questioning). Only one reported that it was not easy, but rather confusing.
Regarding Output issues, participants said that: concept mapping provided them with clear, concrete feedback for self-evaluation; facilitated role in group sharing and discussing.

Question 13: Did electronic concept mapping facilitate your learning of the material? All but two said “yes,” and one of them said “maybe.” (The outright “no” in Q12 above liked Inspiration, but maintained dislike for CMing.)

With respect to Input issues, answers included effectiveness of tools (e.g., participants rejected PIViT, and roundly applauded Inspiration); skill development—they expressed a need for practice and feedback; and motivation (e.g., the pleasant tool (Inspiration) was itself motivating).

Process issues were mentioned in the form of electronic concept mapping was helpful to: re-arrange content; flexible; made changes easy (“beats erasing”), not messy; is helpful when done in face-to-face modality (e.g., the process is “static” if attempted asynchronously).

The Output function of electronic concept mapping was expressed in terms of ease of sharing product of individual/group work (though one stated that it made learning “more complicated”; solving the problem of multiple version/copies. Many of the same comments made in Q12 were repeated here, e.g., facilitated the exchange of ideas, provided a quick visualization, revealed relationships for review, led to in-depth understanding.

Question 14: What did you like best about the concept mapping strategy per se? In response to this question, Input issues revealed themselves when many said they “think that way.” Again, data emerging from Process issues were divided between content and strategy use. Pertaining to content, participants said that it: was easier to understand when graphically represented and brought greater “organizational quality to material.” With respect to strategy use, participants claimed it was: “fun; encouraged collaboration; encourage creativity,” “a nice change from prose” as well as it helped focus, be precise, helped one “think differently” (i.e., encouraged “non-linear, higher-level thinking”; thinking “outside the box”; holistic; demanded structure and flow; different perspectives [considered by one to be “irritating”]). Output issues related creating a visual representation of relationships among concepts→flow and structure; making the abstract concrete; tying key ideas together; summarizing relationships in a new, clear way; a good visual product, but difficult to arrive at.

Question 15: What did you like least about the concept mapping strategy per se? In spite of the question’s focus on the strategy per se, Input issues
participants talked about involved the tools. They did not like PIViT and one said that s/he learned how important good software is in such situations. They also spoke about task relevance, that is, why were they required to generate both prose and map answers to the questions. Finally, participants re-referred to learner preference (e.g., some feel unable to learn that way, that it “forces” a certain kind of learning, and that alternative visual strategies ought to be offered). With respect to Process issue, only strategy related themes emerged: difficult to do well; time consuming to (a) construct a complete, visual representation, (b) present ideas effectively, (c) undertake asynchronously (especially waiting for group member responses), and (d) editing; and group process (while not unique to CMing, they encountered problems with (a) logistics for working together with equal distribution of tasks, and (b) settling conceptual disagreements. No Output issues were presented.

Question 16: What did you like best about the electronic version of mapping? Because many of the issues related to this question had been dealt with in their earlier responses, participants had less to say here. The primary Input issue was Inspiration’s technical ease (including the variety of shapes, clip art, colors). They found the tool flexible, transportable and easily exchangeable. Comments from a Process standpoint dwelt on the tool’s support of the constructivist process (creating their own understanding in visual form), and the note-taking feature. No Output items were cited.

Question 17: What did you like the least about the electronic version of mapping? Comments from an Input perspective focused on PIViT as being “horrible, ineffective, not enough room.” Inspiration was criticized for automatically shrinking the map to a single page, making the text very small. However it was possible to adjust this function of the software, but students did not use the option correctly. Process comments reiterated concern about time demands: perfecting ideas; making the map “pleasing”; making the map “understandable to others.” They also felt uncomfortable about the maps’ two dimensionality. One commented that s/he didn’t like “being observed” (though they knew that participation in the study was voluntary). Curiously, all additional comments were repeats of positive items: made organizing ideas/guiding groups easier; encourages self-evaluation; helped them see all ideas linked.

Question 18: Will you continue to use the concept mapping strategy? Answers fell into the Yes (17), and Unsure (4) categories. No one said only “No.” The reasons for Yes: “for presentations” to improve the communica-
tion of ideas; to “make sense” of course notes; to guide the creation of outlines; “in other classes.” Many referred to the maps’ value in planning and structuring tasks and content, that it gave a macro view of material, that it served as an organizational chart, and that it organized “ill-structured” domains. Many also said they would use it electronically, especially for “sharing broad concepts.” Others were “Unsure,” but all comments were qualifications to yes: it depends upon the context, too early to say, “not by hand” and a misplaced (“it would be great for storyboarding”). Finally, in the “No” space, one added “Won’t use in same way as in class.”

Additional Comments: Many points made in this section (completed by 12 participants) were repeats of previous comments. Useful notes included: should choose either prose or maps; PIViT was demoralizing, Inspiration motivating; one felt like a guinea pig. Regarding feedback, they suggested: groups should present their map to the whole class for critique; they wanted more feedback on what makes a good map (which they felt would NOT curb creativity). Finally: “worth the expense in time and mental output.”

Focus Group Interviews. During the discussions that transpired in the focus groups, the Tuesday group first expressed concern that they had not received adequate training and feedback in concept mapping. They also felt that the tasks that they were asked to do were redundant (i.e., having to create both prose and concept map versions). Moreover, they reported that in having shared their maps on line and they did not like PIViT and were challenged by multiple deadlines. Table 1 indicates more specifically what was reported by the group. By contrast, the Wednesday group believed that concept maps were a good organizational tool, helping them to focus on ideas as well as to obtain a deeper understanding of the material. However, one person mentioned that mapping did not fit with his style of learning. The Wednesday group also shared the feeling that they could have used more feedback in order to make better maps. Moreover, both groups felt that concept mapping and collaboration helped them to wrestle with ideas and to develop an argument.

The focus group data also spoke to one of our central research questions, that is, the nature of the collaborative activities undertaken within and across groups. As noted in the procedure, the groups were asked to generate maps individually, post them, and then work collaboratively on-line to create a group map. Both focus groups stated unequivocally that this approach was problematic. With the exception of one group, all maps were generated during f2f sessions. A number of interesting points emerged: asynchronous map
generation “would have taken six times longer”; f2f mapping was tough enough, but asynchronous mapping was worse, suffering from frustration due to non-participation or “waiting for others’ work,” and the lack of “body language” and immediate feedback (which they said was essential for beginners); posted maps were deemed “static.” Finally, the one group that mapped on-line did so during a 5 hour synchronous chat, with each member submitting their own map beforehand. Participants stated that “when you do it on-line, you have to come prepared,” whereas, with f2f sessions, “you can wing it.”

**DISCUSSION**

Overall, group-based electronic concept mapping proved to be an effective strategy for identifying and organizing course content (i.e., features associated with higher levels of learning). Students said that they liked using the concept mapping strategy: it helped them effectively understand the course content, organize it, revise it, and complete the assigned task. Students said they were likely to use concept mapping in the future. They also liked Inspiration, the concept mapping software that was deemed flexible, transportable, and easily supported exchanges of concept maps among students. Unfortunately, mapping was ineffective in representing the arguments required in addressing the integrative statements (i.e., they did not support high level inferences). A number of issues emerged from this study which are discussed below: electronic sharing of maps, time, the nature of concept mapping modality, training and feedback, redundancy, the role of the teacher, and integration of strategy in context.

The first issue was perhaps the most surprising. Almost without exception, the groups did not use the asynchronous communication route of CMC to share, compare and discuss the maps. They independently chose to create the maps in f2f mode, both while using the strategy *per se*, and as they discussed course content issues related to the mapping exercise. The reasons cited for this modification were that: they were frustrated by delays in exchanging information; they had difficulty understanding each others’ maps without synchronous discussion (including “body language”, etc.); and they felt that deposited maps were “static” (not clear). Interestingly, they even reported the decision to abandon CMC as mostly beneficial. In short, what we had envisaged as a distinct advantage proved to be a liability. It appears that when
students take on the task of analyzing and synthesizing substantial text-based content with the objective of generating a collaboratively submitted concept map in a constrained period of time, such synchronous approaches as face-to-face or simultaneous chat are important for success. It should be mentioned that technical difficulties with PIViT software encountered early in the study might also have been a contributing factor to these findings. Sharing concept maps electronically was nearly impossible with the first (PIViT) maps, and students were forced to adopt alternative methods of communication. This precedent, along with the changes in group membership across exercises, may have inhibited the development of an effective map sharing protocol.

Our second issue addresses one of the most serious problems in the concept mapping literature: it is time consuming. Pintrich and De Groot (1990) contend that people will adopt ideas, strategies, and skills when they perceive them as immediately useful and bearing fruit in the future. Our participants complained about how time consuming mapping was, but persisted nevertheless. Thus, time was perceived as something that simply had to be managed because of the value placed on the strategy. To overcome this problem in the longer term, we would consider an approach adopted by De Simone et al. (1999). They suggest that students initially become familiar with the mapping strategy and the content. Once comfortable with these, students are then shown how to mentally generate their concept maps. Constructing physical maps is reserved for those instances when the content is new and/or complex, as was the case here. In either case, concept maps act as flexible scaffolds to be shaped around the learning situations and the learning needs. In situations where maps must be shared, the use of mental maps would be reserved for one’s initial, individual formulation.

A third problem cited in the literature is related to the use of the paper and pencil modality in concept mapping, that is, they are inflexible, and users tend to avoid making revisions. The electronic version of concept mapping did appear to overcome this problem. Students were able to discuss and negotiate map structure, and generate a number of drafts. Indeed, they reported enjoying the use of the tool to manipulate images and structure, and thus, hopefully, ideas. In one of our earlier studies involving paper and pencil mapping, De Simone and Schmid (1998) found that when students with low prior knowledge of content deviated from the organization suggested by the text, they ended up with large chunks of content in one node, making it difficult for them to decipher how the information was related. With e-maps, the structure and flexibility of the tool would have enabled them to not just rethink concepts
and their relationships, but to then quickly and easily reconfigure the map as a representation of their thinking. Thus, the easier it is for learners to make changes, the more likely they are to expedite the actual process of map making. This shifts learning resources from the mechanics of concept mapping to increased learning within the domain.

A fourth problem noted in this study was participants’ concern about the amount of training and feedback that they received. They found learning both the mapping process and the electronic tool daunting. Thus, what they requested was “just-in-time” support – allowing them to experiment with the tool and explore the content, and then receive constructive, ongoing feedback on both the mapping process and their apparent understanding of the content.

The issue of training became especially apparent when we noticed students’ apparent lack of inferencing skills in concept mapping, and therefore their limited ability to construct an argument. While we offered a basic introduction to concept mapping, given their general low prior knowledge, we did not spend adequate time to cover all the skills required for the task. We erroneously assumed that they would undertake sufficient inferencing because of the integrative nature of the statements. However, inferencing is a very difficult skill even for college students and is often not adopted spontaneously (Britton et al., 1990). We suspect that had students received appropriate scaffolding as they completed the task, they would have been guided to constructed concept maps that would have reflected the logic of an argument.

Under ideal circumstances, training techniques would be aimed at helping students to create maps according to good Gestalt principles. These would begin by ensuring that key ideas are centrally or hierarchically organized, and that multiple and bi-directional links be considered and used whenever appropriate. The maps should also not become too large or “busy,” a particular problem with ill-structured domains and/or tasks – we would thus train for and encourage the development of sub-maps, and the use of sequences or flow diagrams to organize and direct the interpretation of the content. The present participants did not use either of these techniques but still complained about the complexity and size of the maps – further training and experience might reduce this problem, allowing students to make better use of their time.

A fifth issue that emerged with these students was that they did not appreciate the requirement to create both a map and a prose response – they were deemed redundant. This is understandable when one form serves merely
to illustrate or represent the other. However, if mapping and prose served different and interactive functions, not merely illustrative purposes (Paivio, 1986), students might have been in a better position to use both to develop their argument for the integrative ideas. Concept maps could then be thought of as learning arenas to explore thinking, encouraging metacognition, and, as the participants suggested, serving as tools for planning and organizing their understanding of the content.

The redundancy problem brings to the fore a sixth, larger issue, namely the role of the teacher in a constructivist paradigm. In this study, the teacher was eager for the students to learn about concept mapping and its electronic form. However, for concept mapping to be effectively integrated into a course, one of two approaches must be followed. In a directive approach, the instructor would have to be conversant with both the technique and with the kind of feedback and evaluation required to foster the process. De Simone and Schmid (1998), Novak (1998), and others speak of the difficulties associated with reading and evaluating concept maps, adding to the challenges an instructor would face. A more collaborative approach might be represented by Prawat’s (1991) notion of an immersion approach where the content is highlighted but the strategies and processes work in the background. “Training” would become a natural part of the coursework, with shared responsibility for the use of learning strategies, and allowances for flexibility to implement the wide range of options (Driscoll, 2000; Winn, 1989). While concept mapping was a requirement for the course in this study, students saw it as a separate task. This led to their perception of a lack of external support. What is key then, is designing enriched learning environments, where strategies and content are inseparable, requiring and rewarding higher and deeper levels of learning, and providing effective tools and techniques to support it.

Finally, the mapping process facilitated the fundamental constructivist requirement that learners be allowed to manage, construct, and share their own understanding of the content from an ill-structured domain. No two maps were alike even though they treated similar content. Furthermore, the requirement to create their own integrative questions led to interesting and complex questions, constituting an unexpected and desirable artifact. Although the final maps generally failed to adequately generate cohesive arguments in response to their statements, the quest for good concept maps generated what students referred to as fruitful discussion and interesting outputs, primarily because they all had a common, explicit representation of knowledge to refer to—the map. Their “final” maps were in fact treated as their latest draft rather than the
“answer.” These data provide empirical evidence to support Suthers’ notion of the value of social engagement to scaffold individual cognition (Suthers, Toth, & Weiner, 1997). However, as noted above, this context did not support on-line engagement – face-to-face collaboration was generally found to be superior.

In conclusion, the present study has shown that despite the arduous nature of the tasks, students persisted and altered the course of their concept mapping, collaboration, and its electronic context. These students clearly put in considerable effort but felt they obtained significant rewards from having done so. We believe that concept mapping and collaborative learning techniques complement one another. While concept mapping aids in the external representation of ideas, collaborative learning, through its emphasis on dialogue and discussion, furthers the elaborations of these externalizations so ideas can be shared. However, this implies that learners need to be instructed in these strategies, depending upon the goals to be accomplished.

REFERENCES


