LITRE Grant Final Report: Collaborative Online Concept Mapping

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ABSTRACT: Five sections of two different distance education classes completed a series of Web-based concept map assessments using different concept mapping methods. In the first course (ECI 511) open-ended maps applied in section 1 led students to conduct more relational thinking overall, but variance in map items was very high introducing more subjectivity in scoring. Pre-selected term mapping applied in sections 2-3 led students to correctly classify many concepts and express proper relationships compared to an instructor's map. Identifying expected concept sets from the instructor's maps caused students some difficulty. The high volume of readings associated with the task appeared to further this problem. Students touted many benefits of mapping, including synthesizing and connecting course material, reading more intentionally, and thinking visually. In the second course (EAC 595A) there were two sections. In section 1 students completed open-ended maps at mid-term and at the end of the semester, by using core course concepts developed on a wiki during the semester. In section 2, students completed a pre-selected term map in week one, a seeded term map at mid-semester and an open-ended map at the end of the semester. Many students had difficulty learning new software while simultaneously learning to do concept maps. However, by the end of the semester their abilities improved as evidenced by the average increase in grades allocated to the mapping activities.

INTRODUCTION

Web-based concept map assessments were integrated five sections of two different graduate education class in two departments between fall semesters 2005 and 2006. The sections were taught entirely at a distance using the *WebCT Vista* course management system. Concept maps provided an alternative assessment to gauge student understanding of course topics. The purpose for this study was to determine the most appropriate mapping techniques for eliciting and scoring student representations using performance and attitudinal measures.

In ECI 511 (Computer Applications and Curriculum Integration) study participants included 41 graduate students enrolled in three sections of the same graduate distance education course over three semesters (. The course was based on technology integration topics and issues in K-12 schools. Most of the enrollees had limited prior knowledge of concept mapping. Students in sections 2-3 were asked on a course pre-survey if they had ever created an electronic concept map before, and 76.9% indicated "no" they had not (n=26). In EAC 595A, study participants were 26 graduate students in two sections of the course taught one year apart, with most of the students being community college instructors working towards a certificate in community college instruction. The course covered topics on evaluation and classroom assessment.

Project Objectives:

- to investigate the alternative assessment capabilities of the concept mapping method
- to investigate the relative benefits of differential applications of concept mapping (open-ended, seeded, etc.)
- to investigate the value of features embedded in the Cmap concept mapping tool

Student Learning Outcomes:

- the student will engage in specific thinking skills during the act of creating a concept map: classifying, organizing, and relating
- the student will read assigned articles more intently to comprehend specific relationships among important course concepts (either provided concepts or to-be-discovered concepts based on method)

METHOD

Materials ECI 511. Cmap Tools freeware enabled students to develop online concept maps and attach external resources to their maps (IHMC, 2007). Each student downloaded and installed the program on their computer. Cmap is practical for distance courses, since it allows instructors to store student folders and map templates on servers for remote access. IHMC's public Cmap servers were utilized for beta testing with section 1, and the researcher installed a Cmap server on campus for use with sections 2-3.

Students used Cmap to represent concepts from course resources and readings. In section 1, students were required to integrate external resources with their maps, but they were not told which resources to integrate (e.g., course readings, Web links). In sections 2-3, students were also required to integrate external resources with their maps, but the resources were limited to electronic copies of assigned readings placed in each student's map folder.

Also placed in each student's map folder were one or more map templates. For section 1, blank map files were added to the students' folders to which the students added concepts and began their open-ended mapping. For sections 2-3, pre-selected term maps based on instructor maps were added to student folders. To create each instructor map, key terms were selected from assigned reading material and organized around a set of superordinate headers (e.g., see Figure 1). To create the matching pre-selected term map for students, the links and structure were simply removed from the instructor map (see Figure 2).

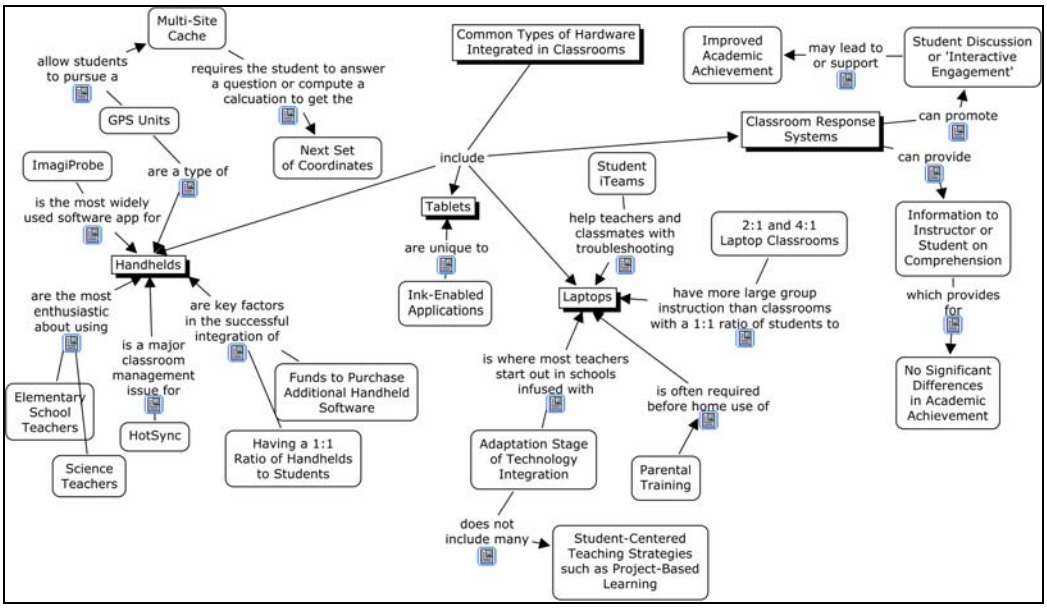

Figure 1. Instructor map illustrating concept classifications, sets, and propositions.

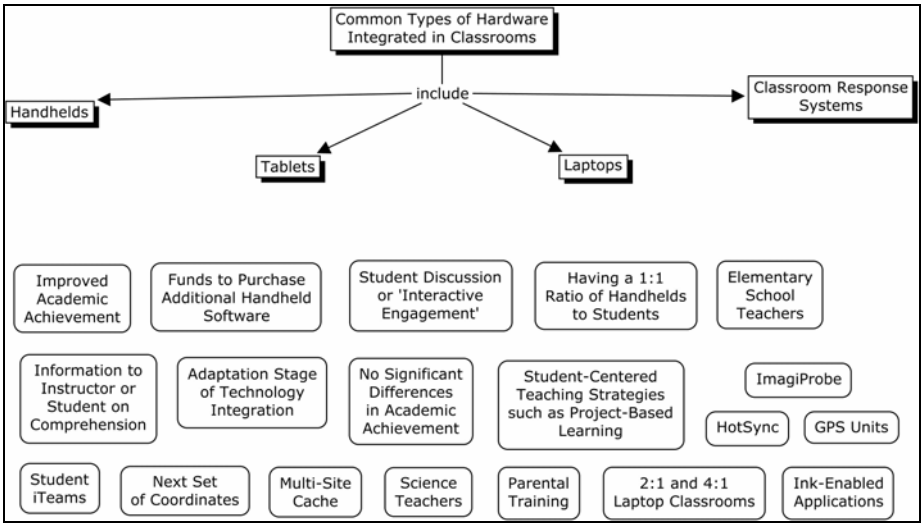

Figure 2. Student pre-selected term map created from instructor map.

Materials EAC 595A

In the first section of this course, the Cmap software was also used. Students were provided with written instructions for how to save their work in a folder on the IHMC's public server. In the second section, the university server was also used, and the instructor created individual student folders. Inside these pre-selected term and seeded term map templates were placed for the students to elaborate on. Feedback was provided using the annotation feature in CMap. After completion of the activity, the instructor also posted completed maps for students to use to compare their maps to. This is only possible to do with pre-selected term and seeded term maps, but not for open-ended maps because of the diversity of the terms used by different students.

Procedures ECI 511. Students completed between two and three concept maps related to course resources and assigned readings. In section 1, open-ended maps were employed with no terms provided to students in advance. Students were responsible for extracting relevant concepts from the course resources and readings, organizing and relating them, and integrating external resources to illustrate where they found depicted relationships.

In sections 2-3, students were provided with approximately 20 pre-selected terms in advance of their reading, and they were responsible for organizing and relating those terms on their maps. Three or four superordinate concepts were listed at the top of each map under which students classified their terms. Table 1 summarizes assigned map activities by section.

Section	Enrolled	Maps Completed and Content Coverage	Task Structure
Section 1, Fall 05	11 students	2 individual maps: • the internet (2 weeks, 8 articles) • influencing factors on tech integration (1 week, 4 articles)	open-ended, no terms provided
Sections 2-3, Summer 06, Fall 06	15 students each	3 individual maps: • hardware (3 weeks, 7 articles) • software (4 weeks, 14 articles) • the internet (3 weeks, 14 articles)	pre-selected terms provided

Table 1. Summary of courses, students, and mapping activities.

Procedures EAC 595A

In the first section of EAC 595A, students (n=13) were required to make weekly posts in a wiki of core course terms, with associated definitions. At mid-term they were asked to use 30 – 40 of those terms in order to construct a map of the content covered to that point. Feedback was give to them on their maps, which they revised to include at least 50 concepts for submission at the end of the semester.

In the second section, students (n=13) were given a pre-selected term map place in their personal folders to complete at the end of week one. The intention was to familiarize the students with the technology and the process of concept mapping early in the course. At mid-term they completed a seeded concept map covering the work from weeks 2 – 8, in which the instructor provided 15 of the terms, and students had to add an additional 15, with associated propositions. At the end of the semester, students produced an open-ended map covering weeks 10 – 15.

Analysis ECI 511. A case study design was employed with section 1 and sections 2-3 representing two separate units of analysis. Across sections, three student data sources were collected: a log of student questions posed to the instructor regarding assigned mapping tasks, student responses to an online survey, and concept map artifacts.

The conceptual analysis method of content analysis was applied to questions received by the students as well as open-ended survey comments, identifying frequently used keywords and sorting text by themes. Numerical student survey responses were summarized with descriptive statistics, and one-way analyses of variance (ANOVA) were employed to determine any differences in response between cases.

Methods for scoring concept maps varied by section. For section 1, the number of concepts, correct propositions, and integrated resources were tallied. Further, content analysis was applied to individual maps to identify the superordinate or higher-level categories students placed in their maps (i.e., major themes). Categories are often exemplified with several specific underlying concepts, and thus easy to identify on a map. As noted by others (Shaka & Bitner, 1996), great variation was apparent across students' maps in terms of propositions and other details.

In an effort to create a scoring scenario that was less subjective, pre-selected term maps were employed for sections 2-3. A combination scoring method was employed, assigning one point for each concept, concept set, and proposition on the students' maps that were similar to items on a comparison instructor's map (Ruiz-Primo & Shavelson, 1996).

An excerpt from one instructor map is shown in Figure 3 from which students could receive five points for correctly classifying shown terms in any way under the header, and another two points for grouping terms in sets--WebQuests, digital archives, and bookmark managers with volume of Web information, and digital archives with student-centered inquiry projects and digital storytelling activities. Where three or more concepts were co-located in a set, the student had to place all concepts together to receive one point. A half-point was assigned if only some of the concepts were placed together.

On the student map shown in Figure 3, the student received five points for classifying all of the expected terms under the header (one extra term, design projects, was incorrectly classified), and one point for identifying the concept set associated with digital archives. The student also received six points for correct propositions. Even though the concept "design projects" was incorrectly classified by comparison to the instructor's map, the student's proposition relating this concept to "WebQuests" was accurate.

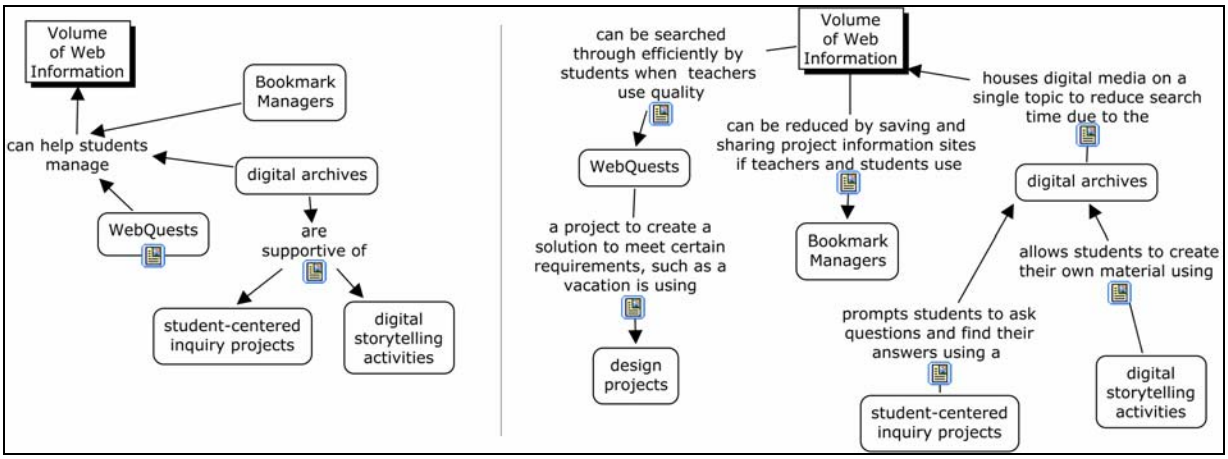

Figure 3. Comparison of excerpts from instructor map (left) and student map (right).

Analysis EAC 595A

An analytical rubric was used to score the rubrics, adapted for each assignment. Constructs for assessment in the rubric included number and correctness of concepts selected from the readings,

organization, quality of connections/linkages, appropriateness of propositions, and directionality of arrows.

RESULTS

Results ECI 511

Open-Ended Mapping. In section 1, students placed an average of 34.7 and 37.3 concepts in their two open-ended concept maps with a highly divergent standard deviation of 21.8 and 23.4 respectively (see Table 2). The number of correctly written propositions and unique resources integrated in student maps also had a high overall variance.

	# of maps scored	# of concepts identified		# of resources attached		# of proposition statements	
		Mean	SD	Mean	SD	Mean	SD
internet (2 weeks)	11	34.7	21.8	20.5	11.6	28.4	13.4
factors (1 week)	10	37.3	23.4	16.6	11.3	34.1	18.8

Table 2. Section 1 concept map results.

Using content analysis, the major categories represented on students' open-ended maps were noted (i.e., the higher-level terms on which they placed the most importance). Table 3 presents the superordinate categories cited most frequently on open-ended student maps, and some of the underlying concepts suggested by students.

Map	Major Categories on Student Maps	# of Maps Citing	Underlying Concepts Shared by Students
internet	communication tools	11	blogs, bulletin boards, listservs, email, podcasts, chat, messaging, conferencing
	copyright	8	acceptable use policies, internet resources, fair use, public domain
	collaboration tools	7	wikis, blogs, class Web pages, global learning projects--thinkquest
	networks	7	LAN, WAN, servers, wireless, modems, DSL, cable, shared tools
	internet resources for teachers	7	digital archives, webquests, government sites, online publications, professional organizations, lesson plan sharing
factors	funding	9	budget, business and industry, government, NSF, grants, seed money, collection development plans, leasing, fundraising, competing needs, restrictive conditions
	professional development	8	on learning theories, on research-based best practice models that are replicable, on teaching/mentoring/coaching skills, for teachers and administrators, collaborative teams, e-learning, in-service
	planning	6	school technology/improvement plans, district/state/national technology plans, shared decision making, goals, strategies, evaluation, SWOT analysis, STAR Charts, collaborative planning
	standards	5	ISTE, 21st Century Skills, No Child Left Behind Act, state technology model, national technology plan
	administrative or leadership support	5	hiring risk takers, flexibility with time, provides resources and professional development, mentors, models, advocates, change agents

Table 3. Categories and underlying concepts cited most frequently on internet (n=11) and influencing factors maps (n=10).

The categories on open-ended student maps clearly represented topics introduced in course units, thus each student was successful at representing at least some of the major unit topics on their maps. However, since most student maps contained only three or four categories among seven or eight possible, the data further illustrate considerable divergence in the focus of student maps. Students emphasized different topics on their maps they found most important or relevant.

For assessment, it was helpful to analyze student maps as shown in Tables 2-3 before assigning points, to develop a standard indicator of performance. The decision to deduct points was admittedly subjective, based on a holistic consideration of concepts, unit themes represented, propositions, and resources.

One procedural advantage noted for open-ended mapping was the ability for students to customize their maps to address personal interests. For the internet map in particular, a few cases were noted where a student who taught a subject such as writing would integrate writing-related concepts and external resources. Personalization of map spaces was discouraged with pre-selected term maps, which a few students in sections 2-3 noted in their post-survey comments:

> The only problem I had was that there is little room for difference of opinion with you. I gathered different ideas and perspectives from some of the articles and thus my concept map varied from yours.
>
> I would like to be able to add other connections that were discussed in the readings.

Pre-Selected Term Mapping. Pre-selected term mapping objectively depicted student understanding of specific topics. As shown in Table 4, students correctly classified more than 80% of pre-selected terms under the superordinate headers provided for each of the three assigned maps. Students also generated between 9 and 14 correct propositions for each map. No correct number of propositions was assumed, but Table 4 indicates the number of propositions on each instructor map for general comparison.

Map	# of Maps Scored	# of Super. Concepts	Concepts Classified		Sets Identified		Propositions	
			Mean	SD	Mean	SD	Mean	SD
Hardware	30	4	16.6/19 (84.7%)	3.1	2.4/6 (39.4%)	1.8	13.6/17 (80%)	5.6
Software	28	4	16.3/20 (81.4%)	2.6	4.6/9 (51.2%)	2.0	12.7/17 (74.8%)	3.7
Internet	28	3	13.8/16 (85.9%)	1.8	5.2/9 (57.9%)	1.3	9.7/12 (80.7%)	4.2

Table 4. Concept map scores for sections 2-3 completing pre-selected term maps.

Students experienced the most difficulty identifying specific concept sets. Compared to the instructor's map, students only identified 39.4% of the expected concept sets on their first map, and improved slightly to 51.2% and 57.9% for their second and third maps respectively. The difficulty students had identifying the same concept sets as the instructor might be attributed to the depth of each topic, with between 7 and 14 articles assigned for each of three maps. Four students in sections 2-3 commented on their post-survey that maps were based on too much content:

> Too many articles to try to find the connections. Smaller Cmaps would have been more useful for me.
>
> There may have been too many articles to relate.

With so many articles, students would sometimes find alternative groupings for concepts that were different from the instructor's map but still valid. Five students in sections 2-3 commented on their post-survey that alternate conceptions were possible:

> Sometimes an idea was vague to me to tie it to a particular reading, or I felt it could be tied more than one way.
>
> I think that sometimes people could make different connections.

Providing pre-selected terms to locate and organize across a selection of readings did encourage better reading among students in sections 2-3. When asked what was most beneficial about Cmap on their post-survey, seven students indicated Cmap helped them to read more thoroughly and to go back and re-read:

> It also forced me to go back and carefully examine all the readings - even though I had read them previously, I always found something I had sort of skimmed over or didn't remember.
>
> It also gave me a reason to go back to the readings and really internalize the information.
>
> Required me to REALLY read over the material. A person might fake their way through some of the discussion, but the Cmap was proof positive that I had thoroughly read the material.
>
> It made me think about the readings on a deeper level.
>
> By having to dissect the readings in order to do the CMaps, I really digested the information.

The results presented in Table 4 illustrate that students were able to structure and relate specific concepts from their readings in a manner moderately similar to the instructor's map. The class averages were useful to assign points, with students falling below the averages receiving fewer points. The standard deviations for concepts classified, sets identified, and propositions were lower overall than the standard deviations for similar points of analysis in open-ended maps, reducing subjectivity in scoring. The most variable skill for pre-selected term maps was proposition writing.

Results EAC 595A

In the first section, students were given the opportunity to submit their open-ended map at mid-semester, but only received a grade for their end-of-semester map (a possible 30 out of 1000 semester points). Using the rubric, the mean grade was 27.7 out of 30 points or 92.3%, which excludes zero grades given to two students who did not turn in the assignment at all. Three students did not turn in their optional concept map at mid-semester, and their end of semester grades were on the lower end of the scale (26.33 or 87.78%).

Because of the small proportion of the final grade allocated for concept mapping, some students downplayed the activity. For this reason, the number of points allocated to the concept mapping task was increased to a total of 130 points (30 points for the first map, 50 points for the second and third maps) the next time the course was offered. Students completed a pre-selected term map in the first week, which was intended to help them learn how to use the software, as well as how to construct a concept map, with an average grade of 85.7% being scored. At mid-term they completed a seeded term map on the content of the first part of the semester, with an average grade of 89.4% being scored. At the end of the semester they completed an open-ended map covering the end of semester

sections, scoring an average grade of 98.2%. There was clearly a dramatic improvement **over the semester in student's abilities to identify and correctly relate relevant concepts together, using appropriate propositions, and thereby constructing better concept maps.**

Faculty Teaching. The effects of this project on faculty teaching are many. The project has enabled the researchers to develop a framework of teaching with concept maps over several semesters of work (see Figure 4). The framework illustrates the tradeoff between structured and unstructured mapping tasks, with the latter providing better opportunities for student thinking with an expected increase in cognitive load. The investigators have furthered discovered that classroom activities can involve not only students creating maps and practicing basic thinking skills such as classification, but also students using the maps they create in support of higher-level thinking processes such as decision making, problem solving, and evaluation. This has had a direct effect on our teaching, with concept map tasks integrated in our courses now including a second phase of "use" toward a higher-level task such as decision making. No longer do students create maps and stop; rather, they create maps and make some use of their representations.

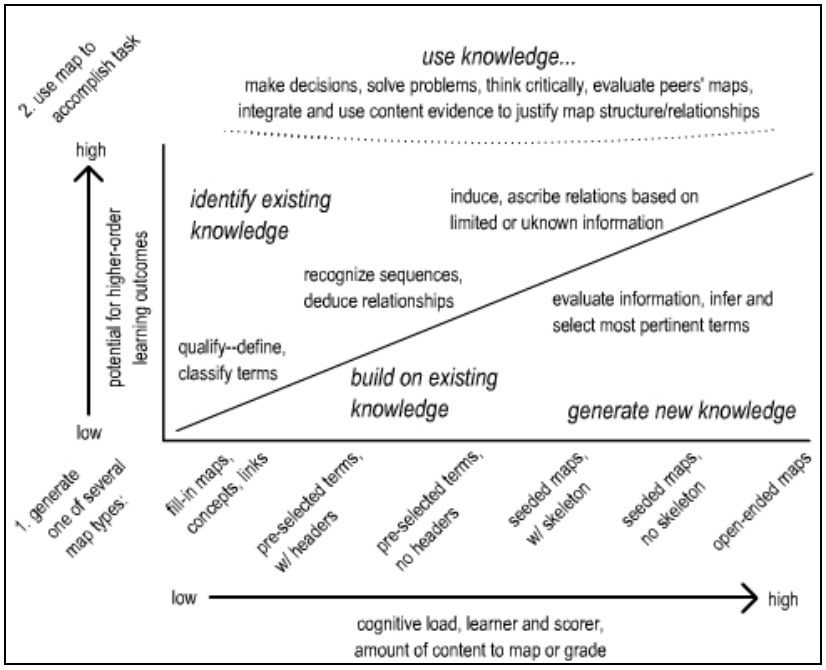

Figure 4: Tradeoffs between structured and unstructured mapping tasks.

In terms of faculty workload, it can take considerable time to grade pre-selected term maps. The task is less subjective as explained in this text, but the process is rather arduous. With open-ended mapping and content analysis, the process is more subjective, but rather holistic and easier to complete in a reasonable amount of time. For these reasons, our recommendation is to employ open-ended maps that seem to engender more student thinking while lessening the scoring task for faculty.

The Cmap technology used in this project was very useful to support students interacting on maps from a distance. Technical support was necessary from the Friday Institute for installing the Cmap Server software on a blade server, allowing students to access their personal folders and map files from a distance. Training was not required to use this tool as faculty, and most students agreed the software was easy to pick up and learn.

DISCUSSION

Reaction to Cmaps – ECI 511

Overall, student reactions to Cmap were very positive. Students were asked on their post-survey if they agreed or disagreed Cmap was a useful course assignment. Using a 5-point Likert scale, 86.2% of students from section 1 and 87.2% of students from sections 2-3 agreed or strongly agreed that Cmap was useful.

Among three students who verbalized a dislike for Cmap in written survey comments, they still believed the tool was educational:

> Personally I hate doing them, but they are effective tools for learning. Therefore, the least beneficial aspect is my personal dislike; however there is no educational downside.

> Not so much useful, but it was a new experience. It challenged beyond memorization.

Many students in sections 2-3 indicated that just learning to use Cmap itself was beneficial. A few students indicated they had adopted or would adopt concept mapping as a strategy with their own students:

> The Cmap activity was immensely useful because it armed us with at least one strategy that we could immediately use in our classrooms.

> Since I had never done one, it was beneficial to experience it as a possible tool to use in my own classroom.

> I loved them! We will be doing these in my class in 2006-07!

> During this course, I have incorporated concept mapping into my classes. My students now use Inspiration.

Reaction to Cmaps – EAC 595A

IN EAC 595A, students were not specifically asked to rate their perception of the Cmap assignment. However, from the qualitative responses, there was general agreement that doing concept maps was a valuable activity. The reaction can also be gauged from the number of students who reported negative attitudes to concept mapping. Two (15.4%) of the students in the first section specifically stated that there was no value to them when asked to state what was most valuable about using concept maps. Similarly, in the second section two students were consistently negative (15.4%) in rating the different survey items. The low rate of negative responses can be taken as indicating an overall positive attitude. However, while concept mapping may be perceive positively by most students, there are those for whom it is not a good learning experience.

In terms of difficulties encountered when asked what was least valuable about concept mapping, students cited that it was time consuming, that the software had been difficult to learn, and others cited the subjective nature of the activity, and subsequent grading, as a detractor to their usage.

> I think people think about items in different ways and often I think the cMap isn't really wrong since it is how the person views the info.
>
> It was subjective. Not everyone thinks alike and sees relationships the same way.

In the second class section, one particular feature of the Cmap tool stood out as being particularly useful to students. The instructor provided feedback on all concept maps in the annotations feature in Cmap and 92.3% of students rated this as a valuable this process. This feature had also been used in teaching the first section, but was not included as an item on the questionnaire.

Thinking with Cmaps - ECI 511. When asked what was most beneficial about Cmap on their post-survey, 41% of students in sections 2-3 provided written comments to suggest the tool helped them make connections, tie information together, link information, or group information. This ability to explicate relationships was the thinking skill students attributed to Cmap most frequently:

> Making connections among concepts was most beneficial.
>
> It forced me to understand and make connections between essential course concepts.
>
> Cmapping helps to tie information together.
>
> It allowed me to connect all the articles and ideas together for each session.

As shown in Table 5, 100% of students in section 1 and more than 75% of students across sections 2-3 agreed or strongly agreed on a 5-point Likert scale that Cmap helped them to make connections within specific course sessions and between major course sessions. A slightly

smaller percentage of students in sections 2-3 agreed that Cmap helped them to make connections between sessions of the course. The opposite effect was predicted, since students in sections 2-3 prepared maps from 3-4 weeks of course material compared to students in section 1 who prepared maps from only 1-2 weeks of course material. It may be that the restrictive nature of pre-selected term mapping, however, left students in sections 2-3 with the impression of connecting fewer concepts overall. In fact, they did relate fewer concepts overall (see mean number of written propositions from Tables 2 and 4). One student commented on the post-survey that pre-selected term maps may lead students to read for specific information and miss other general ideas in the process:

> I think since we were given topics ahead of time, it affected how I read the articles. I was reading for specific information, which can be timely and helpful, but I missed some important facts, I discovered upon re-reading.

The Cmap activity helped me to make connections...	Section 1 n=11	Sections 2-3 n=30	All Sections n=41
within a specific section of the course.	100%	82.8%	86.1%
between sections of the course.	100%	75.9%	80.5%

Table 5. Percentage of students who agree or strongly agree with different values of concept mapping activities (ECI 511).

Based on written comments from the post-survey, however, many students in sections 2-3 disagreed with the minority opinion that pre-selected term maps may prevent the development of big picture comprehension. When asked what was most beneficial about Cmap, other students suggested:

> Seeing the terms that the instructor considered important for each session [was beneficial].
>
> It allowed me to see the "big picture" and make connections with all the concepts.
>
> It helped me to sum up what was learned from the articles.
>
> Creating the Cmap clarified or helped to clarify what I had read and learned.

Finally, several students noted in written survey comments that Cmap helped them represent information visually. The ability to visually organize information was a valued learning mode:

> The visual representation of conceptual meaning--Cmap allows you to organize information in ways that I could understand.
>
> The major benefit of Cmap was the visual representation of our understanding of the readings.
>
> It helped me visualize the connections between subjects and the specifics.

Thinking with Cmaps – EAC 595A.

When asked what was most beneficial about Cmap on their post-survey, 84.6% students in section 1 and 61.5% in section 2 stated that the task had helped them to pull and relate concepts together, with comments like the following being made.

- It was a good learning activity which made me really think about how all of the concepts and ideas tied together.
- Seeing the topics and subtopics connected together gave me a better understanding of the learned information. The meaning was more concrete.
- The activity provided a good visual to show the connections and relatedness and not so relatedness of concepts. It was interesting to see a picture of the evaluation pieces come together as one.
- This was an excellent assignment. It helped me to connect all the dots, so to speak
- It helped me to focus course concepts into a single picture.

Students in the second section also cited the visual nature of concept maps and creativity as being valuable.

Table 6 shows results for both sections

The Cmap activity helped me to make connections...	Section 1 N=13	Sections 2 n=13	All Sections n=26
within a specific section of the course.	76.9%	84.6	80.7
between sections of the course.	84.6%	76.9	80.0

Table 6. Percentage of students who agree or strongly agree with different values of concept mapping activities (EAC 595).

In section 2, 84.6% of student stated that the seeded term activity in lesson 1 helped me them learn to use the cMap software, while 76.9% felt that it had helped them to learn to construct a concept map, and an equal number that the task had helped them learn the difference between qualitative and quantitative research methods (which was the topic for map construction). By the end of the semester, 92.3% of students agreed or strongly agreed that they were able to construct a concept map (with or without using Cmap).

Effects of Content Depth (ECI 511). On a 5-point Likert scale, students were asked on their post-survey if they agreed or disagreed that different concept map strategies varying by depth of coverage could be useful. Strategy one referred to developing focused Cmaps covering only 1-2 sessions of a course. Although this was deemed the most useful strategy by students in both section 1 and sections 2-3 (see Table 7), a one-way ANOVA suggests students in section 1 who had experienced focused mapping found it to be significantly more useful than students in sections 2-3, $F(1, 37) = 5.3$, $p<.03$.

A moderate number of students at 57.2% for section 1 and 69% for sections 2-3 agreed or strongly agreed that strategy three could be useful--building a Cmap week by week over an entire semester. Strategy three was not applied with any section. Interestingly, fewer students across sections reported that strategy two could be useful--mapping between 3-11 sessions of content. The idea of a semester-long, iterative map (strategy three) was deemed more useful than a map covering only two-thirds of the semester (strategy two), perhaps because a dynamic, ever-developing map was enticing, or because students in sections 2-3 had struggled with mapping multiple sessions of content akin to strategy two. Students were also asked if developing a non-iterative, semester-long Cmap at the end of the semester could be useful, and most disagreed (strategy four).

Please rate whether you agree/disagree the following cMap strategies were or could be useful:	Section 1 n=11	Sections 2-3 n=30	Sections 1-3 n=41
strategy one: developing a focused cMap that covers only 1-2 sessions of content	100%	79.3%	84.6%
strategy two: developing a general cMap that covers several sessions of content (e.g., sessions 3-11)	40%	24.1%	28.2%
strategy three: building a Cmap week by week over the whole semester	57.2%	69%	66.7%
strategy four: developing a Cmap for the whole semester, but only at the end of semester	0%	13.8%	11.2%

Table 7. Percentage of students agreeing or strongly agreeing that different map strategies can be useful (ECI 511).

Effects of Content Depth – EAC 595

For EAC 595A, students also had preference for preparing a concept map week by week over the semester.

Please rate whether you agree/disagree the following cMap strategies were or could be useful:	Section 1 n=13	Sections 2-3 n=13	Combined n=41
strategy one: developing a focused cMap that covers only 1-2 sessions of content	53.8%	46.2%	50.0%
strategy two: developing a general cMap that covers several sessions of content (e.g., sessions 3-11)	61.5%	30.8%	46.2%
strategy three: building a Cmap week by week over the whole semester	61.5%	61.5%	61.5%
strategy four: developing a Cmap for the whole semester, but only at the end of semester	15.4%	25.0%	20.0%

Table 8. Percentage of students agreeing or strongly agreeing that different map strategies can be useful (EAC 595A).

Proclivity for Independent Work – ECI 511. Students in all three sections of ECI 511 worked independently on their maps. In the first section, students were told they could collaborate, but only two students chose to work together on their second map. On their post-survey, students were asked on a 5-point Likert scale if they agreed of disagreed that working alone or working collaboratively could be useful strategies for developing concept maps. As shown in Table 7, only 37-40% of students agreed or strongly agreed that co-developing Cmaps with other classmates could be useful. The idea of working collaboratively was not well received by the

distance students in this course, perhaps because most worked full-time and would have difficulty scheduling group mapping sessions. Regardless, the benefits of collaborative mapping are well documented and should not be ruled out based on student preferences alone (Danish & Enyedy, 2007; DeSimone et al., 2001).

A one-way ANOVA revealed section 1 had a significantly higher percentage of students who agreed that developing a Cmap alone could be useful, $F(1, 36)$, $F = 8.96$, $p = .005$. This finding is somewhat unexpected, since one might expect students tasked with open-ended, unstructured mapping to require more support from peers. The application of pre-selected term maps in this class, however, required students to search through numerous articles to find assigned terms. Perhaps the challenge added by this need to search for and contextualize specific concepts may have led students in sections 2-3 to rate the usefulness of independent mapping lower than students in section 1 who struggled less integrating any concept or resource they found important.

Please rate whether you agree/disagree the following cMap strategies were or could be useful:	Section 1 n=11	Sections 2-3 n=30	Sections 1-3 n=41
developing a Cmap by myself	100%	39.3%	55.2%
co-developing a Cmap with another classmate	40%	37.9%	38.4%

Table 9. Percentage of students who agree or strongly agree with the usefulness of individual and collaborative concept mapping (ECI 511).

Proclivity for Independent Work – ECI 511.

Overall, students in EAC 595A had equal preference for developing concept maps individually or collaboratively.

Please rate whether you agree/disagree the following cMap strategies were or could be useful:	Section 1 n=13	Sections 2 n=13	Combined
developing a Cmap by myself	53.8%	53.8	53.8
co-developing a Cmap with another classmate	61.5%	46.1	53.8

Table 9. Percentage of students who agree or strongly agree with the usefulness of individual and collaborative concept mapping (EAC 595A).

CONCLUSIONS

In this study, different methods of Web-based concept mapping were investigated as a form of alternative assessment for distance education. Each method was found to have both advantages and disadvantages.

For open-ended mapping, students are led to integrate more overall concepts and engage in more relational thinking about those concepts. Open-ended maps are also more flexible in allowing students to customize and integrate their own topics of interest and external resources. It follows that great variance is evident in the number of concepts and propositions integrated in open-

ended maps, and this may present a problem for graders with more divergent information to score.

With pre-selected term maps, students are limited to a specific set of concepts and thus engage in directed and more limited relational thinking. Customization of the map is discouraged, which lends itself to lower overall variance in the number of concepts, sets, and propositions. The implications of pre-selected term maps on assessment are less data to score in addition to a criterion map that provides a standard for objectively seeking a one-to-one match in specific classifications, sets, and relations on student maps.

A recommendation is not appropriate for one concept mapping task structure over another. Teachers interested in fostering relational thinking about a course topic may opt for open-ended mapping, particularly if the maps are assigned as a project or activity and not a scored assessment. Open-ended mapping can be used for assessment, but teachers should realize the subjective nature of the scoring task and be comfortable with general content analysis. Teachers concerned with designing an objective assessment may find that pre-selected term mapping carries more precision. In theory, pre-selected term maps carry less cognitive load, but as evidenced by this study, increased content depth may increase the mental challenge significantly.

Regardless of method, student reactions to Cmap as an alternative assessment were positive. When asked to choose between a traditional exam and a Cmap assessment on their post-survey, more than 90% of students in each section chose Cmap (see Table 8). When given more choices, including applied projects and a combination of assessment methods, a majority of students in each section still chose Cmap as the preferred mode.

		Section 1 n=11	Sections 2-3 n=30	All Sections n=41
If you could choose between a Cmap assessment or a regular exam, which would you select?	Cmap	90%	93.1%	92.3%
	Regular Exam	10%	6.9%	7.7%
If you could choose between Cmaps, regular exams, or applied projects, which form of assessment would you select?	Cmap	40%	48.3%	46.2%
	Regular Exam	0%	3.4%	2.6%
	Applied Projects	30%	13.8%	17.9%
	Combination	30%	34.5%	33.3%

Table 8. Percentage of students preferring different methods of assessment in distance teacher education courses.

EXTENSIONS

This LITRE grant has been the impetus for multiple conference presentations, proceedings publications, and journal-based publications as summarized below:

Presentations and Proceedings Publications

Oliver, K. (2007, April). Web-based concept maps for alternative assessment in distance teacher education. Paper presented at the Annual Meeting of the American Educational Research Association (AERA), Chicago, IL. (Proceedings).

Oliver, K. & Raubenheimer, D. (2006, September). Lessons learned from unstructured concept mapping tasks. Proceedings of the 2nd Annual International Conference on Concept Mapping. San Jose, Costa Rica. (Proceedings)

Oliver, K., & Raubenheimer, D. (2006, July). Visualizing student knowledge: Teaching and assessing with online concept maps. Presentation at the National Education Computing Conference (NECC), San Diego, CA. (Powerpoint)

Oliver, K., & Raubenheimer, D. (2006, March). Online concept mapping in distance teacher education: Two case studies. Paper presented at the Annual Conference of the Society for Information Technology and Teacher Education (SITE), Orlando, FL. (Proceedings)

Oliver, K., & Raubenheimer, D. (2006, March). *Alternative assessment with electronic concept mapping software*. Faculty workshop sponsored by the University's Learning Technology Service, NC State University, Raleigh, NC.

Oliver, K., & Raubenheimer, D. (2005, October). *Alternative assessment with electronic concept mapping software*. Faculty workshop sponsored by the University's Learning Technology Service, NC State University, Raleigh, NC.

Raubenheimer, D., & Oliver, K. (2006, April). *Using concept mapping in online courses to track student's conceptual development over a semester.* NC State 4th Annual Undergraduate Assessment Symposium, Raleigh, NC.

Raubenheimer, D., & Oliver, K. (2006, March). *Alternative assessment with electronic concept mapping software.* Workshop presented at the 2006 University of North Carolina Teaching and Learning with Technology Collaborative (UNC-TLT) Conference, Raleigh, NC.

Raubenheimer, D., & Oliver, K. (2006, March). *Collaborative research on online concept mapping.* Presentation at the 2006 University of North Carolina Teaching and Learning with Technology Collaborative (UNC-TLT) Conference, Raleigh, NC.

Journal Publications

Oliver, K. (under review). A comparison of Web-based concept mapping tasks for alternative assessment in distance teacher education. *Journal of Computing in Teacher Education.*

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