Online Concept Mapping in Distance Teacher Education: Two Case Studies

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Abstract: Two faculty members incorporated online concept mapping assessments in their fall 2005 teacher education courses, varying in terms of content depth and participation. Students expressed great interest in mapping as an alternative form of assessment for distance courses, and performed adequately on assigned tasks. Attempts to involve students in collaborative pre-mapping and mapping were not entirely successful, as most students expressed more interest in developing individual maps, at least for purposes of assessment. For assessment purposes, recommendations include focusing student maps on concise content segments and using seeded terms to reduce the overall subjectivity of map assessments.

Introduction

During the fall semester 2005, two university faculty members implemented online concept mapping assessments in their graduate teacher education classes. Both classes were taught at a distance using the university's WebCT Vista course management system. The difficulty in delivering and securing traditional tests at a distance without the need for expensive proctors is well known. Online concept mapping provided the investigators with an alternative assessment to gauge the understanding of their distant students. Concept mapping serves multiple purposes in providing instructors with an assessment tool to determine what students know about a subject and how that knowledge is structured, and in providing students with an active learning tool to build and revise their own model of understanding. Mapping involves merging one's existing knowledge about a subject with new information. In the information age, more than ever students need to make use of tools that allow them to integrate extensive online resources with their own personal knowledge maps, as they seek to understand and solve real problems. It is particularly important for teacher educators to model such knowledge integration strategies in their courses, helping future teachers understand and gain experience with these powerful processes.

A concept mapping task begins with the instructor selecting a limited domain of knowledge to be mapped by the student (Novak, 1998). This knowledge domain should be tied to course material such as required readings, a lab experiment, or an applied problem. The student lists key concepts in the domain and arranges them from inclusive to general and by type. The student completes a concept map by drawing lines between concepts to illustrate relationships and by writing proposition statements on these connecting lines to describe the nature of the relationship. For maps that depict multiple knowledge domains, students may also draw cross-links to show how concepts that are not directly connected relate to one another on some level.

Course management systems supported at our university do not include concept mapping capabilities, thus we selected a third-party tool to meet our needs--Cmap (IHMC, 2005). The free Cmap tool is perhaps the most powerful concept mapping application available today, because it allows students across grade levels to develop either individual desktop or collaborative online concept maps, and it allows students to attach a multitude of resources to developed concepts (e.g., Web links, image files, word processed notes, video clips, etc.) (IHMC, 2005). To help with locating relevant resources, Cmap includes a built-in search feature that searches the Web and other maps on the Cmap network for resources related to the selected concept. Cmap is an excellent example of emerging mapping tools that support a wider range of knowledge structuring and organization, enhancing the static *concept* map to a more descriptive *content* map with attached resources. Cmap is also a powerful collaboration tool that allows groups in different locations to co-edit maps through its networked interface, either synchronously with the support of a built-in chat tool, or asynchronously with the support of a built-in discussion board tool (Canas, Hill, Carff, Suri, Lott, Gomez, Eskridge, Arroyo, & Carvajal, 2004). Discussion boards can be related generally to an entire map, or they can be attached to specific concepts in the map. Small groups working on similar maps about

a specific class topic can also aggregate proposition statements across their maps into "knowledge soups" to help determine common and divergent conceptual structures. The annotation mark-up feature is also useful for collaborating and critiquing others' maps. Once a map is fully developed, users can easily export their map and all attached resources to a Web page format, to publish and share the results on the Web.

Through our case studies, we sought to answer the following questions regarding online concept mapping as an assessment tool for distance teacher education courses:

1. What are student preferences for assessment in online teacher education courses, and how is concept mapping received as an element of distance education assessment?
2. What are student preferences for participation in mapping activities, and is student mapping performance enhanced by a certain type of participation?
3. How well do students mimic the instructor's expert map on concept mapping tasks, and how does the relative amount of content to map influence student mapping performance?

Procedures

Two small graduate classes participated in the study during fall 2005: Computer Applications and Curriculum Integration (ECI 511), and Classroom Assessment and Evaluation (EAC 595). Both classes were taught completely online with 10 and 13 students completing each course and all embedded mapping assignments respectively. We utilized the public Cmap servers provided through IHMC to establish student mapping spaces online. These electronic folders were password-protected with access granted only to the instructor and individual students. In ECI 511, students completed three mapping tasks as individuals during the semester: an eight-week map covering several divergent topics related to technology integration (e.g., different types of hardware and software, technology integration standards, theoretical foundations of technology integration, etc.); a more focused two-week map covering uses of the internet in the classroom; and a one-week map covering influencing factors on technology integration as defined by specified technology planning models. In EAC 595, students completed two mapping tasks as individuals during the semester, covering concepts associated with assessment and evaluation. The first map was done at midterm and covered nine weeks of course content. Students received detailed individual feedback on their first maps and these in turn were used as the basis for a second map submitted at the end of the semester covering all course work. Both instructors incorporated asynchronous communication tools to assist students in collaborative pre-mapping by identifying relevant concepts together before they created maps individually (e.g., use of a discussion board or wiki to post and discuss major concepts found in assigned readings).

Data Sources and Analysis

We collected three student data sources for the described case studies: concept maps, post-survey responses, and a log of student questions posed regarding assigned mapping tasks. As reported by McClure, Sonak, and Suen (1999), several techniques are available to assess concept maps: holistic, or scoring a map for the overall understanding represented; structural, or scoring a map on the basis of higher-level structures, crosslinks between clusters, and propositions; and finally relational, or scoring a map on the basis of propositions only. The relational approach is recommended by some for its ease of use, mechanical simplicity, and increased reliability, allowing scores to be easily defended (McClure et al, 1999). Others suggest, however, there is too much data in concept maps to focus on relationship statements alone (Canas et al., 2004). In our study, we developed expert maps which identified primary course concepts and propositions for each map assigned to students. Our intent was to score student maps on the basis of proposition statements, however this approach changed during the study as discussed below. Student survey responses were summarized using descriptive statistics, and open-ended comments received by the 23 students were limited and concise enough to summarize thematically.

Findings

Students in both classes completed post-surveys with similar questions, including their preference for assessment in distance courses. When asked to choose between a traditional exam and Cmap assessment, a majority of students in both classes chose Cmap as shown in table 1. When given more choices between a traditional exam, Cmap, applied projects, or a combination, a majority of students in both classes still chose Cmap, although applied

projects and a combination of assessment methods were preferred by roughly a quarter of students in both classes.

		EAC 595 n=13	ECI 511 n=10	Both n=23
If you could choose between a Cmap assessment or a regular exam, which would you select?	Cmap	69.2	90.0	78.3
	Regular Exam	30.8	10.0	21.7
If you could choose between Cmaps, regular exams, or applied projects, which form of assessment would you select?	Cmap	38.5	40.0	39.1
	Regular Exam	15.4	0.0	8.7
	Applied Projects	23.1	30.0	26.1
	Combination of Each	23.1	30.0	26.1

Table 1: Student preference for method of assessment in distance teacher education courses.

As further evidence of student satisfaction with Cmap assessments, students in ECI 511 were queried on their post-survey as to the one thing they enjoyed most about the course. Five of ten students provided unsolicited comments suggesting Cmap activities were their favorite course element. When queried as to the one thing they enjoyed least about the course, no students mentioned Cmap. Similarly, three students in EAC 595 sent unsolicited email comments to the instructor about the value of Cmap to pull together various course concepts, although one also noted that it was the hardest thing he had to do all semester. Two students did not turn in their two map assignments during the semester. One of these did complete the Cmap survey and was very negative about concept mapping in their responses. This indicates that concept mapping may not meet the learning style of all students.

On a Likert scale of 1 (strongly agree) to 5 (strongly disagree), students were asked to rate their agreement with the post-survey statements shown in table 2. Mean values are reported for each class, as well as the combined mean across classes. Values between 1-2 represent strong agreement to agreement, between 2-3 agreement to neutrality, between 3-4 neutrality to disagreement, and between 4-5 disagreement to strong disagreement.

		EAC 595 n=13	ECI 511 n=10	Both n=23
Questions related to the value of concept mapping:	The Cmap activity helped me to make connections within a sub-topic of the course (e.g. classroom assessment techniques).	2.2	1.6*	2.0*
	The Cmap activity helped me to make connections between major topics of the course (e.g. assessment and evaluation).	2.2	1.6*	2.0*
	The Cmap activity was worth enough points in the course.	2.5	1.4*	2.2*
	Please rate whether you agree/disagree the following course assignments were useful: Cmap assignments.	not asked	1.4	
Questions related to the application of concept mapping:	Doing the first draft of the Cmap at mid-semester helped me with the final product.	1.5	not asked	
	Do you agree/disagree that developing a general Cmap that covers several weeks' content (e.g. weeks 1-9) could be useful?	2.5	2.7	2.6
	Do you agree/disagree that developing a more focused Cmap that covers only 1-2 weeks' content could be useful?	2.6	1.3	2.0
	Do you agree/disagree that developing a Cmap for the whole semester, but only at the end of semester, could be useful?	3.8	4.1*	3.9*
	Do you agree/disagree that building the Cmap week by week over the semester could be useful?	2.4	2.4*	2.4*
Questions related to student participation:	Do you agree/disagree that developing a Cmap by yourself could be useful?	2.8	1.6	2.3
	Do you agree/disagree that co-developing a Cmap with another classmate could be useful?	2.6	2.6	2.6

**for these questions, n=7 and 20 respectively*

Table 2: Student agreement with the value of, application of, and participation in concept mapping.

Students were asked on their post-survey to describe what was most beneficial about Cmap activities. Nearly every student provided a comment that could be sorted in one of two categories--Cmap helped them synthesize and put together course material (e.g., "helped me to focus course concepts into a single picture," "putting what I had learned into an organized format"), or Cmap helped them make connections between course materials (e.g., "having to think about the terms and make connections," "forcing you to relate the topics"). Two students suggested the activities helped them to "remember" or "retain" course information better.

Students were also asked on their post-survey to describe what was least beneficial about Cmap activities. About one quarter of students surveyed describe technical difficulties learning to use the software (e.g., "...it was difficult to figure out how to use the Cmap software"). At least three students expressed concern over the amount of time it took to create their concept maps, suggesting the hours involved were not worth the number of points awarded for the task (e.g., "...very costly timewise for only 30 points"). Only one student mentioned concern over mapping large chunks of content (i.e., "...having to do it on a huge amount of information").

For ECI 511, the mean number of concepts identified on each of three student maps was computed, as well as the mean number of resources attached and proposition statements written, to provide a general picture of the detail students put into their maps. It was expected that students might identify more concepts, attach more resources, and develop more proposition/relationship statements, for their first map covering eight weeks of content than for subsequent maps covering smaller content segments. T-tests revealed no significant differences, however, in the mean number of concepts identified, resources attached, or proposition statements written, between the divergent map 1 and the more focused maps 2 and 3. Mean values and standard deviations are provided in table 3.

	# of concepts identified		*# of resources attached*		*# of proposition statements*	
	Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*
Map 1 (covering 8 weeks)	38.5	19.6	21.4	15.3	28.8	21.0
Map 2 (covering 2 weeks)	34.7	21.8	20.5	11.6	28.4	13.4
Map 3 (covering 1 week)	37.3	23.4	16.6	11.3	34.1	18.8

Table 3: Level of detail provided in ECI 511 concept maps.

The mean student grades on three mapping tasks in ECI 511 were: 16.6 out of 20 (83%) (map 1 covering 8 weeks), 47.2 out of 50 (94.4%) (map 2 covering 2 weeks), and 48.8 out of 50 (97.6%) (map 3 covering 1 week). Using a holistic grading approach, student scores were the lowest for their first map, and near mastery for their other maps. In EAC 595, students received a grade only for their end-of-semester map (a possible 30 out of 1000 semester points). It proved impossible to compare the maps to an expert map because students chose terms from a wiki of terms developed over the semester, so the selection of terms varied greatly among students. The only proviso from the instructor was that they used at least 50 words from the wiki and that they could add others not listed on the wiki. For grading purposes, a rubric was developed that included as criteria the quantity of words included, the inclusion of main course themes, and the accuracy of propositions. The mean grade was 27.69 or 92.3%, which excludes the zero grades given to two students who did not turn in the assignment at all. Three of the students had not turned in a concept map at mid semester, and their grades were on the lower end of the scale (26.33 or 87.78%).

Discussion

Research Question 1: What are student preferences for assessment in online teacher education courses, and how is concept mapping received as an element of distance education assessment? Concept mapping assessments were well received by a majority of students in both classes, with survey data illustrating a strong student preference for mapping assessments over regular exams. Even when asked to select their preferred method of assessment between maps, exams, and projects, a majority of students chose maps, with about a quarter interested in projects or a combination of methods. In addition, students generally agreed or were neutral regarding the ability of Cmap activities to help them make connections between major topics and sub-topics of the courses. Further, most students provided written comments on their post-survey that would suggest the activities helped them to either piece together and organize course information or to understand how course materials were connected or related.

Research Question 2: What are student preferences for participation in mapping activities, and is student mapping performance enhanced by a certain type of participation? Survey data illustrates that students generally agreed or were neutral regarding two suggested participation strategies: developing Cmaps by themselves versus co-developing Cmaps with another student. A strong preference for one mode over the other was not illustrated by the data, however students in ECI 511 were given the option of co-developing their final Cmap with another student and only two students chose to work collaboratively. In EAC 595, students were not given the option of working collaboratively on concept maps because of problems experienced earlier in the semester on group assignments. Students complained particularly about different work schedules of group members and the times they were available to work on projects. It appeared that most students would rather work as individuals. These divergent modes are likely a matter of preference, but given the isolated nature of distant learners, we recommend providing at least some opportunity for students to work together on maps. Consideration needs to be given to structuring the task to take into account asynchronous student availability. Obvious benefits will ensue as collaborating students discuss and negotiate proper connections between concepts, and collaborating may serve a second purpose in helping students adjust to a new tool and support one another technically on their initial maps.

One participation strategy employed by both instructors was to provide students with collaboration tools (i.e., wikis or discussion boards) to discuss major course concepts, prior to their individual mapping. This strategy was assumed to help students extract and come to consensus on major and minor course concepts to be mapped. Student actions did not illustrate useful collaborations, however. In ECI 511, students were given an optional (non-graded) discussion board to discuss major concepts that should be included in their second map, but only one-third of students took part in the discussion. Nearly every student participated in a separate graded discussion board to discuss concepts that should be included in their third map, but only one original post was recorded per student, and only three students posted replies to other students. To no surprise, the maps created by students following these limited discussions were not significantly better than the first map created by students without any direct discussion.

Research Question 3: How well do students mimic the instructor's expert map on concept mapping tasks, and how does the relative amount of content to map influence student mapping performance? While our intent was to compare the propositions on student maps to those on expert maps, great variation was apparent across student propositions, rendering assessment on the basis of that one map component impossible. Thus, for our purposes student maps were compared to expert maps in a type of holistic assessment, looking for evidence that students correctly identified a majority of the key concepts on the expert map with appropriate proposition statements, and attached at least some of the core readings or personal notes to appropriate concepts. Students received written feedback detailing any point deductions for leaving core concepts off their maps, for failing to attach relevant resources, or for failing to detail concept relationships through proposition statements. Using this holistic approach, students in ECI 511 passed all three of their mapping assessments, with the lowest scores recorded for their first map. This lower score could be anticipated, given many students were learning to map and use Cmap for the first time, and working to integrate some eight weeks of course content--no small task. Similarly, in EAC 595, students who only submitted one final concept map had lower scores than those who had benefited from the mapping process and feedback at midterm. In future offerings of EAC 595, all concept mapping activities will be allocated a grade to encourage students to submit all assignments, and get feedback from the instructor. Early and smaller concept mapping assignments may also help those students who are new to concept mapping or even resistant to the idea.

In ECI 511, why did the number of concepts identified, resources attached, and proposition statements written, remain similar across mapping tasks that involved considerably different amounts of content? This discrepancy might be attributed to how the mapping strategy was applied, since these students were tasked with developing their most complex map first, covering eight weeks of content. This task was followed by more conceptually manageable maps covering only 1-2 weeks of content. It seems logical that students new to concept mapping should be given easier tasks first, bridging to more cognitively challenging tasks after they have mastered mapping basics. Managing a new strategy and a large amount of content simultaneously may have impeded the students' ability to extract and structure all relevant concepts. In fact, 12 out of 15 students originally enrolled in ECI 511 reported they had never created a concept map on a course pre-survey, thus these students were indeed novices who may have benefited from practice mapping before more demanding tasks were assigned. A secondary explanation might relate to student's intrinsic motivation and willingness to contribute to mapping assignments. Since all but one student received a passing grade on their first map, this may have set the expectation for future mapping, with students contributing roughly the same effort deemed necessary to pass regardless of content detail.

In general, survey data across both classes illustrates students believe that focused concept maps covering a defined set of knowledge are most useful. Most students agreed that concept maps can be useful when they are focused and based on only 1-2 weeks' content. Students were less enthusiastic, but still agreed or were neutral regarding the usefulness of concept maps covering several weeks' content (e.g., weeks 1-9 of a course), or concept maps developed week by week throughout the semester. Students disagreed that concept maps would be useful when developed at the end of the semester, covering an entire semester of content.

Future Directions

Student survey data clearly illustrates a desire to include alternative assessments such as concept maps as part of an overall assessment strategy for distance teacher education courses. We plan to repeat our concept map assessments in the fall of 2006 and have received an internal university grant to design associated lessons and analyses. Given the difficulty with assessing unguided or open-ended maps on the basis of propositions, and the large degree of variability across these types of maps, we plan to employ seeded term mapping for our future assessments. Seeded term mapping involves extracting relevant terms from an expert map and providing those to the students for mapping purposes. In this way, each student is working with the same concept set, and analysis can remain much more focused on how these twenty or so terms are related by the students. If propositions are the most important map element to consider, seeded term mapping will allow us to analyze relationship statements branching off of the same defined terms more clearly. Further, the overall assessment will be far less subjective. One concern with seeded term mapping is its ability to stifle student thinking about larger content sets. Student survey comments clearly illustrated the value they placed on "connecting" course concepts, thus instructors should consider including some unguided or open-ended maps that allow students more freedom to interrelate divergent content domains. These maps are difficult to use for assessment purposes, but they represent a useful educational strategy to help students reflect on several weeks' content, perhaps in preparation for an exam. Preparing open-ended maps remains a challenging activity, thus instructors may wish to leverage the collaborative capabilities of tools like Cmap, for students to support one another as they work to understand and relate course materials.

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