Sharing Concept Maps: Using CMapTools and a course blog as pedagogical organization tools

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Introduction and Overview

We have developed a cluster of two courses that combines introductory college mathematics with a topical introductory science course. The two courses are taught as a part of a concerted effort to emphasize the role of mathematics in understanding important complex scientific problems such as the AIDS epidemic and modern climate change. The lack of a course textbook presented a challenge for the students, in that they felt the material was not adequately organized. In response to this challenge, the authors implemented a system of student-generated concept maps collected on a blog for public viewing by course members. We present our experience with this pedagogical technique here.

The Target Class

Georgia College & State University is Georgia's public liberal arts university and a member of the Council of Public Liberal Arts Colleges (COPLAC). The two courses in the cluster are both part of the university's core curriculum. The science course is entitled Necessities of Life and is an interdisciplinary course. The mathematics course is entitled Mathematical Modeling. Both courses are designed for first-year students who are not majoring in the sciences. The clustering of courses was designed to improve student retention, particularly among first year students who were undecided in their choice of major. A group of students fitting this description were placed into two or more courses during their first semester. It should be noted that the students who participated in our cluster typically registered late for their first semester, many of them waiting until the week before classes began. (Incoming first-year students have the opportunity to begin registering in the February preceding the start of their first fall term.) This group of first-year, late registering, undecided major students is prone to an unsuccessful first term of college and are also less likely to register for the spring semester.

Our cluster of courses is fully integrated. Both classes investigate complex scientific issues that affect society through scientific and mathematical concepts. The theme of the cluster in Fall 2007 was climate change. We use common group assignments as well as individual student assignments specific to each class. The math course uses a standard textbook and students are assessed through a combination of group work, lecture, exams and quizzes. The science course is project and discussion based with no formal exams. The information content for the science course comes from a collection of sources; thus there is no single textbook for this course. Both courses expect the students to interpret data in scientific context using simple curve fitting techniques. The content of these courses are united in several interdisciplinary group project presentations.

We have taught this cluster of courses in Fall 2006 and Fall 2007. In examining the course assessment data after Fall 2006, we discovered the students felt "lost" without a textbook to convey the science course content. In addition, despite the common projects, the students exhibited difficulty in organizing content and connections. In order to address this problem, we sought out a pedagogical technique that would organize the course content as well as emphasize the connections between the two courses. Our search led us to concept mapping (and concept mapping software) as a way of organizing information and to blogging as a way to organize and share concept maps.

Concept Maps

Concept maps were first implemented as a method of measuring student's scientific knowledge.[1] The concept map has since become a valuable pedagogical tool that enhances student understanding of concepts as well as developing meta-cognition.[2] A concept map is a graphical representation of concepts connected by linking phrases that illustrate conceptual relationships, typically in response to a focus question. A student with a well-developed understanding of a topic will produce a concept map with a rich hierarchical structure that reveals complex relationships between concepts. Concept maps can be developed using methods that range from a simple pen and paper drawing to a map generated using software tools specifically developed for concept mapping exercises. The process of developing a concept map is an effective way for students to organize content information and connections between seemingly disparate ideas, such as those presented in our courses.

The Technical Details

We decided to implement the concept mapping software CMapTools, developed by the Institute of Human and Machine Cognition, for a variety of reasons. The software is free for educational use and is compatible with both the Mac and Windows operating systems. In addition, the software is not overly complicated and requires little training. Although the features are more limited than those of other commercially available concept mapping software, we felt the students would spend less time learning how to use the product and more time creating concept maps. We did not notice any lack of robustness during the course of the semester.

While students could access CMapTools in a student computer lab, most chose to download and install the software on their own computers. The CMapTools website also has an extensive online community of users and shared concept maps available. We have not used any of these community resources, though we are exploring this option as a means of enhancing the students' experiences with concept maps.

We chose to use a course blog as a means for the students to present, share and critique their concept maps because it provides an easily administered on-line place to collect the concept maps, as well as other important course material and announcements in chronological order. We housed our course blog at Blogger.com because the service is free and does not contain advertising. One important feature of this service is that we could restrict access to the site to students registered in our course by issuing an email invitation to our students through the blog administration site. It should be noted that in order to join and co-author the blog students must have an existing GMail account or will need to establish a new account with Blogger.com.

When students were given a concept mapping assignment, the general process was to create a concept map using the CMapTools software and to export the concept map as an image file. After the concept map was created and saved, students would log in to the course blog, create a new post and upload the image file to the new post. It should be noted that blogger.com has limitations on the types and sizes of files that can be uploaded in a blog post.

The Student Experience

We introduced concept maps with a paper and pen activity during the first class. We also used CMapTools to create a concept map of the syllabus for the cluster. This map included the outcomes for each course, the assignments, assessment methods, course content and the relationships among these. Our intention with the activity and the example was to prepare the students for the biweekly concept mapping assignments. Every other week each student was to create one concept map that organized the content, context, materials and assignments for the two classes. We divided the class in half and staggered the weeks the concept maps were due. For weeks that the students did not have a concept map due, their assignment was to critique the new concept maps and provide meaningful feedback to their peers on the course blog. We also left feedback for the students on the course blog. The feedback is viewable to all blog members, so we were careful not to post individual grades.

Results and Observations

We used a variety of assessment methods and techniques to evaluate the students, the course and ourselves. Our evaluation of student performance on coursework was used as a summative measure of student achievement. In addition, students were asked to assess their own progress at mid-term in the form of a written self-evaluation. Several

formative assessments were also administered in the form of multiple pre and post surveys to measure students' attitudes and content knowledge. In addition to using surveys developed by the authors, we employed the Student Assessment of Learning Gains (SALG) survey developed by the Science Education for New Civic Engagements and Responsibilities (SENCER) organization and our university's standard student opinion of teaching survey to measure student perceptions of their own learning and the course's effectiveness.

Students' ability to create concept maps, make connections and organize concepts is difficult to quantify. However, the level of students' understanding was clearly demonstrated in their concept maps. We also observed an increase in the students' confidence in communicating concepts. Our observations were further reinforced by the students' own perception of the gains they had made in this area. While we can make no general claims about the efficacy of using concept maps in increasing student understanding, our students did show an improvement in both performance and attitude in communicating and organizing scientific concepts. There were also no comments or references to the lack of textbook in any of the assessment data we collected.

The concept map assignments were pedagogically valuable in two ways. First the students' work highlighted common misconceptions and second we were able to track student progress in hierarchical organization of concepts through the quality and quantity of connections they chose to highlight in their maps.

We did notice that the students tended to focus heavily on the assignments, rather than on the content, in some of their maps. We feel that the example concept map of the course syllabus may have indirectly and unintentionally led to that result.

In addition, the students often demonstrated a lack of engagement with the concept mapping activities. We found that the students did not value the concept mapping activities, despite the positive gains in their learning that we observed. The focus question for the concept maps was the same each week (connect the concepts in both classes), though twice we experimented with a more direct question. The students responded more favorably to these directed questions.

Overall, using CMapTools and Blogger for the concept mapping was effective. We did encounter some resistance to learning new technologies from the students and it was time consuming for us initially, however the students learned new skills and ultimately the technology facilitated student learning and assessment.

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1. Novak, J. D. and Gowin, D.B., 1984, *Learning how to learn.* (New York: Cambridge University Press).
2. Ruiz-Primo, M. A. and Shavelson, R. J., 1996, Problems and issues in the use of concept maps in science assessment. *Journal of Research in Science Teaching*, **33**(6), 569-600.