CONCEPT MAPS AS A DYNAMIC TOOL FOR TEACHING SCIENTIFIC THINKING

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Abstract

PURPOSE
Medical education and scientific thinking often involve understanding interrelated and multidimensional topics. We have employed the concept map as an active learning method for teaching a diversity of complex science concepts in an undergraduate scientific thinking course. Here we describe our implementation of concept maps and how it can be used as tool for instruction, assessment and team building.

METHODS
A concept map is a diagram used to organize ideas and depict their relationships, typically constructed of information presented in boxes with labeled lines between them to indicate connections. In our implementation as a teaching tool, students write key concepts from assigned reading onto sticky notes and work in small groups using these notes and dry-erase markers to create a concept map on a white board. The modular nature of this approach enables students to dynamically edit and rearrange concepts both during the initial construction and throughout a class period to incorporate new ideas. Students have created concept maps on topics including the scientific method, the diagnostic process for physicians and scientific research articles.

RESULTS
Concept maps created on the same topic by different groups are rarely identical, thus exposing the entire class to a diversity of understanding. Concept maps created on the same topic by different groups are rarely identical, thus exposing the entire class to a diversity of understanding. The dynamic nature of the concept map in the sticky note/whiteboard format enables students to edit and add to their concept maps in response to new information and discussion. In this manner, concept maps can be used to assess evolution in student thinking during a course period. The concept maps in the sticky note/whiteboard format enable students to edit and add to their concept maps in response to new information and discussion. In this manner, concept maps can be used to assess evolution in student thinking during a course period. Concept map after reading and discussing a critique of the first article. Pink sticky notes are used to indicate the questions posed to the students with a summary of the responses below. Overall students had a favorable impression of concept maps as both an individual and team learning tool that promotes exposure to diverse thought within a class.

CONCLUSION
Concept mapping enables students to collaboratively work towards understanding complex scientific ideas and to think critically about the relationships between them. Visualization of how students organize and rearrange concepts both during the initial construction and throughout a class period serves as qualitative assessment of student scientific thinking throughout the course.

Figure 1. How to Construct a Concept Map

Figure 2. Concept Maps reflect the diversity of thinking on the same subject within a class period

Figure 3. Working with other students to build concept maps can promote teamwork

Figure 4. Concept maps can reflect changes in thinking over a class period

Figure 5. Concept maps can reect evolution in thinking over the duration of the semester

Figure 6. Students find concept maps to be a useful individual and team learning tool that promotes exposure to diverse thought

Conclusions
Concept mapping enables students to collaboratively work towards understanding complex scientific ideas and think critically about the relationships between them. Visualization of how students organize and structure knowledge facilitates the assessment of student growth and the diversity of understanding within a class.

Figure 7. Concept maps by different student groups will often emphasize different aspects of a subject. After creating their concept maps, we have students present their work to each other, enabling the entire class to appreciate the diversity of thinking on a given subject. This approach also enables the instructor to assess how students are conceptualizing a subject. Each concept map in A-C is the work of a different group of students based on the topic of scientific peer review. In the class discussion following the creation of these concept maps students noted how concept map A emphasized the people involved in peer review while concept map B was more focused on the process. Concept map C contains elements of both people and process

Figure 8. End of course survey of student perception of concept maps in a class of 9 students. Only one student had previous experience working with concept maps. The titles of A-F indicate the questions posed to the students with a summary of the responses below. Overall students had a favorable impression of concept maps as both an individual and group learning tool. The responses to questions regarding team work using concept maps were especially positive. Of note nearly all students indicated they would use concept maps in the future.

Figure 9. A student’s approach to concept mapping often becomes more sophisticated as they continue working with the technique. Additionally as students think over many class periods, concept maps can be used as a qualitative method of tracking growth. Initial concept maps often look similar to flow charts with a unidirectional narrative and little complexity. By the end of the course students are often comfortable drawing connections from many different concepts and areas, creating a full network of relationships. Depicted in A-D are example concept maps made by the same student over the course of the semester. A is the first map and D is the last.

Figure 10. Relationships between them. Visualization of how students organize and structure knowledge facilitates the assessment of student growth and the diversity of understanding within a class.

Creating concept maps as part of a team furthered understanding through exposure to a diversity of thoughts and ideas.