Using Concept Maps in Teaching Microbiology

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INTRODUCTION

This article is intended for faculty teaching microbiology and other biological science courses, and is applicable to both the classroom and the laboratory.

Concept maps are graphical tools for presenting knowledge concepts and the relationship between these concepts in a graphical, hierarchical fashion. Cross-links are further used to illustrate the relationships between the various segments of the concept map.

PROCEDURE

As faculty, we are always looking for ways to increase student interaction in our courses, find methods to help students learn and remember what are often complex processes and relationships, and provide more opportunities for visual learning.

While I present my microbiology course as a series of nesting learning objects, each with its own learning objectives, illustrations, photographs, animations, and self-evaluation of the student's understanding of those learning objects, I have always been looking for a method of constructing and providing an interactive, one-page "big picture" of knowledge concepts and their interrelationships. I believe concept maps aid greatly in attempting to achieve that goal.

Concept maps are graphical tools for presenting knowledge concepts and the relationship between these concepts in a graphical, hierarchical fashion. Cross-links are further used to illustrate the relationships between the various segments of the concept map (1). To construct these maps, I use free, downloadable software (<http://cmap.ihmc.us/download/>) called Cmap Tools, available online from The Institute for Human and Machine Cognition. The tools are very intuitive, come with an excellent help section, and can be learned in just a few hours.

The way I use the concept maps in my lectures is to first construct a complete concept map for student use in both learning the specific topic and, later, in reviewing for tests. This software also enables me to provide html links from the concept boxes within the map to animations,

illustrations, and photographs on my website. A webpage version of the completed concept map is published on my website and a link to that map is placed in the menu of my website for easy student access. See the following two examples:

- ♦ Cytoplasmic Membrane (Domain Bacteria) Finished concept map. Available at: http://student.ccbcmd.edu/~gkaiser/puzzles/Unit%201/Answers_Cytoplasmic_%20Membrane.html
- ♦ Cell Wall (Domain Bacteria) Finished concept map. Available at: http://student.ccbcmd.edu/~gkaiser/puzzles/Unit%201/Answers_Bacterial_Cell_Wall.html

For in-class use, I prepare an incomplete concept map by deleting text from various selected concept boxes. These deleted words and phrases are then used in making a separate Key Words and Phrases PDF document that contains the missing text elements. See the following examples:

- ♦ Cytoplasmic Membrane (Domain Bacteria) Unfinished concept map for printing. Available at: http://student.ccbcmd.edu/~gkaiser/puzzles/Unit%201/Cytoplasmic_%20Membrane.html
- ♦ Cytoplasmic Membrane (Domain Bacteria) Keywords and phrases for map. Available at: http://student.ccbcmd.edu/~gkaiser/puzzles/Unit%201/Cytoplasmic_Membrane_Keywords.pdf
- ♦ Cell Wall (Domain Bacteria) Unfinished concept map for printing. Available at: http://student.ccbcmd.edu/~gkaiser/puzzles/Unit%201/Bacterial_Cell_Wall.html
- ♦ Cell Wall (Domain Bacteria) Keywords and phrases for map. Available at: http://student.ccbcmd.edu/~gkaiser/puzzles/Unit%201/Cell_Wall_keywords.pdf

A hard copy of the unfinished concept map, along with the missing keywords and phrases, is passed out to students during lecture immediately after we complete that topic. Students then work in small groups to fill in the missing parts of the map. In this way, the concept map serves as kind of a puzzle where students use their notes and text, as well as the information already provided on the hard copy of the map, to complete the puzzle. Later, students can print additional copies of the incomplete concept map to use as a self-quiz when preparing for unit exams.

There are many ways to use concept maps in both lectures and labs. For example:

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- ◆ Students could be divided into teams and compete to finish the map.
- ◆ Students can be given a list of keywords and phrases and construct their own concept maps. Colleagues of mine that teach Human Anatomy and Physiology pass out individual keywords on note cards and work together with the students in lab to construct their own concept map on the blackboard.
- ◆ Students can generate their own list of key words and phrases and construct their own maps. The CmapsTools software is free to students as well.
- ◆ Once completed, the concept maps can be discussed in class. Different students or groups of students may generate slightly different maps.
- ◆ The concept maps help me to summarize the entire topic on a single page with just essential keywords. I find this very helpful in reviewing for exams.
- ◆ I blow up the incomplete concept maps and paste them on poster board and use post-its to fill in the boxes.
- ◆ The completed concept maps help me to visualize the content and how the various parts are related to each other. The direct links from the completed online concept maps to the animations and illustrations on your website are especially helpful.
- ◆ I really enjoy interacting with other students during class.

REFERENCES

1. Novak JD, Cañas AJ. The theory underlying concept maps and how to construct and use them. [Internet] Pensacola, FL: Institute for Human and Machine Cognition; 2008 [cited 2010 March 5]. Available from <http://cmap.ihmc.us/Publications/ResearchPapers/TheoryCmaps/TheoryUnderlyingConceptMaps.htm>

CONCLUSION

This is the first year I've tried the concept maps but anecdotal responses from students have been overwhelmingly positive. During class, students have commented, and I paraphrase: