

Teacher Guide to “Mapping Evolutionary Concepts Using CmapTools”

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What are concept maps?

In 1972, Joseph Novak (now Professor Emeritus at Cornell University) developed concept maps as he researched patterns and changes in children’s knowledge of science. (Novak and Cañas, 2006) These graphic tools are useful for organizing and representing knowledge from the more general to the specific and can be used to improve both learning and evaluation. Essentially, concept maps allow teachers and students to organize and link various ideas that relate to a focus question or overall topic. Because the process of constructing concept maps exposes a student’s ability to synthesize and relate one concept to another, student concept maps may vary and change as they begin to collaborate with others or revise their own maps. In this regard, constructing the maps (not solely the maps themselves) provides an opportunity for greater understanding and retention.

In this activity, I have developed a relatively simple concept map exploring the question: “What is the scientific basis for evolution?” Using CmapTools computer software (see below), I have created a web-linked diagram that includes resources embedded in some (not all) of the concept boxes. Students accessing these resources may answer questions provided on a student worksheet or others developed by you.

Note that the concepts in this map generally flow from more general at the top to more specific at the bottom. There are words linking the concepts and allowing the viewer to make clear connections. This is not a comprehensive map of evolution and, in fact, there is room for many additional maps to be developed linked with or embedded in this one. For the purposes of this exercise, however, the number of concepts was kept low. Note, too, that concept maps are not used for creating time lines (e.g., a chronology of Darwin’s life) or flow charts (e.g., carbon cycle diagram). For more detail on concept maps and their use, I highly recommend reading *The Theory Underlying Concept Maps and How to Construct Them*, by Joseph Novak and Alberto Cañas available at: <http://cmap.ihmc.us/Publications/ResearchPapers/TheoryCmaps/TheoryUnderlyingConceptMaps.htm>.

What are CmapTools?

CmapTools is software developed by the Institute for Human and Machine Cognition and available free at <http://cmap.ihmc.us/>. Not only does this software allow users to create maps with linked resources connected to specific concepts (e.g., photos, graphs, websites, videos, text, even other concept maps), it also allows sharing of maps over the Internet and collaboration over long distances. A tutorial and help page can help first-time users begin to navigate the software and explore the possibilities. A list of frequently asked questions at the website can also help those who might have problems downloading software.

Suggestions for how to use this activity

This activity was designed as an introduction to Darwin and evolution in a general biology class in high school. It assumes students have an understanding of basic molecular genetics (e.g., DNA, RNA, genetic basis of inheritance).

Though concept maps are often better used as a hands-on activity -- and as such they can uncover students' misconceptions as well as understanding -- here a concept map is provided to help students see the forest for the trees. This map may be daunting for some at first but by introducing it near the beginning of an evolution unit, it may help some students follow what comes after and it can be used as a review tool as well.

Students should open the concept map on the Harvard site using web browser software. Teachers should show students how to navigate the resources; by clicking on an icon, a single or multiple lines of titles appears and each represents an image or website or other resource. Clicking on these will take students to a new window at the resource's location. Specific instructions and questions are found on the student worksheet.

Other options

- 1) Visit the various resources and create your own set of questions.
- 2) Download CmapTools and create your own concept map with resources linked. In addition to a "My Cmaps" folder on your desktop (after downloading), maps can also be saved to user folders on the Internet. See Cmap Help for assistance in creating a new folder and setting up permissions for who has access to the maps inside.
- 3) Assign students the task of adding to this concept map by giving them a specific area (e.g., natural selection) to build on using a separate piece of paper. Without prior experience, students also will benefit from an overview of concept maps and guidelines. Brainstorming (in small groups or as a class) a list of concepts that relate to the overarching one may be useful before starting as well. Ideally, building on this experience, students might create their own CmapTools concept maps on computer.

**My version of a
Lesson Plan
Outreach Project
July 21, 2006**

National and State Learning Objectives:

NSES: Life Science Content Standard C: Biological Evolution as well as elements of Unifying Concepts and Processes and Content Standard A: Science as Inquiry and Content Standard G: History and Nature of Science

Mass. Standard:

Explain how evolution is demonstrated by evidence from the fossil record, comparative anatomy, genetics, molecular biology, and examples of natural selection.

My Learning Objectives

“So What?” Questions

- What is evolution and how does it work?
- Why are there so many species in the world and how did they get here, including ours?
- Who was Charles Darwin and what were his contributions?

Learning Objectives

1. Contrast the theories of Darwin (natural selection) and Lamarck (inheritance of acquired characteristics).
2. Recognize and discuss the sources of evidence of evolution:
 - Fossil Record
 - Biogeography
 - Comparative Anatomy
 - Comparative embryology
 - Molecular Biology
3. Practice using concept mapping to make connections between the scientific and historical background of evolution.

Materials

Concept Map – “Modern Evolutionary Theory”
Descent with Modification Student Worksheet
Access to student computers (either in pairs or individually)

Activities

The lesson should build on some previous practice with concept mapping. If necessary, an introduction to what concept maps are and how they are used may be sufficient to use the exercise as is.

First have students open the Diversity of Life concept map and answer the questions related to it. They should do the same with the Descent with Modification concept map as well.

Extended Activity Options

1. Teachers can easily adapt the worksheet to expand or redirect student exploration of the linked websites.

2. Teachers may download CmapTools and create an alternative concept map that suits their needs.
3. These concept maps can be expanded with other evolution topics (e.g., speciation, artificial selection, microevolution) and students may be assigned to work individually or in groups to create additional concept maps that can be incorporated into larger ones.

Evaluation Suggestions

Assess answers based on students understanding of broader concepts as well as factual knowledge, using formal and informal assessment tools (e.g., test questions, classroom discussions).