

# Demystifying Concept Mapping: Applications in Teaching Lab and Lecture of Introductory Biology and Anatomy and Physiology

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## Extended Abstract

Concept mapping is the practice of visualizing knowledge using a diagrammatic and hierarchical structure of concepts linked by labelled lines. Growing evidence indicates that concept mapping is a powerful yet underutilized technique to evaluate student learning as formative and summative assessments of concept mastery and lab competencies. During this workshop, a variety of teaching implementations of concept maps were explored, including: (i) Method 1: Concept Map Training with Low Stakes Examples - Teach students how to build concept maps by using simple non-scientific examples (e.g., syllabus, foods, superheroes) as a way to encourage students to build their own maps for studying purposes, (ii) Method 2: Provision of Pre-Made Concept Maps - Provide students with pre-made concept maps summarizing course content, (iii) Method 3: Fill-in-the-Gaps Concept Maps - Provide students with incomplete concept maps (i.e., maps with selected concepts missing) which then have to be completed by students, (iv) Method 4: Course Content Concept Map Construction Demonstration - Showcase to students the building of a concept map during lecture while simultaneously encouraging real-time student feedback as the map is being built and then post the map for the class, (v) Method 5: Concept Maps as Assessments - Concept maps can be used as formative assessments (graded or ungraded) and summative assessments. Pros and cons of using concept maps during teaching were discussed (Fig.1). Example concept maps for methods 1-4, as presented during the workshop, are provided as a supplement (See Appendix A).

Using concept maps, students can learn challenging biology concepts in flexible, efficient, and adaptive ways. In addition, concept maps prevent reliance on rote memorization and can be used to identify misconceptions and gaps in knowledge. In practice, concept mapping can be employed extensively in lab and in lecture. Our workshop utilized a popular, free concept mapping software program (Cmap, <https://cmap.ihmc.us/>) to demonstrate, construct, and review concept maps in biology teaching. Park discussed best practices of teaching with concept maps, based on his experience. A variety of topics were explored such as organismal diversity and evolution, general chemistry, animal cell organelles, mitosis and meiosis, the eukaryotic gene, ecology of populations, chordate evolution, human tissue types, human musculoskeletal system, and human special senses. Using a concept map that detailed the objectives for anatomy and physiology

laboratory classes, Emanuel discussed how identical content could be displayed as different concept maps. The differences between a novice user and an experienced user of concept maps were examined.

<h2>Pros/Cons of Concept Maps</h2>	
<u>PROS</u>	<u>CONS</u>
<ul style="list-style-type: none"> <li>- Elicits prior knowledge</li> <li>- Encourages high-level Bloom's learning (analysis, synthesis)</li> <li>- Integrative across topics</li> <li>- Adaptive, flexible</li> <li>- Many right versions (NOTE: Some can be wrong!)</li> <li>- Visual, diagrammatic</li> <li>- Minimizes rote learning (e.g., memorization, flash cards, outlines)</li> <li>- Supplements and enhances existing learning habits</li> <li>- Quick evaluation tool of student mastery</li> </ul>	<ul style="list-style-type: none"> <li>- Requires prior knowledge</li> <li>- Encourages high-level Bloom's learning</li> <li>- Difficult to grade! (NOT rubric-friendly)</li> <li>- May take time for students to master (students may be frustrated initially)</li> <li>- In-class map building activity can be time-intensive</li> <li>- Not always applicable to all subjects</li> <li>- Some maps make sense only to the map's author</li> </ul>

**Figure 1.** Pros and Cons of Teaching with Concept Maps.

At the conclusion of this workshop, we conveyed the critical importance of encouraging students to confidently create their own concept maps. While pre-made concept maps may be convenient, it has been our experience that there is no one-size-fits-all concept map for biology topics. In general, as students build their own maps, attention to accurate hierarchies of conceptual nodes and links is crucial for making course content understandable and accessible, and additions such as embedding images and incorporating colors aligned with specific themes can enhance concept maps by coding and chunking key concepts and links. We acknowledge that there can be multiple versions of a "correct" concept map for specific biology topics. In summary, evaluation of student-generated concept maps can highlight misconceptions, gaps in knowledge, and the nature of one's own knowledge scaffolding which extends beyond simple memorization.

**Keywords:** concept map, anatomy

**Link To Supplemental Materials:** <https://doi.org/10.37590/able.v42.sup36>

## **About the Author(s)**

Peter J. Park is an Assistant Professor, with expertise in evolutionary ichthyology, in the Department of Biology at SUNY Farmingdale State College in Long Island, New York. He teaches majors Introductory Biology II (Organismal diversity and evolution) and coordinates its laboratory course. He is an HHMI BioInteractive Ambassador Academy member, enthusiastic contributor to NYC fish community science programs, and co-developer of instructional tools such as Laboratory Aquaponics and the HHMI Stickleback Evolution Virtual Lab.

K. Emma Emanuel is a British Medical Doctor (Cambridge University 1991 MA MB BChir). She passed board exams for Royal College of General Practitioners in 1997 and has worked in general practice, internal medicine, OBGYN, pediatrics and psychiatry in England. She transitioned to teaching in USA in 2013. She teaches Anatomy and Physiology I and II and non-majors human biology (Essentials of Human Anatomy and Physiology).

## Appendix A

Method folders can be found in Supplemental Materials.

- Method 1 folder includes the .cmap file for an activity focused on basic chemistry, demonstrated during the workshop. An answer key is also provided.
- Method 2 folder contains pre-made concept maps, constructed by Park, spanning the following subject areas: Anatomy and Physiology I, Ecology, Genetics, and Introductory Biology I and II.
- Method 3 folder includes a fill-in-the-gaps activity focused on the human nervous system, demonstrated during the workshop. A key is also provided.
- Method 4 folder contains concept maps, constructed by Park and his students during lectures. Two maps are provided, one covering organismal diversity and the other photosynthesis.

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