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| C:\Users\bjaco\AppData\Local\Microsoft\Windows\INetCache\Content.Word\SLS-Teaching-Toolkit-Logo_Stacked-Initials.jpg | **Concept Maps** |
| **Time Commitment:** 15-60 mins | **Type:** Discussion; Take-home assignment/project; In-class exercise | **Big Ideas:** Long-term visioning  |
| **OVERVIEW:**This Concept Maps tool introduces and provides an overview of concept maps, which can be used to assess student knowledge in a specific module or assignment. Concept maps are a useful tool for assessing student knowledge over the course of a project, module, or course. You can utilize concept maps as a pre- and post-assessment activity to test student knowledge regarding a specific topic or skill. This tool was contributed by Drs. Carol Thurman and Owen Cantrell |
| **INSTRUCTIONS:** 1. Read the Concept Maps Overview to understand what concept maps are and how they can be used in your course.
2. Review the Concept Mapping Workshop PowerPoint in your course (include link)
3. Utilize the Concept Map handouts below (Activity 1, Activity 2, Activity 3, How to Build a Concept Map) to have students complete their own concept maps
4. Review the CMap Tools handouts (How to Download CMap Tools, How to Use CMap Tools) if you wish students to use the program CMap Tools to create their concept maps (include link).

Use the guides and rubrics to assess student concept maps using either the analytic or traditional method (include link). |
| **SLS STUDENT LEARNING OUTCOMES & ASSESSMENT**  The Serve-Learn-Sustain toolkit teaching tools are designed to help students achieve not only SLS student learning outcomes (SLOs), but the unique learning outcomes for your own courses. Reflection, concept maps, rubrics, and other assessment methods are shown to improve student learning. For resources on how to assess your students’ work, please review our Assessment Tools at <http://serve-learn-sustain.gatech.edu/tool-category/assessment>. **This tool achieve SLOs 1-2, 5. See the end of this tool for further details.**  |

**Want Help?**

Carol Thurman is the contact for this tool. You can reach her at carol.thurman@gatech.edu

**Concept Maps**

Overview

This Concept Maps tool introduces and provides an overview of concept maps, which can be used to assess student knowledge in a specific module or assignment.
Concept maps are a useful tool for assessing student knowledge over the course of a project, module, or course. You can utilize concept maps as a pre- and post-assessment activity to test student knowledge regarding a specific topic or skill.

In the documents below, you’ll find some step-by-step instructions for introducing, explaining, implementing, and assessing concept maps as a component of your course. This PowerPoint produced by Dr. Mary Katherine Watson of The Citadel may be useful for introducing concept maps for you (and your students).

After introducing concept maps, some in-class activities are provided you may want to do when teaching students how to do concept maps for the first time.

While students can create concept maps either by hand or by using traditional word processing tools, an online resource is also available. CMap Tools is a program where students can create concept maps digitally and submit them to you. Step-by-step instructions for CMap Tools are also included.

When students complete their concept maps, there are two ways we suggest you may want to score the concept maps: traditional/structural, and analytic. We’ve provided instructions on how to score concept maps using the traditional method. Additionally, there are tools available to score concept maps automatically. Finally, if you wish to score the concept maps using the analytic method, a rubric is available.

If you want to learn more about concept maps, additional resources are also supplied. These Concept Map materials were developed by Dr. Mary Katherine Watson of The Citadel and adapted by Serve-Learn-Sustain.

How to Build a Concept Map

1. Identify a focus topic you wish to map.
2. Guided by this question, create a list of concepts that are pertinent to the topic using CmapTools®
3. Sort through the concepts, and move to the side any that you do not fully understand or is not related to any other term.
4. Using CmapTools®, arrange the remaining concepts in a way that makes sense to you. Terms you see as related should be kept fairly close together. One approach is to place general concepts near the top of the map and specific concepts at the bottom of the map. Other layouts may also be appropriate.
5. Draw linkages using CmapTools® between concepts you see to be related.
6. Write on each line the nature of the relation between the terms.
7. Review your map and determine if there are any more concepts you can add. You may add to the map new concepts or concepts set aside in step 3. If you do add additional concepts, you should be sure to link them to other concepts and provide descriptive linkages.
8. Again, review your map. Look for cross-links, which link together concepts in different areas of your map. Cross-links will help you to elaborate how concepts are interrelated.
9. Finalize your map. Make sure that appropriate concepts are linked that all linkages are described.

Additional Resources for Further Reading

Barrella, E. M. and M. K. Watson (2016). Comparing the outcomes of horizontal and vertical integration of sustainability content into engineering curricula using concept maps New Developments in Engineering Education for Sustainable Development. W. L. Filho and S. Nesbit. Cham, Switzerland, Springer International Publishing.

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Ruiz-Primo, A. (2000). "On the use of concept maps as an assessment tool in science: What we have learned so far." Revista Electrónica de Investigación Educativa 2(1): 29-53.

White, R.; Gunstone, R., *Probing Understanding*. Falmer Press: Philadelphia, PA, 1992

Segalàs, J., D. Ferrer-Balas and K. F. Mulder (2010). "What do engineering students learn in sustainability courses? The effect of the pedagogical approach." Journal of Cleaner Production 18(3): 275-284.

Van Zele, E., J. Lenaerts and W. Wieme (2004). "Improving the usefulness of concept maps as a research tool for science education." International Journal of Science Education 26(9): 1043-1064.

Watson, M. K., Pelkey, J., Noyes, C. R., & Rodgers, M. O. (2015). Assessing Conceptual Knowledge Using Three Concept Map Scoring Methods. Journal of Engineering Education, 105(1), 118-146. doi:10.1002/jee.20111

Watson, M. K., Pelkey, J., Noyes, C., & Rodgers, M. (2016). Assessing impacts of a learning-cycle-based module on students’ conceptual sustainability knowledge using concept maps and surveys. Journal of Cleaner Production, 133, 544-556. doi:10.1016/j.jclepro.2016.04.063

Watson, M. K., & Barrella, E. (2017). Using Concept Maps to Explore the Impacts of a Learning-Cycle-Based Sustainability Module Implemented in Two Institutional Contexts. Journal of Professional Issues in Engineering Education and Practice, 143(2). doi:10.1061/(asce)ei.1943-5541.000030

**Activity 1: Connecting SLS Outcomes & Concept Map Topics**

*Directions: Reflect on your SLS-associated course. Brainstorm concept map central topics related to your course that could be used to assess SLS outcomes. Use the table below to record your ideas, and the ideas reported by your peers.*

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| **SLS Outcome Category** | **SLS Outcome** | **Concept Map Central Topics** |
| Develop skills and knowledge | Students will be able to identify relationships among ecological, social, and economic systems. |  |
| Students will be able to describe how their actions impact the sustainability of communities. |  |
| Connect to Professional Practice | Students will be able to describe how they can use their discipline to make communities more sustainable. |  |

**Activity 2: Engaging in a Concept Mapping Exercise**

*Directions: Creating a concept map can be hard! Before implementing a concept mapping assessment in your classroom, practice making a concept map on one of your central topics from Activity 1. Use the space below to brainstorm, but draw your final concept*

**Activity 3: Scoring Concept Maps using the Traditional (Structural) Method**

*Directions: One of the biggest challenges to using concept maps is extracting useable data from student submissions. Take a look at the concept map below and see if you can apply the traditional scoring method.*

1. Count the number of concepts (indicator of knowledge breadth). How many are there? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. Number first-level concepts, which define the hierarchies. How many hierarchies are there? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. Number each of the remaining concepts based on which hierarchy that they fall under.
4. Count the number of cross-links, or connections between concepts from different hierarchies (indicator of knowledge connectedness). How many cross-links are there? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
5. Count the level (or number of concepts) in each hierarchy, not including the central topic. What is the highest level for this concept map (indicator or knowledge depth)? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**SLS Student Learning Outcomes**

**Goal: Develop Skills & Knowledge**

1. Identify relationships among ecological, social, and economic systems
2. Describe how actions affect community sustainability
3. Work effectively in different communities
4. Analyze the impact of decisions on community sustainability

**Goal: Connect to Professional Practice**

1. Relate discipline to community sustainability

**Goal: Work in Diverse Contexts**

1. Create and evaluate approaches to addressing community sustainability
2. Communicate with the public about sustainable communities

**Goal: Build Long-Lasting Values and Beliefs**

1. Manifest personal values and beliefs demonstrating responsible community membership