Concept Maps as Teaching, Learning, and Assessment Tools

A Serve-Learn-Sustain Assessment Workshop
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Workshop Overview

Introduction to Concept Maps

Concept Mapping Activities

Concept Map Scoring Methods

Practical Suggestions
Introduction:
“Serve-Learn-Sustain” Context

Serve-Learn-Sustain (SLS) Learning Outcomes:

- Develop Skills & Knowledge
  - **Identify** relationships among ecological, social, and economic systems.
  - **Describe** how sustainability and community engagement relate to their civic lives.

- Connect to Professional Practice
  - **Describe** how sustainability relates to their professional practice.
  - **Describe** the social and cultural impact of their professional practice.

Many outcomes target improving *conceptual knowledge*. 
Introduction: What is Conceptual Knowledge?

- Includes **facts**, **generalizations**, and **principles**.
- Includes **relationships** between concepts.
- Encompasses how **facts** are **organized**.
- Should be **deep** and **rich** with **connections**.
Introduction:

Why is conceptual knowledge important?

Conceptual Knowledge

Foundation for higher-order learning

Critically analyze new scenarios

Deviate from templates & heuristics

Develop innovative, tailored solutions
Introduction:
Need for Assessments

Given the role of conceptual knowledge in professional competence, there is a need for appropriate:

- Teaching & Learning Tools
- Assessment & Research Tools
Introduction:

**Concept Maps (Cmaps)**

Cmaps are graphical tools for organizing and presenting knowledge.
Introduction: Construction of a Concept Map

• Include concepts related to a central topic in boxes.

• Connecting lines with phrases show concept relationships.

• Cmap Components
  • Propositions
  • Hierarchies
  • Cross-links
Introduction:
Examples of Concept Maps in Higher Education

Cmaps can be used to promote & assess knowledge in a variety of areas:

- Ill-defined
- Broad
- Subjective
- Disciplinary/Technical
Introduction:
“Serve-Learn-Sustain” Context

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**Connect to Professional Practice**
- **Describe** how sustainability relates to their professional practice.
- **Describe** the social and cultural impact of their professional practice.

Concept maps can be used to promote *learning and assessment* of SLS outcomes.
Activity #1:
Cmap Applications for “Serve-Learn-Sustain”

• Make a list of SLS topics that could be assessed using cmaps.

• Identify the SLS outcome associated with each topic.
Workshop Overview

Introduction to Concept Maps

Concept Mapping Activities

Concept Map Scoring Methods

Suggestions
Concept Map Activities: 
*Key Components*

Three components of a concept mapping activity/assessment:

- **Task**
- **Format**
- **Scoring Method**
Concept Map Activities: Task

Several levels of task directedness:

**Construct-a-Map:**
Students structure their own maps using original concepts and linking phrases.

**Intermediate:**
Students create their own map structure using instructor-provided concepts and/or linking phrases.

**Fill-in-a-Map:**
Students fill in blank structure with instructor-provided concepts and linking phrases.

Low Directedness

High Directedness
Concept Map Activities: Format

By Hand:
- Easy to administer
- No program to learn
- Difficult to organize cmap
- Can be harder to score

CmapTools:
- Easy to organize cmap
- Can be easier to score
- Program easy to learn
- Requires computers to administer
Concept Map Activities: Scoring

Scoring methods needed to:

- Provide formative feedback.
- Capture changes over time.
- Detect differences between groups.

*Scoring is the major bottleneck in use of concept maps.*
Concept Map Activities:
Activity #2

Create a cmap!

• Choose an SLS topic and create a concept map using the poster board.

• You can work individually or in groups.

• Post your concept map at the front when you are done!
Concept Map Activities:
Ready to Try in Your Classroom?

**Before Pre-Assessment**
- Watch training video
- Download CmapTools
- Construct practice cmap

**Pre-Assessment**
- Quick (5 min or less) cmap refresher
- Provide focus topic/question
- Allow at least 20 – 30 min for cmap activity
- For CmapTools, submit .cmap file
- For paper, provide large 11 x 17 paper

**Post-Assessment**
- Quick (5 min or less) cmap refresher
- Provide focus topic/question
- Allow the same amount of time as pre-assessment
- Use the same format (CmapTools or paper) as pre-assessment

Sample resources available in workshop folders.
Workshop Overview

- Introduction to Concept Maps
- Concept Mapping Activities
- Concept Map Scoring Methods
- Practical Suggestions
Concept Map Activities:

**Key Components**

Three components of a concept mapping activity/assessment:

- **Task**
- **Format**
- **Scoring Method**
Concept Map Scoring: Overview of Methods

Structure
- Counting Components (Traditional Method)

Content
- Qualitative Concept Coding

Hybrid (Structure & Content)
- Interlinks & Complexity
- Analytic Rubric
Concept Map Scoring: 
Overview of Methods

Structure

Counting Components (Traditional Method)

Content

Qualitative Concept Coding

Hybrid (Structure & Content)

Interlinks & Complexity

Analytic Rubric
Concept Map Scoring: 
Traditional Scoring Method

- Number of concepts (NC) represents knowledge **breadth** sub-score.
- Highest level of hierarchy (HH) represents knowledge **depth**.
- Number of cross-links (NCL) represents knowledge **connectedness**.

\[
\text{Total Score} = NC \times 1 + HH \times 5 + NCL \times 10
\]
Concept Map Scoring: Traditional Scoring Method

**Traditional Scores:**
- NC = 13
- HH = 3
- NCL = 4
- Total = 68

**Scoring Method:**
1. Count unique concepts
2. Number hierarchies
3. Assign each concept to a hierarchy
4. Determine highest hierarchy
5. Determine number of cross-links
Concept Map Assessments:
Activity #3

Score a cmap!

• Count unique concepts
• Number hierarchies
• Assign each concept to a hierarchy
• Determine highest hierarchy
• Determine number of cross-links
Concept Map Scoring: Traditional Scoring Method

The traditional method seems easy...

But what about this one???
A concept map scoring program is available!
Concept Map Scoring: Overview of Methods

Structure
- Counting Components (Traditional Method)

Content
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Hybrid (Structure & Content)
- Interlinks & Complexity
- Analytic Rubric
A study conducted in CEE at Georgia Tech:

Environment
Resource scarcity
Social impact
Values
Education
Future
Unbalances (spatial)
Technology
Economy
Actors/Stakeholders

Concept Map Scoring:
Qualitative Concept Coding
Concept Map Scoring: Qualitative Concept Coding

A study conducted in an SLS course:

You can choose any categories that are of relevance to your concept maps.
Concept Map Scoring: Qualitative Concept Coding

Word clouds can provide quick, easy qualitative analysis.

Try Wordle!
Concept Map Scoring: Overview of Methods

- Structure
  - Counting Components (Traditional Method)

- Content
  - Qualitative Concept Coding

- Hybrid (Structure & Content)
  - Interlinks & Complexity
  - Analytic Rubric
Concept Map Scoring: Interlinks and Complexity

STEP 1: Categorize each concept in the concept map.

- Ecological
- Technical
- Social
- Temporal
- Economic
- Balance

STEP 2: Count “interlinks” between concepts from different categories.

STEP 3: Calculate complexity for each concept map.

\[ CO = NC \times \frac{NIL}{NCAT} \]

CO = Complexity
NC = No. Concepts
NIL = No. Interlinks
NCAT = No. Categories

Captures content and structure of concept maps.
Concept Map Scoring: Qualitative Concept Coding

A study conducted in an SLS course:

**PRE**
- Avg. NIL = 5.2
- Avg. CO = 23.4

**POST**
- Avg. NIL = 14.7
- Avg. CO = 137.8

- Ecological: 46%
- Social: 22%
- Economic: 12%
- Technical: 16%
- Balance: 3%
- Temporal: 1%

- Ecological: 25%
- Social: 40%
- Economic: 16%
- Technical: 12%
- Balance: 2%
- Temporal: 5%
Concept Map Scoring: Overview of Methods

Structure
- Counting Components (Traditional Method)

Content
- Qualitative Concept Coding

Hybrid (Structure & Content)
- Interlinks & Complexity
- Analytic Rubric
# Concept Map Scoring: Analytic Rubric

**Besterfield-Sarce et al. 2004 Rubric**

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Comprehensiveness</strong> -</td>
<td>The map lacks subject definition; the knowledge is very simple</td>
<td>The map has adequate subject definition but knowledge is limited</td>
<td>The map completely defines the subject area. The content lacks no</td>
</tr>
<tr>
<td>covering completely/broadly</td>
<td>and/or limited. Limited breadth of concepts (i.e. minimal</td>
<td>in some areas (i.e., much of the coursework is mentioned but</td>
<td>more than one extension area (i.e., most of the relevant</td>
</tr>
<tr>
<td></td>
<td>coverage of concepts, little or no mention of employment,</td>
<td>one or two of the main aspects are missing). Map suggests a</td>
<td>extension areas including lifelong learning, employment, people,</td>
</tr>
<tr>
<td></td>
<td>and/or lifelong learning). The map barely covers some of the</td>
<td>somewhat narrow understanding of the subject matter.</td>
<td>etc. are mentioned).</td>
</tr>
<tr>
<td></td>
<td>qualities of the subject area.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Organization</strong> -</td>
<td>The map is arranged with concepts only linearly connected. There</td>
<td>The map has adequate organization with some within/between</td>
<td>The map is well organized with concept integration and the use</td>
</tr>
<tr>
<td>to arrange by systematic</td>
<td>are few (or no) connections within/between the branches. Concepts</td>
<td>branch connections. Some, but not complete, integration of</td>
<td>of feedback loops. Sophisticated branch structure and</td>
</tr>
<tr>
<td>planning and united effort</td>
<td>are not well integrated.</td>
<td>branches is apparent. A few feedback loops may exist.</td>
<td>connectivity.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Correctness</strong> -</td>
<td>The map is naïve and contains misconceptions about the subject</td>
<td>The map has few subject matter inaccuracies; most links are</td>
<td>The map integrates concepts properly and reflects an accurate</td>
</tr>
<tr>
<td>conforming to or agreeing</td>
<td>area; inappropriate words or terms are used. The map documents</td>
<td>correct. There may be a few spelling and grammatical errors.</td>
<td>understanding of subject matter meaning little or no</td>
</tr>
<tr>
<td>with fact, logic, or known</td>
<td>an inaccurate understanding of certain subject matter.</td>
<td></td>
<td>misconceptions, spelling/grammatical errors.</td>
</tr>
<tr>
<td>truth</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Adaptation for sustainability-focused cmaps is available in workshop folder.
Workshop Overview

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Concept Map Scoring: Practical Considerations

**Impact of Format on Scoring**
- CmapTools makes scoring easier!
- Cmaps are more organized & legible.
- Allows for use of automated scoring.
- Easy export of concepts for coding

**Choice of Scoring Method(s)**
- Two methods can support validity of results.
- Capture aspects of content and structure.
- Consider whether multiple raters are needed.

**Student Grades vs. Assessment Scores**
- Assessment scores may not be appropriate as grades.
- There is often no right or wrong answer.
- Scoring methods may not provide timely, meaningful feedback.
Closing & Summary:
“Serve-Learn-Sustain” Context

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Questions?

Thank You!
References


