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:

- **Identify** relationships among ecological, social, and economic systems.
- **Describe** how sustainability and community engagement relate to their civic lives.
- **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
- Subjective
- Broad
- Disciplinary/Technical
Introduction:
“Serve-Learn-Sustain” Context

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- Describe how sustainability relates to their professional practice.
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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.

Brainstorm!
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.
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
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 Transition

Introduction to Concept Maps

Concept Mapping Activities

Concept Map Scoring Methods

Practical Suggestions

9:15 to 10:15 AM Session

10:30 – 11:30 AM Session

Questions?

Thank you!
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

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Content
- Qualitative Concept Coding

Hybrid (Structure & Content)
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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**.

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

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

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

- **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

MEGA CATEGORY
Environment Economic Social

CATEGORY RELEVANCIES (CR) (%)

Environment (21.9%)
Natural Resources (36.7%)
Tech (6.3%)
Econ (7.7%)
Social Impacts (14.0%)
Temporal (6.4%)
Other (3.6%)
Stkhldrs (3.4%)

Environment (24.0%)
Natural Resources (36.1%)
Tech (13.6%)
Econ (5.7%)
Social Impacts (12.2%)
Temporal (3.3%)
Other (2.3%)
Stkhldrs (2.8%)

Environment (23.2%)
NatRes (12.8%)
Tech (16.3%)
Econ (15.7%)
Social Impacts (17.6%)
Temporal (3.7%)
Other (6.2%)
Stkhldrs (4.6%)

Environment (25.1%)
Econ (13.8%)
Tech (15.3%)
Temporal (5.4%)
Other (2.7%)
Stkhldrs (4.0%)

Pre Scores
Intervention Cohort

Post Scores
Intervention Cohort
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.
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
Concept Map Scoring: Overview of Methods

Structure
- Counting Components (Traditional Method)

Content
- Qualitative Concept Coding

Hybrid (Structure & Content)
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### Besterfield-Sarce et al. 2004 Rubric

<table>
<thead>
<tr>
<th>Comprehensiveness – covering completely/broadly</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>The map lacks subject definition; the knowledge is very simple and/or limited. Limited breadth of concepts (i.e. minimal coverage of coursework, little or no mention of employment, and/or lifelong learning). The map barely covers some of the qualities of the subject area.</td>
<td>The map has adequate subject definition but knowledge is limited in some areas (i.e., much of the coursework is mentioned but one or two of the main aspects are missing). Map suggests a somewhat narrow understanding of the subject matter.</td>
<td>The map completely defines the subject area. The content lacks no more than one extension area (i.e., most of the relevant extension areas including lifelong learning, employment, people, etc. are mentioned).</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Organization – to arrange by systematic planning and united effort</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>The map is arranged with concepts only linearly connected. There are few (or no) connections within/between the branches. Concepts are not well integrated.</td>
<td>The map has adequate organization with some within/between branch connections. Some, but not complete, integration of branches is apparent. A few feedback loops may exist.</td>
<td>The map is well organized with concept integration and the use of feedback loops. Sophisticated branch structure and connectivity.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Correctness – conforming to or agreeing with fact, logic, or known truth</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>The map is naïve and contains misconceptions about the subject area; inappropriate words or terms are used. The map documents an inaccurate understanding of certain subject matter.</td>
<td>The map has few subject matter inaccuracies; most links are correct. There may be a few spelling and grammatical errors.</td>
<td>The map integrates concepts properly and reflects an accurate understanding of subject matter meaning little or no misconceptions, spelling/grammatical errors.</td>
<td></td>
</tr>
</tbody>
</table>

Adaptation for sustainability-focused cmaps is available in workshop folder.
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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.
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1. Introduction to Concept Maps
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3. Concept Map Scoring Methods
4. Practical Suggestions

Questions?

Thank You!
References


