HIGHER-ORDER THINKING: TESTING DEEP LEARNING

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Presentation prepared for the Office of Faculty Enhancement

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Road Map for the Day

- Higher-order Thinking and Testing Higher-order Thinking
- Concept Maps
- SOLO Taxonomy
- Professional Learning Communities
Higher-order Thinking (HOT)

• What is it?
  • Mental engagement with ideas, objects, and situations in an analogical, elaborative, inductive, deductive, and otherwise transformational manner that is indicative of an orientation toward knowing as a complex, effortful, generative, evidence-seeking, and reflective enterprise

• Examples
  • Writing a persuasive essay
  • Doing a geometric proof
  • Using primary sources to understand a point of view
  • Explaining why a chemical reaction occurs
  • Composing music or artwork in a certain style
  • Determining what defense to play in soccer

Discussion

• What HOT activities do you have your students engage in?
• How do you know they are engaging in HOT?
• Are these easily assessed through selected-response items or traditional rubrics?
• Or – do we need better ways to assess HOT?
  • Concept Maps
  • SOLO Taxonomy
What is a concept map?
What is a concept map?

• Graphical Tool
• Used for conveying RELATIONSHIPS and ORGANIZATION of conceptual understanding

• Words, symbols, even visual representations

• Relational words may be included

Components (Novak & Gowin, 1984; Cronin et al., 1982)

• Concepts
• Groupings
• Branching
• Propositions
  • Relationships between concepts linked with lines
• Hierarchy
  • Subordinate grouping (general → specific)
• Cross Links
  • Meaningful connections between different groups
• Examples
  • Specific examples labeled
Examples

Clouds

Temperature

Weather

Wind

Air

Rain

Family kayak trip to Canada

Ocean Beach Resort

services

Ocean Beach Resort

rent kayaks

guide services

ate

clams and

kayaking around

Quadra Island

looks like other things to do

fishing
digging clams

beautiful beaches
sand dunes
lush forests

Bellingham, WA.

Vancouver, BC

traveled

distance

1240 miles

time

4 days

stayed in

and

4 days

stayed in

and

Bellingham, WA.

Bellingham, WA.
Now You Try

What is/are the BIG IDEA(S) (most important topics/concepts) in your subject area?
## Evaluating Concept Maps

<table>
<thead>
<tr>
<th>Concepts</th>
<th>Concepts are objects, events, situations, or properties of things that are designated by a label or symbol.</th>
<th>Score 1 point for each concept that is connected to at least one other concept by a proposition.</th>
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<td>Groupings are the ways concepts can be linked or joined together. There are three types of groupings: 1. Point groupings: a number of single concepts emanating from one concept 2. Open groupings: three or more concepts that are linked in a single chain 3. Closed groupings: concepts that form a closed system (a loop)</td>
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<td>Hierarchy</td>
<td>Concepts on a map can be represented as a hierarchical structure in which the more general, more inclusive concepts are at the top of the map; the specific and exclusive concepts are at the lower end of the map</td>
<td>Does the map show hierarchy? Is each subordinate concept more specific and less general than the concept drawn above it (in the context of the material being mapped)? Score 5 points for each valid level of the hierarchy.</td>
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<tr>
<td>Cross Links</td>
<td>Does the map show meaningful connections between one segment of the concept hierarchy and another segment? Is the relationship shown significant and valid?</td>
<td>Score 10 points for each cross link that is both valid and significant and 2 points for each cross link that is valid but does not illustrate a synthesis between sets of related concepts and propositions. Unique or creative cross links might receive special recognition or extra points.</td>
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## Evaluating Concept Maps

### Concepts

- Concepts are objects, events, situations, or properties of things that are designated by a label or symbol.

### Score

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# Evaluating Concept Maps

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## Evaluating Concept Maps

| Proposition | Relationships between concepts are represented by connecting word(s) and phrases written on the line joining any two concepts.  
• Simple Proposition is a simple English word or phrase  
• Advanced Proposition is a phrase or statement that is composed of technical or scientific word(s). | • Simple Propositions score 1 point for each word or phrase; give a half for repeated use of Simple Propositions  
• Advanced Propositions score 2 points for each proposition. Give 1 point for repeated use of Advanced Proposition |
SOLO TAXONOMY

The Structured Observation of the Learning Outcome (SOLO) taxonomy

• Examines responses to open-ended questions to assess:
  • how many relevant pieces of data students can use
  • if and how these relevant pieces of data relate
    • induction – can generalize only within the given system or information
    • deduction – can use logic to generalize to information outside the given system
  • if and how inconsistencies and closure may be present in responses
    • inconsistencies – you may get different answers using the same data
    • closure – the need to find “an answer”
<table>
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<tr>
<th>Developmental stage with minimal age</th>
<th>SOLO description</th>
<th>1 Capacity</th>
<th>2 Relating operation</th>
<th>3 Consistency and closure</th>
<th>4 Response structure</th>
</tr>
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<tr>
<td>Formal Operations (8+ years)</td>
<td>Extended Abstract</td>
<td>Maximally case + relevant data + interpretations + hypotheses</td>
<td>Deduction and induction can generalize to situations not experienced</td>
<td></td>
<td><img src="image1" alt="Diagram" /></td>
</tr>
<tr>
<td>Concrete Generalization (5-7 years)</td>
<td>Relational</td>
<td>High case + relevant data + investigations</td>
<td>Induction. Can generalize within given or experienced context using related aspects</td>
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**Table 2.1**
Base Stage of Cognitive Development and Response Description

| Mental Concrete (16-11 years) | Multistructural         | Minimum case + isolated relevant data | Can "generalize" only in terms of a few limited and independent aspects | Although has a tendency for consistency, can be inconsistent (i.e., rests too soon on basis of isolated factors or data, and so can come to different conclusions with same data) | ![Diagram](image3) |
| Early Concrete (7-6 years)     | Unistructural            | Low case + one relevant datum          | Can "generalize" only in terms of one aspect | No felt need for consistency, thus closure too quickly. Jumps to conclusions on one aspect, and so can be very inconsistent | ![Diagram](image4) |
| Pre-operational (4-6 years)    | Prestructural            | Minimal. case and response confused    | Denial, caution, multidivision, Brandon to specifics | No felt need for consistency. Closes without even seeing the problem | ![Diagram](image5) |

* Kinds of data used: X = irrelevant or inappropriate; • = related and given in display; ...
  = related and hypothetical, not given
### Taxonomy Level

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<th>Taxonomy Level</th>
<th>Score</th>
<th>Response characteristics</th>
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| Prestructural        | 0     | Cue and response undifferentiated  
No logical interrelation for cue and response  
High closure or low consistency  
Cue linked with irrelevant feature(s) |
| Unidimensional       | 1     | Relate question with one piece of relevant data with a logical operation  
Drawing a conclusion from a particular instance  
Responses equally correct but inconsistent with each other  
One relevant feature to link question and response |
| Multistructural      | 2     | Two or more relevant concepts or data  
Uses several features but does not link them  
Closure but lack of consistency  
Several relevant features link question and response |
| Relational           | 3     | Response which interrelates multiple concepts  
Overall concept or principle accounting for data presented  
Waits for all aspects before interrelating to make coherent whole  
Definite overgeneralized answer tied to concrete experience  
Uses relevant data in a conceptual scheme |
| Extended abstract    | 4     | Give information comprehended in relevance to an overriding abstract principle  
True logical deduction  
Heavily qualifies set out principle to application in given situations  
Question left relatively open  
Relevant data with interrelations under hypothetical abstract structure with alternative outcomes and no definite closure |
| Transitional responses | 5.    | At a level of the taxonomy but marked by confusion or inconsistency  
1.5: Handles more information than able to cope with  
2.5: Loses track of the argument  
or 3.5: Forced to give up before reaching next SOLO level |

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### Formulating Questions for SOLO Responses

- **Must be** open-ended questions
  - For example: Why do cells die?  
  - Not open ended: How long do cells live?

- The questions should enable students to:  
  - Explain using more than one piece of data  
  - Should be able to relate relevant pieces of data
PROFESSIONAL LEARNING COMMUNITIES

Moving Forward

• Continued support
• Opportunity to engage in a study on assessing HOT at the post-secondary level
Questions

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