Concept map as a tool for teaching and assessment in the classroom

Concept maps were developed by Joseph D. Novak at Cornell University in 1972 when he conducted a study to understand changes in children’s knowledge of science (Novak & Musonda, 1991). Since then concept maps have been widely used in different areas of teaching and learning. To inspire teachers to make use of concept mapping, this short paper focuses on recommending three sets of basic yet useful techniques: (1) Steps to construct good concept maps; (2) Steps to design a concept mapping activity; and (3) Ways to assess concept maps based on a simple scoring rubric.

Steps to construct good concept maps

Based on the recommendations by Novak & Cañas (2008), there are basically 5 simple steps in constructing good concept maps. The sequence of constructing a concept map by going through these steps is illustrated below by a simple example – building a concept map of “What are the key forms of water?”.

Step 1: Construct a Focus Question
To define the context for a concept map, a focus question is required to be constructed, e.g. “How do we measure time?”, “What are the key forms of water?”, etc.

Step 2: Identity the key concepts and prepare a rank ordered list
Given a specific focus question, the next step is to identify the key concepts that apply to this domain. Then the key concepts can be listed in a rank ordered list, with the most general at the top and most specific at the bottom.
E.g. Focus Question: “What are the key forms of water?”
Rank Order List:
1. Steam
2. Solid
3. Liquid
4. Rain
5. Mist
6. River
7. Gas
8. Ice

Step 3: Construct a preliminary Concept Map
In concept maps, concepts are represented in circles or other shape of boxes with labels, and they are connected by directional links with labels called linking phrases (or prepositions). Based on the
ranked ordered list of key concepts, a preliminary concept map can be constructed.

**Step 4: Revise the map**

It is always necessary to revise a preliminary map. Cross-links should be sought; these are links between concepts in different segments of domains of knowledge on the map.

**Step 5: Improve the map to the final version**

The final step is to make the final version of the map. Concepts should be re-positioned in ways that lend to clarity and better overall structure. A final “dress up” can be done by improving style and adding colors.
Steps to design a concept mapping activity
Based on the study reported by Vanides, Yin, Tomita & Ruiz-Primo (2005), concept maps have great potentials as both instructional and assessment tools in the classroom. Concept maps give students an opportunity to think about the connections between key concepts being learned, organize their thoughts and visualize the relationships between key concepts in a systematic way, and reflect on their understanding. The following steps were recommended to effectively use concept maps in the classroom.

Step 1: Select key concepts being taught
Teachers can select key concepts from a chapter in a textbook or a specific section of a curriculum unit. Keep the number of key concepts to 8-12 terms. Based on the selected key concepts, find out linking phrases that reflect what students should know and able to express.

Step 2: Determine where in the unit or curriculum the maps will be embedded
Consider inserting a concept mapping activity at key junctions in the unit. These are the good times to evaluate the understanding of the concepts in the class.

Step 3: Create the activity
The final step is to design delivery procedures including topics and tools for practice. Examples of concept map assessment activity can be downloaded at www.vanides2.com/conceptmaps/conceptmap-example.doc

Ways to assess concept maps based on a simple scoring rubric
For using concept maps by teachers as an assessment tool, Bartels (1995) had proposed a scoring rubric (Table 1) to assess a student’s knowledge of mathematical concepts and the connections among concepts, the ability to construct a map, and the ability to communicate through a concept map. This rubric is recommended to teachers in this paper because (1) it is one of the simplest rubrics available, yet it can fully cover all the important aspects of assessing concept maps; (2) it can apply not only to mathematical concepts, but also concepts of other subjects and topics. Other rubrics for assessing concept maps can be found at: http://www.docsrush.net/2471379/concept-map-rubrics-university-of-iowa.html
Table 1. Bartels’ Scoring Rubric for Concept Maps

<table>
<thead>
<tr>
<th>Concepts and Terminology</th>
<th>3 points</th>
<th>Shows an understanding of the topic’s concepts and principles and uses appropriate terminology and notations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2 points</td>
<td>Makes some mistakes in terminology or shows a few misunderstandings of concepts</td>
</tr>
<tr>
<td></td>
<td>1 point</td>
<td>Makes many mistakes in terminology and shows a lack of understanding of many concepts</td>
</tr>
<tr>
<td></td>
<td>0 points</td>
<td>Shows no understanding of the topic’s concepts and principles</td>
</tr>
<tr>
<td>Knowledge of the Relationships among Concepts</td>
<td>3 points</td>
<td>Identifies all the important concepts and shows an understanding of the relationships among them</td>
</tr>
<tr>
<td></td>
<td>2 points</td>
<td>Identifies important concepts but makes some incorrect connections</td>
</tr>
<tr>
<td></td>
<td>1 point</td>
<td>Makes many incorrect connections</td>
</tr>
<tr>
<td></td>
<td>0 points</td>
<td>Fails to use any appropriate concepts or appropriate connections</td>
</tr>
<tr>
<td>Ability to Communicate through Concept Maps</td>
<td>3 points</td>
<td>Constructs an appropriate and complete concept map and includes examples; places concepts in an appropriate hierarchy and places linking words on all connections; produces a concept map that is easy to interpret</td>
</tr>
<tr>
<td></td>
<td>2 points</td>
<td>Places almost all concepts in an appropriate hierarchy and assigns linking words to most connections; produces a concept map that is easy to interpret</td>
</tr>
<tr>
<td></td>
<td>1 point</td>
<td>Places only a few concepts in an appropriate hierarchy or uses only a few linking words; produces a concept map that is difficult to interpret</td>
</tr>
<tr>
<td></td>
<td>0 points</td>
<td>Produces a final product that is not a concept map</td>
</tr>
</tbody>
</table>

Summary

Visual representation of concepts and their inter-relationships of a topic or domain are the key values of constructing concept maps in teaching and learning. This paper describes a few key skills of using concept maps in the classroom for teaching and assessment. As a summary of recommendation to teachers who would like to apply concept mapping in their classrooms, the following activities are highly recommended.

- Before teaching a curriculum unit, students are first requested to create individual maps of the selected topic of the unit. This individual reflection elicits the personal understanding of each student. Students are then requested to review their concept maps in small groups and finally representatives of each group can spend a few minutes to report their findings;
- Upon completion of a curriculum unit, students are requested to construct a concept map. The
understanding of the students on the unit can be gauged by assessing the concept maps collected;

- Concept mapping can also be applied as a tool for class discussion on a specific topic. Key concepts can be discussed in the first part of class discussion so that a skeleton concept map can be constructed. Students are then requested to discuss in small groups. Detailed concept maps can be followed by adding new concepts, links and cross-links.

References:

