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Concept Mapping and PLA: Assessment of Tacit and Non-Linear Learning

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This is a multimedia article that includes a link to the concept mapping presentation created by the author.

Non-Linear Learning and Assessment

Prior Learning Assessment (PLA), or assessment of college-level learning acquired independently from formal learning settings, is a challenging task, given that this learning has not been organized by academics into a carefully crafted curriculum that is further amendable based on prescribed outcomes. When information is learned independent of traditional instruction, this information is generally collected from various sources and self-organized by the learner into "conceptual models" (Sheckley & Bell, 2006). With greater access to information through open education resources and other Web-based means, increasingly, students have developed their own conceptual models associated with the knowledge they have gained. How, then, can these models be made visible for measurement in the framework of college-level expectations?

Before we answer this question, let's make a distinction between linear and non-linear learning and assessment. Linear learning can be akin to non-active learning, limited by using teaching techniques (i.e., linear teaching), based on a sequential presentation of material for the purpose of student memorization--often the single delivery mode and source of instruction, such as lectures (Kinchin & Cabot, 2010; Paulson & Faust, 2011). This type of learning tends to result in declarative knowledge, which demonstrates the presence of new information, but does not exhibit a learner's ability to make connections between ideas or concepts (Hay, Kinchin, & Lygo-Baker, 2008). Learning strategies that are presented in such a linear and organized manner have been criticized for not addressing the complexities of living and working in the real world (Stewart, 2012). Critics of linear learning stress that learners need the ability "to know differently" rather than to know more (Youatt & Wilcox, 2008, p. 26).

On the other hand, non-linear learning, or self-organized knowledge, if approached effectively, can result in many learning activities and outcomes, including:

- relational learning, which refers to students' ability to make connections across knowledge sets and is associated with a higher order set of learning and critical thinking skills (Stewart, 2012; Travers, 2012);
- integrative learning, which refers to students' ability to make connections between information from various sources of learning (Youatt & Wilcox, 2008);
- active learning, which refers to students' ability to organize their own knowledge and is considered to be the opposite of inactive learning where students acquire rote knowledge (Gleason et al., 2011);
- meaningful learning, which refers to students' ability to demonstrate acquisition of new information (or concepts) combined with the ability to create new connections between these ideas (Hay, Kinchin, & Lygo-Baker, 2008).

The concepts of learning, instruction and assessment have significantly evolved over the last decade (Illeris, 2009; Sharan, 2008; Kang, 2007), resulting in a shift that allows students to become active participants in their learning process through analyzing and organizing their own knowledge (Cooper, 2007), as opposed to memorizing information that has previously been organized by someone else.

Emerging scholarship (e.g., Sheckley & Bell, 2006; Stewart, 2012) suggests that concept mapping can serve as an effective tool to engage students in non-linear learning and assessment experiences. Learning and assessment practices that utilize concept mapping tools and approaches require students' participation in a reflective process based on meaning-making by way of collecting relevant information and organizing it graphically, as opposed to presenting it in a linear essay format (Kinchin & Cabot, 2010; Kinchin, Cabot, & Hay, 2008). A concept map has been defined as a tool for representing one's understanding of a knowledge domain (Cañas & Novak, 2008). Furthermore, concept mapping is used to represent knowledge in a visual graphic format that can be measured and assessed (Hay, Kinchin, & Lygo-Baker, 2008).

Even though there is a limited discussion of suggested application of concept mapping within PLA practices (Popova-Gonci & Lamb, 2012), scholars suggest that concept mapping is an effective tool for adult students, especially for those who hold professional knowledge and experiences (Hay, Tan, & Whaites, 2010). Concept mapping has been used as a tool for assessment of experiential learning in the context of the traditional academic environment. Archavarungson et al. (2011) applied concept mapping to analyze whether students were able to connect theoretical and experiential learning, and found that theoretical learning was enhanced due to the added experiential learning component.

Tacit Knowledge and Assessment

The following argument is based on the assumption that traditional learning is a largely explicit type of learning, whereas non-traditional experiential learning is primarily tacit. This assumption is based on common definitions of explicit and tacit learning, with explicit knowledge generally associated with a type of knowledge that is communicated via language and is kept in records (e.g., manuals or books) and tacit knowledge described as knowledge acquired through experience (Bautista-Frias, Romero-Gonzalez, & Morgan-Beltran, 2012). Wagner and Sternberg (1987) suggested that tacit knowledge is one of the primary characteristics of practical experience and observation, which is usually acquired in the absence of direct instruction. According to Kothari, Bickford, Edwards, Dobbins and Meyer (2011), expertise and experience are closely associated with tacit knowledge acquisition and sharing. In turn, characteristics of learning and experience described above are similar to those commonly exhibited by PLA students.

Even though tacit knowledge cannot be easily subjected to measurement and assessment, some scholars suggest that if appropriate mediums are afforded to externalize tacit knowledge, it can be communicated (Tee & Karney, 2010) for the purposes of sharing or assessing knowledge. Furthermore, scholars suggest that concept mapping can be used as one of the tools of transferring, or capturing and externalizing, tacit knowledge (Fourie, Schilawa, & Cloete, 2004). Interestingly, some scholars indicate that writing is not an efficient way of codifying tacit knowledge and suggest that knowledge maps can be used to convert tacit knowledge into explicit knowledge (Bautista-Frias, Romero-Gonzalez, & Morgan-Beltran, 2012). Application of concept mapping in the study of tacit knowledge also has been addressed by Kothari, Bickford, Edwards, Dobbins and Meyer (2011). Tacit knowledge and concept mapping have been further linked to knowledge management practices (Jabar et al., 2011). Other scholars addressed tacit knowledge as a critical aspect of organizational knowledge creation (Insch, McIntyre, & Dawley, 2008) and processes of knowledge construction (Tee & Karney, 2010).

The following presentation was prepared by the author and provides a multimedia discussion on the application of concept mapping as an assessment tool. Please click on the link below and select the "play" icon to watch the video before continuing with this article.
http://vimeo.com/61019506

Morphology of Concept Mapping as an Assessment Tool

The following discussion will delineate concept mapping features that can assist evaluators with assessing tacit and non-linear learning. Educational assessment that is based on concept mapping tools involves a range of criteria (Strautmane, 2012) and is contingent upon multiple features of concept maps, or concept mapping morphology (Miller & Cañas, 2008), which will be discussed later. Concept maps can be assessed by evaluating both the content (Villalon & Calvo, 2011) and the structure of the maps (Hay, Kinchin, & Lygo-Baker, 2008)). Analysis of concept mapping morphology can be indicative of students' levels and types of learning (Kinchin & Cabot, 2010). Concept mapping tasks and conditions also can be diverse and have been found to affect the process and the outcomes of assessment (Anohina-Naumeca & Graudina, 2012; Cañas, Novak, & Reiska, 2012).

Basic features of concept mapping morphology are concepts, propositions, linking phrases and crosslinks (for images and examples, refer to the presentation link provided earlier). These features can be a subject to content assessment.

Concepts

A concept is defined as a word or a phrase that describes an object or an event (Novak & Cañas, 2006). In addition to distinctions between object-type and event-type concepts, there is a reference to abstract concepts that cannot be as easily categorized into groups that are unified by common qualities (Cañas & Novak, 2008). Assessment of concepts, or terminology, chosen by a learner has been used as one of the indicators of student's learning (Villalon & Calvo, 2011). Students' learning can be assessed on correct choice of concepts, as well as on their ability to present self-developed concepts (Archavarungson et al., 2011). Assessment of concepts can be approached both quantitatively and qualitatively (Koul, Clariana, & Salehi, 2005; Oliver, 2008). Thus, PLA evaluators can first assess a student's concept map by reviewing the relevance of chosen concepts (such as ideas, principles, theories), as well as the actual labels, themselves. Concept labeling can represent a student's familiarity with appropriate terminology that is common within a certain discipline. Assessment of concept relevance and labeling can be indicative of a student's levels of learning, as well as mis-learning and non-learning.

Linking phrases

Concepts are not viewed as isolated elements of learning but are presented and assessed as constituent elements within a system that is unified by relational affiliation to other concepts (Cañas & Novak, 2008). This relational affiliation is expressed in the form of linking phrases that connect two concepts by indicating their relational value (Cañas, Novak, & Reiska, 2012). Some scholars consider assessment of relational value between concepts as a more accurate representation of a student's knowledge than other features that are based on quantitative assessment (Walker & King, 2003). High density of interconnectedness between concepts is associated with higher levels of learning within a domain of knowledge mapped out by a user (Strautmane, 2012). Concept maps constructed by experts are found to display significantly more connections in the form of linking phrases between concepts than those maps constructed by non-experts (Simon & Levin, 2012). Similarly, researchers indicate that faculty members generally create more networks, while students tend to produce fewer links, or connections, between concepts because students' knowledge may not have reached a stage of integrated understanding of a subject area (Walker & King, 2003). Linking phrases can be assessed for the types of values learners assign to the relational connection between two linked concepts (da Costa Jr, da Rocha, & Favero, 2004). In addition to expert/non-expert (or instructor/student) differences in the quantity of linking phrases, there is a noted difference in the quality of chosen links, with novice learners using more general references and experts demonstrating more succinct descriptions of relational connections between concepts and ideas (Cathcart, 2011). Similarly to the assessment of concepts, assessment of linking phrases can be conducted both qualitatively and quantitatively.

Cross-links

Cross-links are similar to linking phrases (as they connect two concepts). Cross-links, however, differ structurally from linking phrases. Unlike linking phrases, cross-links connect concepts that belong to different subtopics on the map (Salmon & Kelly, 2008). Assessment of crosslinks can be quantitative and can be based on the quantity of crosslinks in a concept map (Hsu & Hsieh, 2005). The ability to create cross-links between seemingly unrelated subtopics within a domain of knowledge (represented by a concept map) is generally indicative of a learner's advanced mastery of knowledge (Salmon & Kelly, 2008).

Therefore, an evaluator can acquire an understanding of how a student sees the relationships across concepts by assessing the linking phrases. The depth of student knowledge can be assessed by the vocabulary used in the linking phrases and the complexity of links. The number of links and the ways in which those links connect concepts can give insight into how the student understands relationships across concepts.

Structure

Original discussions of the concept mapping structure were limited to a hierarchical structure, with a learner's ability to position general concepts on top of the structure and more specific concepts branching out to the bottom of the structure (Novak & Gowin, 1984). This author, however, suggests that hierarchical structuring is likely to be indicative of declarative learning and does not exhibit higher levels of learning. Further studies of concept mapping structures were reviewed for alternative ways of organizing and demonstrating knowledge. Kinchin, Hay and Adams (2000) identified three basic structures of a concept map: spokes, chains (single and multiple) and networks. The concept mapping structure can be assessed for information on a student's levels of knowledge by associating spoke structure with a "learning readiness" stage, chain structure with a procedural type of learning and network structure with "scholarly" levels (Hay, Kinchin, & Lygo-Baker, 2008), or a holistic understanding of a domain of knowledge (Kinchin & Cabot, 2010). Kinchin & Cabot (2010) noted that chain structure can be a result of linear teaching, or teaching that is based on sequential presentation of learning for student's memorization.

Progressive differentiation and integrative reconciliation introduce yet another layer of concept mapping characteristics of structure (Novak & Gowin, 1984). Progressive differentiation is the degree to which a student elaborates from general (or more inclusive concepts) to less inclusive concepts, which is similar to a hierarchical structure and an arguably declarative type of learning (or factual knowledge). Integrative reconciliation is what demonstrates a student's ability to determine and exhibit relational connections between concepts that are not directly related to each other through progressive differentiation.

Morphological assessment is not limited to a single concept mapping approach. Whereas some approaches are based on having students generate their own list of concepts and organize them into a relational map, others can be based on having instructors present students with a set of pre-determined concepts to be arranged and linked into a concept map (Walker & King, 2003). Researchers found that, depending on specific educational objectives, some concept mapping strategies are found to be more effective than others (Wang & Dwyer, 2004)

To better understand how these features of concept mapping can assist in evaluating student learning, follow the link below to view a graphic representation of concept mapping morphology discussed earlier. The following discussions explain these features further.
http://cmapspublic3.ihmc.us/rid=1LTH3922R-H98BZS-4FQG/Structures.cmap
(re-drawn from Popova-Gonci & Lamb, 2012)

Note the following features of the map:

- The student addressed three subtopics or themes (expressed in three main branches on the map). The subtopic positioned on the left side of the map is primarily expressed via chain structure, which is generally indicative of procedural knowledge. The student is likely able to discuss both factual learning (declarative knowledge) and a chain of processes associated with a particular practice (procedural knowledge).
- A second subtopic includes a spoke structure and a few forms of a chain structure that are more complex than the one demonstrated in the first subtopic. Spoke structure is generally indicative of lower levels of

learning, as this type of relational value between concepts does not denote integrated learning but references primarily factual knowledge, supported by additional information and/or examples. Presence of other structures, however, may indicate higher levels of learning. Also note two examples of linking phrases. A linking phrase "is" can be referred to as a weak linking phrase, as it does not offer a detailed description of a relational value between two adjacent concepts. Linking phrase "promotes development of" is considered a strong linking phrase, as it exhibits a learner's understanding of a concrete description of integration between two concepts.

- A third subtopic (on the right) is expressed via spoke and net structures. Network structures indicate advanced levels of learning. Also note that two concepts from subtopics two and three are connected through a cross-link. Ability to make connections between discrete subtopics or themes also is one of the indicators of higher levels of learning.
- A student's learning is not evenly distributed across the map, with a first topic exhibiting the weakest level of learning and a third topic, the strongest. This type of uneven distribution may be common for learners who acquire knowledge from non-linear learning.

Conclusion

Increasingly, students are augmenting their knowledge from non-traditional sources, such as Web-based information and open educational resources. Students are adding self-organized knowledge to what they have gained through traditional means or what they have learned along the way. Learning strategies that are presented in a linear manner have been challenged by new approaches to learning that recognize the complexity of the real world (Stewart, 2012). In addition, new strategies to assess augmented traditional learning and/or completely self-authored learning are essential.

Concept mapping has been suggested as one of the approaches to managing and assessing learning in a nonlinear mode. Concept mapping tools have been recognized for their reliability and validity as an assessment tool (McClure, Sonak, & Suen, 1999) and as an effective tool for assessing students' integrated learning (Salmon & Kelly, 2008) and higher order cognitive skills (Cañas, Novak, & Reiska, 2012). Concept mapping also has been discussed as an effective assessment tool for evaluation of adult student learning and skills (Hay, Tan, & Whaites, 2010). Furthermore, the application of concept mapping has been frequently addressed as an effective tool for externalizing, sharing, and assessing tacit knowledge (Fourie, Schilawa, & Cloete, 2004).

Concept mapping tools offer a range of approaches to both organize learning into a comprehensive representation of a domain of knowledge, as well as to assess tacit and non-linear learning that has been acquired via a non-academic, experiential environment. Whereas concept mapping learning and assessment offers intriguing opportunities for demonstrating and assessing integrated and tacit learning, training needs to be provided to ensure effective application of concept mapping tools.

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