The Application Of Concept Maps To The Instruction Of Accounting Information Systems

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Introduction

Accounting information systems (AIS) is the area of accounting characterized by the highest rate of change. This is attributable largely to AIS's inherent and inextricable connection to technological advances in computer hardware and software design, computing power, networks and communications. The rate of change has presented a formidable challenge to educators. They must not only strive to stay abreast of what represents the most appropriate content for classroom instruction, but must additionally determine the most effective method of delivering such content. As such, methods of pedagogy in AIS are diverse and still in their infancy. This paper proposes the use of concept maps, tools used across many disciplines to both organize and represent knowledge, for the presentation of key concepts and principles in AIS.

Concept maps rely on a two-dimensional structure to indicate the 'shape' of a topic and to convey the relative importance of information as well as the way the information relates to other information. They are more compact than the conventional notes taken by students and as such can facilitate associations (mindtools.com, 2001). Concept maps exploit the power of vision toward the integration of complex information. Concept maps are currently being used in a variety of disciplines to develop research frameworks for projects, for curriculum development, to assist students in developing new cognitive structures, and to evaluate students' knowledge of course material (Temple, 1996). The application of such instruments to AIS education is suggested to be both natural and fruitful.

The Concept Map Technique

Concept maps were developed, in part, by Novak and Ausubel and based on the learning psychology of David Ausubel (Ausubel, 1963, Novak, 2000). The function of concept maps is the concise, visual, hierarchical presentation of the ideas presented in the curriculum. More general, inclusive concepts are represented at the highest levels in the hierarchy with progressively less inclusive concepts incorporated at appropriate levels below. Although concept maps were initially most often hierarchical in structure, they have evolved into a number of accepted formats including (<http://classes.aces.uiuc.edu/ACES100/Mind/Cmap.html>, 2001):

- Spider-The central theme is placed in the center of the map and sub-themes radiate outward.
- Flowchart-Information is presented linearly.
- Systems Concepts Format-Linear presentation of information is supplemented by indicated inputs and outputs.
- Multi-dimensional/3-D-Presents information too complicated for a two-dimensional format.

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- Mandala-Interlocking geometric shapes are used to present information using a telescopic visual effect to focus the user's attention/thoughts.

They are drawn, preferably through the assistance of computer software (use of the drawing functions in Microsoft Word® are sufficient and were, in fact, used for the maps included here), with concepts enclosed in boxes (or circles). Connecting lines and arrows indicate relationships between concepts. Words on the lines are used to describe the type of relationship that exists between the concepts. Most concepts are properly labeled with words. Linked concepts can form propositions, basic statements about events or objects often representing a semantic unit (Noval, 2000). Such maps can be built at varying levels of detail. That is they can be used to provide an overview of the material to be delivered in the AIS course as per the syllabus or they may focus on the details of a specific AIS function or topic. Although the general flow of the maps is top-down in vertical fashion, horizontal lines can be used to represent interconnected, networked ideas.

Theoretical Justification

According to Ausubel's Assimilation Theory (1963), concept maps facilitate learning by allowing new concepts and propositions to be assimilated into the individuals existing propositional framework. The concept map is Assimilation Theory's primary methodological tool for "ascertaining and representing what is known" (Ford, 1993). Such use of concept maps highlights Ausubel's principle of subsumption, which posits that new information is frequently relative to and subsumable under more inclusive concepts and is most effectively learned in such a manner. This type of learning is designated as *meaningful* learning (as opposed to rote learning) and is distinguished by three required conditions (Ausubel, 1963):

- A conceptually clear presentation that includes language and examples that can be related to prior learning.
- The learner possesses significant prior knowledge, which Ausubel maintains is present in most learners after the age of 3 years of age.
- The learner must choose to learn meaningfully. This can be affected by the educator's choice of evaluation modes. Objective-type exams tend to promote and depend primarily on rote memorization and recall.

It is maintained here, that it is precisely such learning that is critical to successful AIS instruction. In AIS, it is necessary for students to go beyond the memorization of bits and pieces of information, assorted facts. Systems knowledge inherently requires the imposition of a structure and organization upon its factual building blocks. Systems understanding subsumes an explicit recognition of connections and relationships, particularly when moving from theory to the design and implementation of systems. Concept Maps are seen as a means of facilitating the cognitive integration of AIS principles.

Such a notion is compatible with work performed in cognitive psychology beginning with the seminal work of George Miller, *The Magical Number Seven Plus or Minus Two: Some Limits on Our Capacity for processing Information* (Miller, 1956). Miller found that people's capacity for processing information was limited to approximately seven pieces of information with a variance of plus or minus two pieces across individuals (Miller, 1956). Each piece could be comprised of a single isolated item, such as a number, or a piece could be comprised of several interrelated numbers or words, held together in a meaningful fashion, known as a "chunk" of information (Miller, 1956). Chunking increases the individual's capacity for processing information by increasing the amount of information contained in each piece.

The process of chunking requires information to be recoded into pieces whose information content has been enriched by the addition of linkages. The goal for educators should be to provide mechanisms, through their instruction, that will allow students to more readily recognize the relationships between ideas and thereby promote the use of chunking. Concept Maps, by explicitly representing the significant concepts and interrelationships between those concepts within a topic, serve as means of facilitating learning that is characterized by both improved memory and recall as well as more fundamental understanding.

Lenneberg (1967) states “the abstractness underlying meanings in general may best be understood by considering concept-formation the primary cognitive process”. Thus, it is conceptual learning that is meaningful learning capable of adaptation to and integration into new newly presented scenarios. This view of learning is emphasized by Gestalt Theory. Gestalt theory began in the early nineteenth century as a reaction to the prevailing mechanistic views of learning. The core of Gestalt theory lies in its “holistic” view of the human psyche and the contrast between what are identified as andsums and trandsums (Wertheimer, 1980).

An andsum represents a total that is precisely equal to the sum of its parts, while a trandsum “transcends the sum” (Wertheimer, 1980) in that it contains something more. To Gestaltists, the world is comprised chiefly of trandsums and the learning process occurs not incrementally, but through a leap of insight or understanding (the “Aha!”). Significant to Gestalt theory are the concepts of “Dynamic Self-Distribution”, where the parts of a whole are not seen as held together arbitrarily, rather their position and function are determined by the dynamics of the whole, and the very similar “Relational Determinism”, where the nature of parts is determined by their relationships to other parts and to the whole (Wertheimer, 1980). Key to Gestaltists is the process of reorganization, in which an initial perception is modified to achieve understanding. Meaning and understanding are not to be equated with memorization. Memorization leads to the mechanical application of rules to situations, without regard to the characteristics of the situation, whereas, true learning or understanding permits the flexible transfer of knowledge to new situations. Concept Maps provide just such trandsums, with structures that adhere to both “Dynamic Self-Distribution” and “Relational Determinism”.

In addition, concept maps are visual devices. Visual techniques have long been accepted in AIS as preferred methods of representing processes such as transaction cycles and database designs. Visual models permit abstractions that eliminate “fussy” details and allow students to focus on the critical components of an idea or topic. Their application to conceptual information can be equally effective. Vision dominates immediate perception. Effective visual displays can play an important role in facilitating not only the learning process but the ability of students to store and recall information as well. Allen Paivio highlighted the role of mental imagery in aiding human memory by arguing that humans use two codes to store an experience: a spatial/imaginal code and a linguistic one (Paivio, 1971). For individuals predisposed to spatial memories, concept maps can facilitate effective mnemonics where remembering the shape and the structure of a concept map can supply the cues required to remember the information included within the map (mindtools.com, 2001).

Finally, if meaningful conceptual understanding is accepted as the desired learning objective, then the teaching method should be one that is most likely to meet that goal. Bonner (1999) suggests that, while multiple methods are typically used and often desirable in instruction, generally more complex skills and cognitive strategies require more active learning techniques. Concept maps lend themselves quite readily to active learning. Students can participate in the construction of concept maps as a group exercise, either during the class period, or on their own time.

If conducted as an exercise during class time students can be broken into smaller groups and asked to work on a map of a topic that has been newly introduced. This forces students to “get their feet wet” and concretely represent the concepts and relationships that are a part of their current understanding and to determine where their understanding breaks down. Students are assisted in assessing their existing knowledge and competence. Alternatively the class as a whole can be engaged in the interactive construction of a concept map, with the instructor, that serves to integrate all previously discussed ideas in an area that is, at this point in the curriculum, being summarized. Such an exercise can provide a very nice means of reviewing material prior to a formal examination.

If students are requested to construct maps on their time, the maps should be brought back into the classroom and discussed. Concept maps can serve as very effective evaluation tools, permitting the instructor to identify “both valid and invalid ideas held by students” (Novak, 2000). Class discussion of the maps allows the instructor to provide the students with feedback. Feedback is identified as necessary for fostering the assimilation of complex cognitive rules and strategies (Bonner, 1999). It is important to note that the process of constructing concept maps can be either extremely formal or quite informal depending upon the educational objective and setting.

Construction Pointers

Concept maps are context dependent and can be constructed to model something as broad as an entire domain of knowledge or as specific as the answer to one particular question (Novak, 2000). That is, concept maps can be prepared on either the macro level, the micro level or something somewhere in between. The context creates the hierarchical structure.

The first step in creation is to decide upon the topic. Once this is done then a list of key concepts should be generated that can be ordered from the most general or all-inclusive to the most narrow and specific. At this point, “mapping” can begin. The labels for both concepts and relationships should consist of simple words and phrases. The most powerful or information-rich words and phrases should be chosen. As with other visual techniques, care must be taken to eliminate excess words and to avoid clutter. It is helpful to use some method (such as computer software, or post-its) that can easily permit revisions, as the mapping process is decidedly iterative. A good map may require from several to many revisions to ensure clarity, logical structure and attractiveness.

The final steps are the indication of cross-links (for networked concepts) and “dressing up” the design with font sizes/styles and color. Color can be used to separate ideas or as an organizational device indicating concept levels (subordinate vs. superordinate).

Examples

Several examples are provided here to illustrate some of the possible applications of concepts maps within AIS. In view of space limitations the examples have been restricted to partial maps. Figure 1 provides a partial map of components of a possible AIS curriculum that is hierarchical in structure. Figure 2 depicts a partial map of Internal Control Systems that is being structured as a spider. Finally Figure 3 illustrates the beginning of a hierarchical map for Database Management Systems.

Conclusion

Concept map development would appear to serve as an effective pedagogical technique in AIS education. The process of constructing such maps encourages students to re-examine their understanding of conceptual relationships by integrating new, relevant concepts, by constructing new relationships or by

re-configuring existing relationships. The map is an explicit, visual symbol of their cognition that can be used to communicate their understanding for evaluation purposes. The exploration and mastery of AIS, a subject replete with networked conceptual relationships and interrelationships can benefit from the application of concept mapping.

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**Figure 1: Partial Map of Possible AIS Curriculum
Hierarchical Structure**

Figure 2: A Partial Map Of Internal Control Systems
Spider Structure

**FIGURE 3: A Partial Map of DBMS's
Hierarchical Structure**