Use of Computer Based Concept Mapping Tools

Working Group 3.5

Chair: Eric Bruillard (FR)

Rapporteur: Lesley McCarthy (AU)

Participants: Maj-Britt Andreassen (DK), Sue Fewster (AU), Phil Nanholy (AU), Hajima Ohiwa (JP), Cynthia Sistek-Chandler (US)

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Abstract: Concept mapping has been a subject of investigation especially since the introduction of computer based tools, which have simplified the creation and modification of concept maps. In education, concept maps can be used in many different ways: as planning tools, reflection support, creative support, assessment tool, teaching and learning tools. This professional group will identify and explore the range of applications for concept maps currently undertaken in the countries/systems/institutions of the participants and discuss issues surrounding the effective implementation of such strategies.

1. CONCEPT MAPS: WHAT IS IMPORTANT?

Concept mapping, the process of spatial representation of graphic and text based pieces of information and their links, has been a subject of investigation for many years but more so since the introduction of computer based tools, which have simplified the creation and modification of concept maps. Concept maps are used in many ways in education and also in other domains such as business and management. There are many definitions of concept maps, or knowledge representation strategies, in the literature beginning with Novak in 1976 (Novak 1990). According to Jonassen et al. (1993) concept maps are representations of concepts and their interrelationship that are intended to represent the knowledge structures that humans store in their minds. They are also, “spatial metaphors that indicate

relationships among concepts in a node-link-node visual display" (Jonassen et al. 1993) Concept maps can be viewed as simplistic representations of what we know as humans. Data with labels is *Information*; information linked with other information is *Knowledge*. A concept map models those links. We can find many other definitions, many types of concept maps indicating that there are very general notions or objects.

In education, many authors have advocated the importance of concept maps (see review in Bruillard and Baron 2000). For example, Jacobi reported on the importance of concept maps in education as a means of presenting structure and an assessment tool, whilst McAleese (1994) commented on the process of creation. From a constructivist viewpoint, concept mapping aids the construction of meaning, organisation of ideas and information, creation and modification of links and relationships. But according to applications and contexts, what seems to be important may be different and sometimes almost opposite. For example, in the business community in Japan, the KJ method for concept map formation without crossed links is well known. This method was proposed in the 60's by an anthropologist Jiro Kawakita (1982) for creating new ideas from the scratch. KJ method is far more popular than Novak in Japanese schools (Ohiwa et al. 1990, Ohiwa et al. 1997). The method is widely accepted by business community in Japan because not only new idea generation but the method is extremely useful for consensus forming among the participants. If some map representation causes uneasy feelings among the participants, discussion starts and final map is formed through this discussion. Unease often comes for different interpretation of the word written in a box. After reaching a common understanding of the word, consensus for the map is easily reached. In the KJ method, important criteria for good map formation is that links must be formed among the adjacent boxes and links must not cross each other. The effort to realise these criteria requires a series of setting of the boxes and links. This forces participants to think deeply about the problem. The map Kawakita formed follows these criteria.

If we follow these criteria, we often have to give up and place either some boxes or links, for the clarity of the whole map. This may seem that an important part of the problem is discarded, but often our concept structure for the system is immature. Complex systems in the real world require simplicity and clearness if they have to work in the complex situation. In this example, the process of producing a map goes from the complex to the simple. But other examples suggest other methods. A reason for investigating the use and value of the cognitive tools known collectively as concept maps is their close association with the structure of hypermedia texts. These text types, with their characteristic structure of linked nodes, are becoming ubiquitous as the basis for the Web and widespread in other media

types such as digital TV, electronic games and cellular phones. The influence of interactive screens and linked information nodes can even be seen in non-digital media such as cinema and popular magazine design.

From the most basic use as a graphical, perhaps linear, representation of knowledge to a complex web of spatially organised, interrelating concepts containing text, images, symbols and colours, concept maps are a very personal and individual expression of information. Here the process goes mainly from the simple to the complex. The more complex the concept map, the more profound the understanding of their producer. Another point is the evolution of a map and how to take into account this evolution. The requirements can be very different according to successive stages of learning.

To summarise, a concept map is a trade-off between opposite constraints. In some situations, the nearness of concepts on the map may be more important than the existence of links, the spatial nature of the map allowing the expression fuzzy relationships, links expressing more formal ones. Placement is essential.

2. CONCEPT MAPS IN EDUCATION

In elementary schools, students and teachers alike take advantage of computer assisted concept maps. Teachers have utilised concept mapping software to: plan a unit of work linking outcomes/curriculum areas or themes; develop new concepts and relationships; map current knowledge or understandings; as a teaching tool to scaffold learning; demonstrate progression in concept development; assess student understanding; and plan for further research or investigation. Students use concept maps for: planning research tasks; literature reviews; record current knowledge, understandings and relationships; explore understandings of a concept; geographical maps; and planning or mapping web-sites or web presentations.

These lists have to be viewed as examples and are certainly far from being exhaustive. They give an idea of the wide range of applications we can imagine. Notice that behind all these examples, concept maps are a kind of external representation which can help to develop high order skills. Thus, as a brainstorming tool, concept maps can be used to help young children represent what they know about a subject. This can make more concrete the abstract and ephemeral ideas of 'thinking' and 'knowledge'. In this way concept maps can be a tool for children to move towards meta-cognition.

To draw a parallel with multimedia, concept maps can be seen as simplified representations of knowledge structures. A logical-hierarchical view of human knowledge creation and retention divides all that is known on a subject into a taxonomy of major ideas or all-embracing concepts which

are defined more narrowly focused supporting concepts. So an example might be the idea of animals which different individuals would define with their own set of supporting concepts. Some of these would be logical (mammals, birds, reptiles etc) and some would be associative and possible social-emotional in nature (memories of the sight, touch, smell and feelings towards a pet). As a learning model it is suggested that humans compare each new piece of information with their growing stock of major concepts and accommodate the confirmation or contradiction the new brings to the store of experience. While such a view of learning and/or the structure of knowledge is simplistic it directly parallels with the structure and purposes of both concept maps on a micro scale and the Internet on a macro scale.

2.1 Computer based concept maps

The use of computer based concept maps has several advantages, mainly the ease of construction, the ease of revision, and the ability to customise maps in ways that are not possible when using paper and pencil. The ease of modification encourages effective learning through the creation of new schema (mind maps/knowledge maps) and the extension, modification and reconstruction of existing schema. The ease of input, the fluid nature of computer assisted concept mapping tools assist students to construct more detailed and complex concept maps with attractive visual representation. Computer assisted concept maps allow, assist and encourage development of higher order thinking skills, especially the analysis and synthesis of information and the delving deeper to extend/explore/create more complex understandings, links and interrelationships. They also assist in understanding and navigation of web design and the mapping through understanding of links that is inherent but not explicit in web construction.

Computer assisted concept maps are also used in collaborative group activities to develop shared understandings. Their use encourages greater exploration and in depth discussions, and the ease of manipulation of data, the modification of order, hierarchy, links and relationships ensures more time on thinking and less on the mechanics of producing the map.

The KJ method mentioned earlier, has been tried to be performed on the computer, and has been used for map forming in general. An important aspect of the computer support for map formation is the direct manipulation capability of software, because the forming process requires very hard concentration. If it requires, e.g. scroll bar operation, your concentration is damaged. Careful human interface design is essential for such software. One advantage of using the computer is re-trial of map forming is easy, the other is the process of the map formation can be recorded and replayed. This is useful for educational and research purposes of the human brain activities.

Concept maps are used in different contexts (education, business, personal development); references are accessible but very mixed (scientific books and papers, more ideological resources, commercial resources etc.) and may be contradictory. We have seen that requirements concerning concept maps can be very different, as the way of constructing them. Concerning one specific domain or phenomena, it is not possible to decide what can be the best concept map, even for a given purpose. We can only say when we are expert in a domain if a map is good or not. One key idea emerges is the idea of flexibility of such tools. In this context, the general question of interest of concept maps in education is meaningless. More practical questions are how these tools can be used in a powerful way in education. For that, good examples provide interesting hints.

3. EXAMPLES

As group participants, we shared some experiments showing very different uses of computer based concept mapping tools.

3.1 First example (thanks to Phil Nanholy)

This example of concept map usage describes their role as a support for research and for the creation of hypermedia texts in elementary school student's study of history. As the students prepared to research key historical figures in Australian history they used pencil and paper concept mapping to organise their brainstorming of areas to investigate. In one classroom small groups of students also created a wall display using string and file cards to publish their group maps for class discussion and comment. These same concept maps were later used to organise the structure of the hypermedia texts they created to report the findings of their research.

3.2 Second example (thanks to Sue Fewster)

Students aged 5-13 years use concept mapping (Inspiration) as a tool for constructing individual learning plans. Briefly each student chooses an issue of interest. They then set themselves a learning challenge in all areas of learning as described in the curriculum framework. These challenges are the first layer of their map. A next layer gives information about the resources they will access to find information and complete their learning challenges. Finally the students add a layer describing the way they intend to document their learning. Their concept map is then used to communicate and share

their ideas with an adult during their Individual Learning Meeting. This takes place before they commence their challenges.

The concept map provides the adults, the student and their family with a means to reflect an existing knowledge, learning preferences and discuss the challenges. Inspiration ensures this collaborative construction is easy and stress free. There is no 'crossing out' of ideas as would occur on paper. Ideas can be altered, extended and regrouped as the learning conversation develops. During learning time the concept map forms the basis on which information can be added. For example, URLs are copied and pasted into notes that lay behind the resource bubble. Keywords, phrases and other relevant information can also be copied and pasted into notes the same way.

Some students/small groups may choose to use a concept map as a way of documenting their learning. For example, to communicate with others the factors affecting global warming, and the measures taken by governments as a way of dealing with the issue. Some also find concept maps useful for planning web pages, Hyperstudio stacks and imovies.

3.3 Third example (thanks to Maj-Britt Andreassen and Cynthia Sistek-Chandler)

In this example, concept maps are used for working with genres. One group member, discovering concept map for the first time, tried to prepare a classroom activity. She imagined that a concept-mapping tool might be applied to a 'Robisonade' project, already done with her class. The goal is for each student to write their own 'Robinsonade' in diary format. At the start the class will discuss 'Robinson Crusoe' by Defoe and other similar stories. Most students also know the TV-show 'Survivor'. By employing concept maps, several benefits are expected such as to get a better-structured Robinsonade, to help the students to see (literally), and remember, the individual parts that make up a Robinsonade, to evaluate more easily the project which can be more fun and instructive for the students.

Use of the Concept map in the 'Robinsonade' project could be implemented as follows (maps designed with the help of an expert in the use of concept mapping tools in school)

This map can be used in many different ways: as a tool for the teacher to organise the activity, as an assignment for the student, a reference for them, a template they have to complete etc. Another map shows an example of what a student could produce on the subject.

These three examples show uses of concept maps as brainstorming, organisational and planning tools.

4. SOME RESEARCH ISSUES

Many research questions emerged from the group discussion, at both a practical level and also a more theoretical one.

The main question is how to use computer based mapping tools in a fruitful way in education and how to take into account all kinds of students. The problem of culture and of learning styles appeared essential. According to various characterisations of learning styles (e.g. Lee's Learning Preference Scale, Gardner's Multiple Intelligences, and Kolb Learning Styles Inventory), which relations can be drawn with concept mapping (see for example Oughton and Reed 2000)?

In depth study about concept maps as organisational tools seems also important. As assessment devices, concept maps are to be considered. These cognitive tools are not only a better assessment strategy to assess explicit knowledge but also a method to give insights into the types of attribute that at present is not being assessed. Higher order skills and understandings need more subtle assessment strategies that give insights into the processes used to create a product. More theoretical problems could be investigated such as 3D (or more) representation of maps, the design of tools for comparing to maps (different persons or the same person at different stages), and the method for designing maps without crossings.

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