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VARIETIES OF CONCEPT MAPPING

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Abstract. There are different versions of concept mapping. The purpose of this paper is to compare some of them and to explicate the main differences. Proper concept mapping methods include all methods of knowledge graphic presentation that are clearly based on the seminal writings of Novak and his research group from 1981 to 2002. Some writers may use the term concept mapping, although one of the most basic requirements is not fulfilled: No meaningful propositions are produced out of linked concepts. Sometimes no links at all are present, only concepts spread in a conceptual space. In "the Novakian Standard Concept Mapping Format" there are some unnecessarily complex rules. Critical reflection on alternative ideas about concept mapping may suggest alternative and better ideas in the future.

1 Introduction

There are different versions of concept mapping. The purpose of this paper is to compare them, and to explicate the main differences. In the future this may lead to theoretically better and empirically more efficient concept mapping than we have today. Our main interest, however, are those varieties of concept mapping in which its is clearly admitted that researchers first used and tested Novakian concept maps (e.g., Novak & Gowin, 1984; Novak 1998), and perhaps then adapted it for their own purposes. There are many ideas of what concept mapping is about and how it is described. There are differences in definitions of concepts and in ideas of how general or specific a concept mapping tool should be.

2 History of concept maps

It is commonly known that concept mapping was developed at Cornell University. Stewart, Van Kirk, and Rowell (1979, p. 171) claim in *The American Biology Teacher* that they developed concept maps. However, in their concept maps the links were not named and no propositions were formed from concepts. In that same journal, Novak (1979, 1980) later published two articles in which he referred to Stewart, Van Kirk, and Rowell (1979). He also presented examples of concept maps, but the links were still unnamed. However, in Novak (1981, p. 14) the links were named, and meaningful propositions were created out of concepts. This is the form of Novakian concept maps that has been spread globally. In fact, Novak and Gowin (1984) were very influential in spreading it all over the world.

There are many researchers (e.g., Slotte & Lonka, 1999, pp. 522 – 523) who refer to Novak and Gowin (1984), but clearly mix concept maps with Buzan's (1974, 2000) mind maps, which are much simpler association maps. It is strange that a refereed journal accepts this kind of language use. Some researchers circle or frame full propositions, connect them with lines, and call the end product "concept maps" (e.g., Palmer, 1995; 1998, p. 113). Ahlberg (1993) presents an overview of many different methods that are misleadingly called concept maps (see also Ahlberg & Ahoranta, 2002).

3 Novak and Gowin (1984) and Novak (1998) as standard starting points compared to other options

Most articles published that describe the use of concept mapping refer to Novak and Gowin (1984) In their book, the most common version of concept mapping is as follows: There are circled concepts with links connecting them, and the links are labeled or phrased in order to create meaningful statements. The ideal concept map has hierarchy. Links flowing from the top concept to other concepts are mostly lines. It's only when links are horizontal or are read upwards that arrows are used. This formatting style for concept maps is presented as his pending trademark in Novak (1998). It is remarkable that Wandersee (2000, p. 136) criticized one of the figures in Novak's (1998) book because the "concept map on rhizobotany … fails to follow the Novakian Standard Concept Mapping Format."

Novak (1998) has applied for a trademark of his style of concept mapping: Concept Maps ™. However, many of Novak's own students and research partners do not follow all the rules. Neither does Novak himself

(e.g., Novak, 2002). According to Novak and Gowin (1984, p. 182): “Lines connecting concepts were not labeled in our earlier work.” They referred to manuscripts and publications from the 1970s. Now a research question arises: When did the first labeled links appear in concept maps? This is an important question because everything in the world is somehow connected. It does not tell very much about somebody’s thinking and learning if s/he only lists words, arranges them spatially, circles them, and links them by lines. But if links are labeled, then meaningful statements about the world are created and everybody knows what that person thinks or has learned about the world, and considers important enough to express. As far as we know, Novak (1981, p. 14) was the first publication in which the links were named and meaningful propositions were created out of concepts. This is the form of Novakian concept maps that has been spread globally.

An overview of the work that has been done at the Institute for Human & Machine Cognition (IHMC), where Joseph D. Novak continues to work after retiring from Cornell University, has been published by Coffey et al. (2003). This document illustrates a mix of concept maps in which all links are labeled as ordinary lines in some and labeled as arrows in others. “The Novakian Standard Concept Mapping Format” (expression from Wandersee 2000, p. 136) is used on the IHMC CmapTools (Cañas et al. 2004) Web site (IHMC 2004) Web site as well as the Web site of the First International Conference of Concept Mapping (CMC2004 2004). The links are mainly lines, and arrowheads are used only according to “the Novakian Standard Concept Mapping Format.”

Safayeni, Derbentseva, and Cañas (2003) presented an idea about cyclic concept maps, which are hierarchical. This is a special case of an improved method of concept mapping in which the concept map can be constructed in any way that is the best justified option. This is because according to modern science, the world is a system and everything in the world is connected. That is why a concept map can be interpreted as a tentative theory of a part of the world. Hierarchies or circles may sometimes be natural and economical, but sometimes a network can be an even better option.

4 Elements of an improved method of concept mapping

Ahlberg (2001) presented a list of commonalities differences between improved concept maps and traditional Novakian concept maps. Below we present an improved list from the viewpoint of research methodology:

1) All concepts are interpreted as main elements of thinking and learning, and they are always inside frames. In Novak and Gowin (1984, pp.14, 22, 52) and Novak (1998, p. 100) concepts are sometimes inside frames and sometimes not.

2) Novak and Gowin (1984) and Novak (1998) prefer very short verbal labels for concepts. However, concepts sometimes require many words in order to be correctly labeled. There is no accurate limit on how many words may be included in a concept label. In an improved concept map as many words as are needed are used to name the concept accurately.

3) In order to have a meaningful proposition, all links between concepts have arrowheads to show in which direction the connection from one concept to another is to be read. However, if they were following their own rule, in Novak and Gowin (1984) and Novak (1998), only the concepts that are either horizontal or are to be read upwards should have an arrowhead. Thus, this complex rule is not always remembered even by those who use the traditional Novakian concept mapping (e.g., Novak & Gowin, 1984, p. 176; Novak, 1998, pp. 52, 84,121). Novak (2002, p. 553) presented a concept map “showing the nature and structure of concept maps.” In this concept map all links have arrowheads, not only horizontal or upward links. Already Novak and Gowin (1984, p. 102) presented a concept map in which all links had arrowheads, and they called it “a good concept map.” We agree, it is a good one.

4) The expressions connected to links may be short or long, but they must accurately express the thinking of the person whose thoughts are concept mapped. Novak and Gowin (1984) and Novak (1998) favor very short verb expressions. The essential point is that the link includes a verb expression and the resulting proposition is meaningful and more or less true, plausible, probable, et cetera.

5) You may connect pictures, videos, sounds, et cetera to concept maps (e.g., Ahlberg, 1993; IHMC, 2004). Novak and Gowin (1984) and Novak (1998) never do this.

6) Novak and Gowin (1984) and Novak (1998, 2001) stress the importance of Ausubel’s learning theory. Ahlberg (1993, 2002) has come to conclusion that whatever learning theory is used, you may still use

concept mapping because it is as general a method as is speaking or writing. Everything that is spoken or written may be transformed to concept maps, and all good concept maps may be easily transformed back to ordinary speaking or writing.

7) Novak and Gowin (1984) and Novak (1998) argued that concept maps should always be hierarchical. This is often sound and economical, but not always. For instance, Novak and Gowin (1984, pp. 16-18) demonstrated how the same concepts can be arranged hierarchically in three different ways. The same effect could be better achieved if the most important concept is sometimes in the center of the concept map but sometimes somewhere else, as long as that choice can be justified to be the best option. Then, we may imagine the center of the concept map as the top of a pyramid seen from above. It is good to remember that the world is a system, and therefore, sometimes the best presentation for the world and its part systems are conceptual systems, which are not always hierarchical. Novak and Gowin (1984, p. 16 - 18) presented three concept maps illustrating the same concepts. They look hierarchical, but there is no way to show that the topmost concept is either the broadest or most inclusive one, as it should be in a real conceptual pyramid according to Novak and Gowin (1984, p. 33) and Novak (1998, pp. 3, 227). There are also ontological and epistemological reasons why good concept maps may not be always hierarchical. The world is a system, and therefore, the best conceptual representation of it is a conceptual system, a concept map, which may not always be hierarchical. A similar idea has come into the minds of Safayeni, Derbentseva, and Cañas (2003) who presented an argument for cyclic concept maps, which are not hierarchical.

8) In a good concept map each concept is mentioned only once, similar to a good geographical map in which each place is named only once. Novak (1998, e.g., pp. 14, 66-67, 121) does not always follow that simple and elegant rule. Nicoll, Francisco, and Nakhleh (2001, p. 864) showed that there may sometimes be practical reasons not to follow this rule. Sometimes there is a concept that has so many links to other concepts that the only imaginable option is to have this concept twice in the concept map, but this kind of exception needs a good explicit explanation.

9) If each concept is only mentioned once on the concept map, then it is easy to count how many links each concept has to and from other concepts. The number of links with other concepts is a good estimate of centrality of that concept in the thinking of the person whose thoughts are concept mapped. Let's explore a "Gedanken" experiment: If you would remove from the concept map, the concept with the most links to other concepts, this would result in the greatest possible damage to the concept map. That is to say, that concept is, in this sense, the most central concept in the concept map. This idea has also been tested and presented by Ahlberg and Ahoranta (2002), Ahlberg, Turja, and Robinson (2003), and Ahlberg, Aanismaa, and Dillon (2005).

10) Sometimes it is useful to be able to read a concept map only in the order that you intend it to be read. It may not always be from top to bottom. For example, it may be a transformed part of a textbook, and the order in which propositions are read is important. Then you may add to each link a number showing the order according to which the propositions should be read.

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