

## Chapter 47

# Concept Maps as a Technique for Organizing, Analyzing, and Transforming Knowledge

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### **ABSTRACT**

*The chapter begins with the origins of concept maps as a tool to promote constructivist learning, an educational philosophy and practice, and is followed by a concept map taxonomy. A definition of concept maps is provided and the main differences between Mind Maps®, Thinking Maps®, and Concept Maps are discussed with Thinking Maps classified as a type of concept map that is separate and different from both other maps. The chapter then offers a second definition of the term “concept maps,” with a detailed discussion of Thinking Maps resulting in a new taxonomy of knowledge or concept maps. The authors then investigate integrating concept maps with cognitive styles theory to determine if concept mapping might have a neuro-psychological basis and if mapping theory can be related to different academic fields and professions. The chapter concludes that the use of concept mapping can promote more holistic and effective teaching, learning, and practice in STEM education.*

### **INTRODUCTION**

Concept maps is a generic term for graphic organizers in need of clearer definitions and a more definitive taxonomy to enable further research on their use not only in education but also in business, science and engineering. In pursuit of such a taxonomy this Chapter focuses on three specific concept maps, also known as knowledge maps: Mind Maps, Concept Maps and Thinking Maps. It is argued that these specific types of maps are isomorphic with three cognitive styles: the Object, the Verbal and the Spatial. The

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linking of Mind, Concept and Thinking Maps with cognitive styles theory allows for a more functional taxonomy, more rigorous quantification of their effectiveness, and greater applicability in the real world.

Concept mapping traces its origins to David Ausubel's "Advanced Organizers," which were constructed as an attempt to break out of the 20<sup>th</sup> century positivist, reductionist and behaviorist approach to psychology and education. J.D. Novak, reacting against the same traditional philosophies and scientific methods, modified Ausubel's advanced knowledge organizers into visual diagrams, coining the term "Concept Map" and made their construction into a major tool to advance constructivist education. After giving a background to Novak's Concept Maps and the subsequent more generic term, "concept maps" (i.e. without caps), we then take Martin Eppler's knowledge map taxonomy and modified it as a provisional framework to help meet the objectives of this chapter.

After detailing with the similarities and differences between the three kinds of concept maps, we then discuss how Mind Maps, Concept Maps and Thinking Maps, can be correlated with different cognitive styles, the Object, the Verbal and the Spatial. This correlation of concept maps with cognitive styles theory, especially as presented by neurophysiologists, Blazhenkova and Kozhevnikov, opens up the practice of concept mapping to neural patterns to the brain on one level and to the larger world of STEM education and professions on another. The Chapter concludes with evidence that the three major kinds of maps continue to have a significant impact on scholarly research. The issue involved in this regard, however, is not whether or not one concept mapping technique is more effective than another but that all three maps, can be used together each complementing the other. The result is a more holistic and balanced way of constructing knowledge than previous methods of organizing, interpreting and analyzing information.

## **BACKGROUND**

J. D. Novak, a constructivist education scholar modified educational psychology "Advance Organizers" (Ausubel, 1963, 1968) and translated them into visual form by drawing diagrams which he called "Concept Maps." This simple but highly significant step occurred when Novak and his colleagues at Cornell were tracking changes in children's knowledge of science in a science, technology, engineering and math (STEM) research project. Novak (2010) saw that this method of recording student achievement could be transferred to improving student performance in itself. The invention of concept mapping for student improvement paralleled a constructivist paradigm initiated by such prominent educational psychologists such as Piaget (1971), Vitgosksy (1978) and Von Glaserfeld (1995).

This alternate paradigm could be characterized by a shift from a passive learning process in which students are given materials to be learned and problems to be solved to a more "constructive" student centered and interactive way of teaching and learning. In the old paradigm, dictated by positivist stimulus and response theory, students were rewarded with good grades if they learned the material and solved problems to the satisfaction of the teacher and punished with lower grades and other negative means if their academic performance was evaluated as unsatisfactory (Novak and Canas, 2008; Herrick, 2012). In addition, the constructivist mapping technique posits that new knowledge can be learned most effectively by relating the new to previously existing knowledge, a practice now known as scaffolding, (Berk, 1995; Hmelo-Silver, 2007). Moreover, Concept Maps are organized hierarchically, following Ausubel's notion of subsumption, that in the natural order of things, more general or superordinate concepts subsume more specific, detailed concepts. (Novak, 1990, Novak and Canas, 2008; Novak, 2010). Finally, The links in a concept map, are defined by the use of connecting phrases between concepts to

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