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# Book Review

# Advanced Concept Maps in STEM Education:
## Emerging Research and Opportunities

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*Advanced Concept Maps in STEM Education: Emerging Research and Opportunities*
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Concept maps are used as a learning tool in many educational settings, and are proven effective across science, technology, engineering, and math (STEM) and non-STEM knowledge domains (Torre, Durning & Daley, 2013; Schroeder et al., 2018). By combing through the origin of concept maps and the STEM context, this book 'Advanced Concept Maps in STEM Education: Emerging Research and Opportunities' (written by Michael Tang and Arunprakash T. Karunanithi) offers readers a clear view of concept mapping in STEM education.

The book contains three sections, and each holds a piece of the puzzle for this topic. Section 1 constructs a brief history of concept maps and describes the aftermath of the scientific revolution. In Section 2, the authors deal with classification of concept maps and classify them into three types: object maps, verbal maps, and spatial maps. Section 3 expresses that an urgent need exists for new approaches and strategies to improve the students' learning experience in STEM disciplines.

Chapter 1 follows the work of Ramon Lull in the middle ages and Peter Ramus who worked at the beginning of the Scientific Revolution, and compares their maps to better understand the change in emphasis from mapping out the soul (basically religious in nature) to the mapping out of thought (comparatively highly verbal and abstract). The following chapter reveals the evolution in concept maps after the Scientific Revolution. Two kinds of concept maps are introduced: one that point to the parts, structure and natural laws of the universe and its contents, created by Johannes Kepler, and the other, which maps thoughts and feelings, such as ones created by Lull & Ramus. Euler Diagrams

created by Leonhard Euler and Venn diagrams created by John Venn are described, along with its applications in logic and mathematics. Carroll Diagrams, created by Lewis Carroll, are also listed, as Carroll was among the first to use visual diagrams and mathematical games to teach formal subject matter. Charles Sanders Peirce's Triangle of Reference provides theory on concept mapping from the perspective of semiotics, the study of signs and symbols and their use or interpretation. The ground work laid by these scientists and mathematicians made concept maps and the logic associated with them popular in the Western world.

In Section 2, Chapter 3 explains verbal concept mapping in detail through works by Albert Upton, David Ausubel, and J.D. Novak. On the groundwork laid by Ramus, Upton retrieved his conceptual maps as a general analytical tool, and Ausubel built a theoretical foundation based on constructivist learning theory, which is proper for education purposes. He emphasized that three aspects of constructivism can be used to organize the mental constructs. Novak took Ausubel's mental organizers to develop his technique of using mapping as graphic organizers, put them in visual form by drawing on paper and called them "concept maps." The author presents functional figures and tables to facilitate understanding. In addition, analysis shows that among different fields, concept mapping is most used in business and education. In chapter 4, the authors try to classify concept maps according to different frames of cognitive style theories. Three types of concept maps are identified: object maps, verbal maps, and spatial maps, which correspond to three distinct styles of learning and communication. This helps readers to understand the nature of concept maps, and the implications of these maps. Distinct figures and diagrams are presented to illustrate the categorization, including Witkin's field dependent/independent theory, Multi-Dimensional Cognitive Styles, and Object-Spatial-Verbal Cognitive Style Model.

Section 3, comprising the last chapter, proposes Visual Logic Maps (vLms) to increase concept comprehension and improve learning in STEM education. Experiments conducted at the University of Colorado Denver provide positive results, which could be seen as proof for vLms as useful tools in STEM disciplines. The authors point out that vLms shifts emphasis from map structure to map glyphs, and propose seven specific glyphs that operate as constant logical operators. Various figures and classification maps are presented to illustrate the difference between Object Maps, Verbal Maps and Spatial Maps, which give readers a structural sense of what is mentioned in the former chapters. At the end of the chapter, the authors turn to hypothesize about the future of concept mapping and its correspondence with the World Wide Web. They conclude that the best maps are the appropriate ones which address the nature of the problem through conceptual mapping.

The authors of this book have done a fine job of recapitulating the biographies and contributions of important historical figures in the history of concept mapping development. With corresponding concept maps to enhance understanding of these masters' viewpoints, readers can get a better look at the context and classifications of concept maps. The insights provided by the authors regarding the future of concept mapping impacted by communication media and the Internet are also worth investigating. However, it would be helpful if the editor employed stricter standards for proofreading of the book to make it free of ambiguity. Another suggestion for the authors, should they prepare a second edition, is to unify the formats of tables and drawings to make them more pleasing to the eye.

## REFERENCES

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