# Editorial: Concept mapping: Improving learning and understanding

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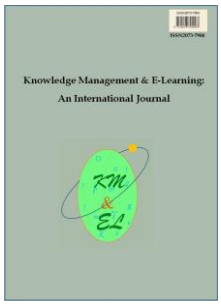


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# Editorial: Concept mapping: Improving learning and understanding

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**Abstract:** Concept mapping has undergone significant evolution over the past half-century. Initially developed by Joseph Novak and his graduate students as a graphic representation to model the science understanding of elementary school students through interviews, it has now become a widely used knowledge representation tool across age groups and in a broad range of domains. Although mainly used to support meaningful learning, its application has expanded to an ever-increasing variety of applications. Those of us who have worked with concept maps for years and seen their potential continually seek to improve their use, with a focus on understanding how to construct effective maps, how the maps can support knowledge construction and learning, and how they can aid in the development of higher-order thinking skills and knowledge integration. Such improvements can come in various forms, including software tools that support these efforts. This special issue showcases a selection of papers from the 9th International Conference on Concept Mapping that aim to improve and extend the use of concept mapping to enhance learning, understanding, and knowledge construction and sharing. Each author offers a unique perspective within this common theme.

**Keywords:** Concept mapping; Meaningful learning; Understanding

**Biographical notes**: Priit Reiska is professor of Science Education in Tallinn University, Estonia. He has been 12 years vice rector for academic affairs in Tallinn University. He has worked earlier as physics teacher at school, laboratory assistant in university, researcher and senior researcher. His main research area is using of concept mapping in education, He has (co)organized three international conferences of concept mapping. He has published over 50 articles and 2 monographs, he has led or participated in more than 10 R&D projects.

Alberto J. Cañas is co-founder and a Senior Research Scientist (emeritus) at the Institute for Human & Machine Cognition, in Pensacola, USA. For decades he has led the research team at IHMC that develops the CmapTools software toolkit, used extensively by concept mappers throughout the world, and has been principal investigator of research projects that involved concept mapping with organizations such as NASA, US Navy, NSA, the Government of Panama, and Microsoft. He has co-organized all International Conferences on Concept Mapping, has published extensively and has lectured throughout many

countries in North and Latin America, Europe, Africa and Asia.

## 1. Introduction

Concept mapping has undergone significant evolution over the past half-century. Initially developed by Joseph Novak and his graduate students as a graphic representation to model the science understanding of elementary school students through interviews, it has now become a widely used knowledge representation tool across age groups and in a broad range of domains. Although mainly used to support meaningful learning, its application has expanded to an ever-increasing variety of applications. Those of us who have worked with concept maps for years and seen their potential continually seek to improve their use, with a focus on understanding how to construct effective maps, how the maps can support knowledge construction and learning, and how they can aid in the development of higher-order thinking skills and knowledge integration. Such improvements can come in various forms, including software tools that support these efforts. This special issue showcases a selection of papers from the 9th International Conference on Concept Mapping that aim to improve and extend the use of concept mapping to enhance learning, understanding, and knowledge construction and sharing. Each author offers a unique perspective within this common theme.

## 2. Preview of papers

Cañas, Reiska and Shvaikovsky (2023) discuss in their article the difference between using concept maps as a meaningful learning tool and as an assessment tool. They argue that concept maps are often used for assessment purposes rather than for their potential to enhance learning. While applying a rubric and giving a grade may be the easiest way to evaluate a student's concept map, it does not necessarily encourage meaningful learning. The article proposes steps towards using concept maps as a tool to enhance learning and understanding, such as providing students with clear guidelines and examples, encouraging reflection and revision, and fostering a collaborative learning environment. By utilizing concept maps as a learning tool, teachers can help students develop a deeper understanding of the material and improve their ability to think critically and solve problems.

Correia, Kinchin and Conceição (2023) discuss the evolution of concept mapping and the role of Ausubelian learning theory in its development. While this theoretical basis has been useful, the article argues that contemporary learning theories must also be integrated into concept mapping to keep pace with changes in the educational context. This involves shifting the focus from the end product of concept mapping to the learning process itself and changing the role of the learner from passive to active. The article proposes the use of semantic waves as a way to move beyond simplistic knowledge representation and towards the development of more complex knowledge structures. Overall, the article suggests that by augmenting concept mapping with modern learning theories, it can become a more effective tool for achieving meaningful learning outcomes.

The article of Oliveira, Fonseca, Rendas, Carreiro-Martins and Neuparth (2023) describes a study that aims to analyze the use of visual tools in medical education, specifically maps such as concept maps, knowledge maps, and mind maps. The authors used a scoping review following the PRISMA extension methodology to gather relevant

articles from databases such as EBSCO, PubMed/MEDLINE, PsycINFO, Scopus, and Eric, using specific search terms. The selected articles were analyzed based on construction rules, teaching area, student level, use for assessment, capacity to relate basic science knowledge to clinical concepts, use of maps with other educational methods such as problem-based learning, and provision of feedback to students. The study found that concept mappings were the dominant visual tool used in all phases of medical education. However, around half of the articles labeled as concept mapping and knowledge maps failed to follow Novakian rules. Mind maps were also considered relevant in helping students summarize and retain information, but simultaneous use with other educational methods was only found with concept mapping.

Jeong and Kuba (2023) discuss in their article how including causal links in concept maps can help learners relate concepts to a larger context and improve learning transfer. The study aims to analyze diverse syntaxes used to convey causal relationships in concept maps presented in the Proceedings of the 8th Int. Conference on Concept Mapping. The study also examines how causal link syntaxes combined with semantic links work together to create temporal flow and how causal and semantic links can be integrated to increase the saliency and quality of causal networks connecting concepts to outcomes. The findings from this study can help to improve the accuracy, meaning, and effectiveness of concept maps in helping students apply concepts to solve complex problems. Understanding how causal links are expressed and integrated in concept maps can also provide insights into ways to help students create better maps.

The article of Bleckmann and Friege (2023) describes an approach to formative assessment using concept maps and machine learning techniques to quickly evaluate student performance. The traditional process of formative assessment is time-consuming for teachers due to the large number of students they work with, and this approach seeks to address that problem. A concept map on the topic of mechanics was developed and after human raters evaluated the student maps a supervised machine learning algorithm was trained on the data, and the results showed a high level of agreement between human and machine learning evaluation. The findings suggest that this approach could be embedded in everyday school life to support teachers in using and interpreting automatic evaluation in the classroom.

Hamnell-Pamment (2023) describes a study that examines the relationship between student language use and sensemaking in science education using concept maps. The authors argue that this relationship needs to be further explored in order to meet government standards in science education. The study analyzed 88 concept maps from five different school classes and two school systems and applied a Vygotskian perspective to analyze the language use and concept formation in the maps. The authors propose that there is a close relationship between language use, concept system formation, and sensemaking in science. The findings of the study suggest that there are possible implications for learning and formative assessment using concept maps. Overall, the study contributes to our understanding of how students make sense of scientific concepts and the role of language in this process.

## Author Statement

The authors declare that there is no conflict of interest.

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