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# The Use of Visual Tools in the Academic Research Process: A Literature Review

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ABSTRACT

An academic librarian, especially one who works primarily in a research consultation capacity, often encounters individuals who are seeking in-depth help with research projects that they struggle to explain. The number of concepts, interdependencies and assumptions involved in research projects today can make them difficult to define and discuss with other people. The multidisciplinary nature and globalization of many areas of research is forcing researchers to not only discuss, but to collaborate with many others from different academic backgrounds and disparate physical locations. Many researchers struggle with project paralysis at various points along the way as they attempt to manage both the myriad of details and the bigger picture relationships and implications of their project.

A number of visual tools including concept mappers and mind mappers are well suited to help advanced students, faculty, researchers and librarians to organize the ideas and knowledge throughout the various stages of complex research, from envisioning an idea to the early stages of actively researching and documenting research findings. This paper will discuss the potential uses of visual mapping tools and review the current state of academic literature surrounding the topics of mind mapping and concept mapping.



## INTRODUCTION

Pictorial representations to record knowledge and model thought processes go back to the earliest humans who left a history of their life through their drawings on cave walls. Information or Knowledge Mapping as we know it today, however, grew out of several parallel movements in the 1970′s. Dr. Joseph D. Novak created the technique of concept mapping as a tool to aid Cornell students who were learning about the latest discoveries in science. Novak (1998) declares that the "central purpose of education is to empower learners to take charge of their own meaning making. Meaning making involves thinking, feeling and acting" (p. 9). All three of these elements must be synthesized together for true knowledge creation, and concept mapping, Novak asserts, is one valuable tool in facilitating this process.

In parallel with Dr. Novak, Tony Buzan began in 1974 to promote a visual technique to aid in many different kinds of sensemaking activities. He called his tool a mind map. Buzan defines a mind map as "a powerful graphic technique which provides a universal key to unlock the potential of the brain. It harnesses the full range of cortical skills – word, image, number, logic, rhythm, colour and spatial awareness – in a single, uniquely powerful manner. In so doing," he asserts, "it gives you the freedom to roam the infinite expanses of your brain. The Mind Map can be applied to every aspect of a life where improved learning and clearer thinking will enhance human performance" (Buzan, 2011).

Whether we call it mind mapping, concept mapping, information mapping, knowledge mapping, or knowledge cartography (Okada, Buckingham, Simon, & Sherbourne, 2008), using visual tools to facilitate knowledge creation and knowledge transfer has played an important role in research and academic pursuits. It is surprising, therefore, that librarians have not been more deeply involved than the literature seems to indicate. In this paper the author intends to review the current state of visual tool usage in the academic research process, concluding with ways in which academic librarians, especially those in STEM fields, have found to support their researchers and students in these techniques.

## MIND MAPPING

Proponents of mind mapping claim that an individual's ability to remember information, and, more importantly, remember how that information relates to other concepts and facts, increases greatly by the use of mind mapping (Fig. 1). The process of placing ideas and facts into circles, and then relating those circles to each other via connecting lines forces the individual to evaluate information and visually identify the relationships of ideas to each other. Even the terminology of mind mapping, with "nodes" of information identified as "parent", "child" or "sibling" assigns basic hierarchical understanding. The process of map

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creation guides the mapper to think about the information more deeply and to recognize how new information relates to an already existing knowledge base.

Significant research in various educational fields shows a correlation between increased short-term memory retention and the use of various kinds of knowledge mapping techniques. Hall and Sidio-Hall (1994) found that the spatial display of mind mapping made concepts easier for students to assimilate, and that freedom of recording their new knowledge in the order that made the most sense to them helped students concentrate better and remember more when later tested.

Brinkmann (2005) found that by utilizing mind maps in the mathematics classroom, students demonstrated, not only their own method of knowledge organization, but also the gaps in their understanding of new concepts. The maps could then serve as a guide for the teacher so that further instruction could focus on the weaker concepts, allowing students the opportunity to achieve more well-rounded mastery of the material.

While a successful tool for K-12 students, mind mapping becomes even more valuable for students at the university level. "Adult learning literature supports the notion that relational linking of new information to old information promotes cognitive knowledge development in the learner" (Pinto Zipp, Maher, & D'Antoni, 2015, p. 43). Indeed, by mastering the tool in lower grades, students are more equipped upon entering higher education to use their mind mapping skills to help them integrate the more complex ideas and concepts they will encounter in their college study. Schwendimann (2015) explains that STEM subjects are good candidates for benefiting from mind mapping. Often, the complexity of these subjects forces professors to split the concepts and facts into isolated chunks in order to cover the material in the depth required. This can lead to students learning many facts, but not assimilating these facts into a cohesive body of knowledge. Focused mind mapping can help students identify and solidify the relationships of material from different classes together, thus achieving a better mastery of their field of study.

However, while the value of mind mapping for clarifying relationships is well documented, there are several other valuable uses for mind maps in the classroom, including their value in a group setting. Peer review of mind maps can help students sharpen their ability to support their ideas by grounding them in scientific thinking and fact. In the scientific world in particular, the ability to respond appropriately to peer critique with logical thinking is critical, and the ability to relate interdisciplinary concepts to problem solving can be an effective negotiation tool. Kotcherlakota, Zimmerman, and Berger (2013) successfully used the fishbowl technique to this end in their graduate level nursing classes. The authors had their classes research various topics, presenting their theses in the form of mind maps. Each student then participated in a "fishbowl" exercise where the student was placed in the center of a circle of their classmates and instructors. They then had to field probing questions about their topic, leading them to view their findings from alternative points of view and to approach their work more critically.

Another discipline which has embraced the use of mind mapping is the field of management. Developing creative thinking skills when dealing with large volumes of information is a necessary skill for today's business professional. Eriksson and Hauer (2004) had their students use mind mapping in a MBA marketing course to document and clarify many of the steps required when analyzing complex business problems on topics such as customer relationship management, SWOT analysis, strategic opportunity analysis and stakeholder analysis. Solutions required the consideration of both domestic and international situations and mind mapping provided visual clarity on viable options. When the added complexity of science and engineering topics are added to the mix, mind mapping can be a powerful management tool for STEM executives.

Mento, Martinelli, and Jones (1999) encourage the use of mind maps in their EMBA classes by guiding their students through several stages, first of mind mapping the key points of assigned readings, then progressing to having the students assimilate several different readings into one mind map and finally having the students prepare and then lead a class discussion of a case study that was mind mapped. Many of the students reported a side benefit of increased confidence in their presentations when it had first been mind mapped.

Wheeldon and Faubert (2009) encourage their students to use mind maps as a collection tool to document data collected during interviews with research participants. They found mind maps to provide a good starting point for designing more detailed subsequent interviews. By consistently using a structured map to document the interviews, patterns often emerge when conversation maps are compared. These patterns can then help define or shift the research topic in question as well as point out next steps and other related concepts that need to be explored.

One challenge of mind mapping is the misleading simplicity of the technique. "We suggest that mind mapping be considered a skilled technique, and as with any learning of a skill, thoughtful practice is necessary to develop from a novice learner/performer to a master performer." (Pinto Zipp et al., 2015, p. 46). Pahankangas, Passerini, Casal, and Somers (2013) found this clearly illustrated in their study which compared the quality of mind maps created by advanced undergraduate business school students, MBA level students and business school faculty. A clear progression of mind maps which grew significantly more complete and complex occurred as the level of experience and education increased, with the business faculty maps being both more comprehensive and integrated. The lack of the students' ability to integrate concepts across several courses in order to solve one comprehensive business case study clearly showed how systematically including mind mapping practices into the academic program could benefit the development of students' problem analysis skills on real-life scenarios.

## CONCEPT MAPPING

The distinction between mind mapping and concept mapping is often blurred in the literature. Whereas mind mapping identifies items which are related to one another, concept mapping is more refined in that the nature of the relationship between two nodes is much more distinctly defined than simply considering the relationship

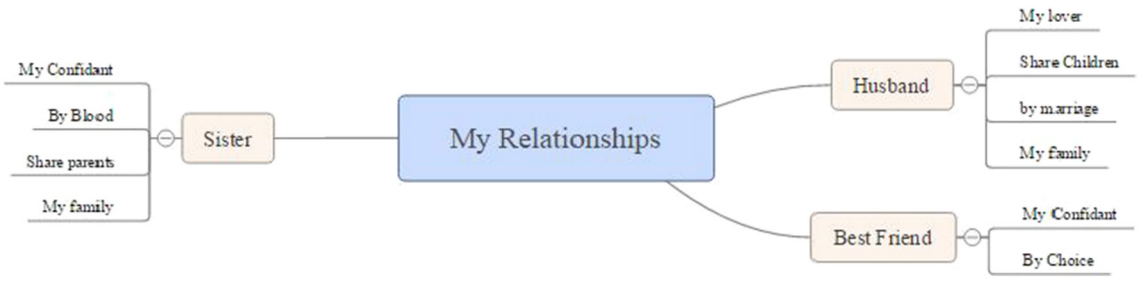


**Fig. 1.** Sample Mind map using Xmind.net.

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