

APPLICATION OF CONCEPT MAPS FOR CONDUCTING RESEARCH

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Abstract. This literature review focused on how scholars and practitioners have used concept maps for conducting research. The purpose of the use of concept maps for research fell into three main categories: data collection, data analysis, and data presentation. The uses in data collection included participant data generation as well as concept and process gathering. The main themes for uses of concept maps in data analysis were: organizing information from the data collection, quantitative and qualitative coding, and processing and interpreting data to identify linkages, relationships, and gaps. Researchers described using concept maps to present data in more general terms or without explicitly stating the use. Many advantages of concept maps for research were found including the benefit of exploring issues in real time, creating a visual dialogue, and documenting issues quickly. However, the lack of clearly documented steps for integrating concept maps into the research process was noted. Lastly, ideas for further implementation of concept mapping into research and a synthesis of findings through a concept map are given.

Keywords: Concept maps, Research, Data collection, Data analyses, Data presentation

1 Introduction

Concept maps have been used in a variety of ways as a tool for conducting research – from problem formulation and illustration, data collection and organization, to data analysis. As we use concept maps when doing research or working with doctoral students, we decided to conduct a literature review to identify strategies scholars use with concept maps for better conducting our own research and instructing students. Although authors in our literature review operationalized concept maps as a visual organizer in multiple ways, we considered concept maps in the format proposed by Novak and Gowin (1984). The purpose of this paper is to identify and analyze existing literature in which concept maps were utilized as a research tool. By theorizing from the literature and making connections among different approaches that use concept maps, we can broaden our understanding of the application of concept maps in research. We start the paper by presenting the methodology we used for completing the literature review. Next we present our literature review findings beginning with: the most common applications of concept maps in research, uses of concept maps in research methodology, purposes of concept maps for research, advantages and limitations of the use of concept maps for research, and implications of the use of concept maps for research. We conclude our paper with a synthesis of our findings in a graphical representation of our themes through a concept map (Figure 1).

2 Literature Review Methodology

In this literature review of concept maps for research, we confined our search to the use of concept maps in research specifically as a research tool. A search was conducted on a variety of databases including ERIC, EBSCOHost, PsychINFO, ProQuest, and Google Scholar. The search was restricted to the years 1998-2013. The key terms used in the search were “concept map,” “concept mapping,” “research,” “analysis,” “presentation,” “collection,” and “data.” Research studies that looked at concept maps as a learning tool were excluded, as they did not fit our parameters of using concept maps as a research tool. A refined search on these terms produced 2000 hits on EBSCOhost. We narrowed our search to 24 peer-reviewed journal articles, one dissertation, and one published book that met our set of criteria.

Once we identified the publications to review, we developed a matrix for analyzing the literature with the categories to extract from each article: article name, application (data collection, data analysis, data presentation), research methodology (quantitative, qualitative, mixed methods), purpose of use (how concept maps were used), advantages, limitations, and implications (See Table 1). We distributed the articles among the three members of our research team. After reviewing the articles, we completed the matrix, and member checked our findings to verify that we met the set of criteria we established. We then looked for themes and patterns within each category. Our findings are presented based on the categories we established in the matrix and respective themes.

Table 1: Matrix for Analyzing the Literature Review

Article	Application	Research Methodology	Purpose of Use	Advantages	Limitations	Implications

3 Most Common Applications of Concept Maps in Research

Our initial analysis of the publications was based on three main strategies: data collection, data analysis, and data presentation. Of the 24 articles we selected, we found 9 publications that fit within the parameter of concept map application as a tool for data collection (for example, Campbell & Salem, 1999; Wheeldon, 2011), 15 for data analysis (for example, Brightman, 2003; Maxwell, 2013), and 5 for data presentation (for example, Butler-Kisber & Poldma, 2010; Wheeldon, 2010). Many of the publications applied concept maps for data analysis and data collection as part of a process for conducting research (for example, Daley, Cañas, & Stark-Schweitzer, 2007; Morgan, Fellows, & Guevara, 2008). Little was found in publications about the application of concept maps for presentation.

4 Use of Concept Maps in Research Methodology

The majority of the publications indicated the use of concept maps for qualitative research. When used as a part of quantitative research methodology, researchers used mixed methods. Within mixed methods, qualitative methodology was used to collect data and quantitative methodology was used to analyze data. For qualitative research, concept maps were used for different purposes: data collection, data organization, data analysis and interpretation, analysis of participant generated data of experience, or to explain and present a conceptual framework or theory. For quantitative research, concept maps were used to display information, graphically illustrate concepts and connections, and cluster data.

5 Purpose of Use of Concept Maps for Research

We found a variety of purposes for which concept maps have been used for data collection, data analysis, and data presentation. We analyzed the three concept map application categories and present them next based on themes within each category.

5.1 Use of Concept Maps for Data Collection

Concept maps have been used for data collection mostly for (1) participant data generation through recall, reflection deconstruction, and organization of data or (2) concepts and processes gathering, refining, or honing.

5.1.1 Participant Data Generation

Wheeldon (2011) showed how participant generated data of experiences using maps helped to reach greater recall. Brightman’s (2003) methods for qualitative research used the interviewer as facilitator and data gatherer through concept maps. This method allowed for concept building at the time of data gathering. Likewise Meagher-Stewart, Solberg, Warner, MacDonald, McPherson, and Seaman (2012) used participant generated concept maps, but they were used for integrating and displaying information, deconstructing personal experiences, and identifying key concepts. In this case, concept maps were created in groups and permitted meaningful ways for participants to clarify the connections between people and concepts and enabled consensus building.

Morgan and Guevara (2008) also used participant generated concept maps, but with groups to guide participants in individual interviews or focus groups through the generation of the relationships among a set of key concepts. In this instance, this method provided an opportunity to “give voice” to participants and offered participant ascribed insights into the meaning of their experiences. Campbell and Salem (1999) used concept maps to bring people together to generate ideas. This method gave voice to women and included “the direct expression of participants’ voices with minimal interpretation by researchers” (p. 85).

5.1.2 Concept and Process Gathering

We found unique ways for collecting data through the use of concept maps: to reveal conceptual typologies, to generate a literature review, to refine and hone data, and to formulate and illustrate the research problem.

Hay and Kinchin (2006) used concept maps to explore and explain knowledge, the understanding of a topic, and to reveal existing knowledge. Rather than following a usual approach to data collection, this method allowed for the revelation of the structure, organization, and elaboration of concept understanding. Another approach to data collection was used by Burke, O'Campo, Peak, Gielen, and Trochim (2005) in a participatory qualitative research. In this case, a conceptual framework for how a group viewed a particular topic or aspect of a topic was used. This method allowed for the collection of a wide range of participant-generated ideas.

Wheeldon and Faubert (2009) also used concept maps as a data collection tool and an alternate means of communicating (not just the verbal or written narrative). The concept maps gave a "snapshot" of perception. In this case, concept maps allowed for the refining and honing of additional data collection processes.

Pokharel (2009) used concept maps for a conceptualization purpose as a way to formulate and illustrate the problem. This method provided a process for helping people think more effectively as a group without losing their individuality. In addition, the methods provided a process for groups to capture complex ideas without trivializing them or losing detail. Researchers could also develop and detail ideas for their studies. As a process, it provided an objective record of what was done in each step and researchers could be more publicly accountable.

5.2 *Use of Concept Maps for Data Analysis*

Concept maps have been used for data analysis primarily for (1) organizing information from data collection; (2) quantitative and qualitative data coding; and (3) processing and interpreting data in order to see linkages, relationships, and gaps. Although there was overlap in categories, the resources have been organized into the main foci. Because the data analysis process is not a linear one, several authors commented on the interconnection between the collection and the analysis processes (Burke et al., 2005; Campbell & Salem, 1999; Meagher-Stewart et al., 2012; Morgan & Guevara, 2008).

5.2.1 Organizing Information from Data Collection

Researchers have found that concept maps can be an effective way to organize information. Carnot (2006) suggested that concept mapping could be an effective tool for organizing large literature reviews. In particular, she argued researchers can find major categories and "cross-cutting" topics in order to pull together themes and visualize complex connections (Carnot, 2006). Cmap Tools as an online computer software can facilitate this process (Daley, Canas, & Stark Schweitzer, 2007). Through the organization of information with Cmap Tools, researchers may be able to see interrelationships of multiple themes in the literature.

Richardson (2007) also addressed concept mapping to organize data from literature reviews. Richardson presented the development of a software for computer science articles that automatically generates concept maps to supplement abstracts of electronic theses and dissertations. The software allowed for a more detailed description of the abstract and allowed the researcher to better organize information.

Daley (2004) and Brightman (2003) suggested that creating a concept map of participant interviews can help the researcher organize data by reducing the volume of research documents. The linkages displayed in the concept mapping document then can be used for further data analysis.

5.2.2 Quantitative and Qualitative Coding

Concept maps can facilitate quantitative and qualitative coding. Jackson and Trochim (2002) suggested that using concept maps for a quantitative analysis of qualitative data, such as coding open-ended survey questions, might provide greater reliability over forced computer categorization of results. Statistical concept mapping that infuses researcher judgment might create a more contextualized interpretation of data.

Burke et al. (2005) also discussed the use of computer concept mapping software to code data. They used concept mapping software to facilitate the coding of data gathered in a public health setting. The software was used to facilitate the production of illustrative cluster maps, which depicted the relationships between concepts described as the clustering ideas. In addition, Trochim (2006) used computer supported multidimensional

scaling and cluster analysis in order to code and analyze the qualitative input from all research study participants. Trochim and Kane (2005) combined group processes with a sequence of multivariate statistical analyses to construct maps as a way of coding for further action planning and program development in health care.

The generation of researcher developed concept maps of interviews (Daley, 2004) can also facilitate the coding of data. Daley stated that the initial sorting of concepts presented in interviews puts order on as well as begins to code the data. This process also provides initial researcher conceptual understanding of interviews, which are important inputs into the data coding process (Brightman, 2003).

5.2.3 Processing and Interpreting Data to See Linkages, Relationships, and Gaps

Concept maps can enhance the processing and interpreting of data. Kinchin and Streatfield (2010) and Daley (2004) suggested that using concept maps to analyze interviews can be helpful. Concept maps also can be used to examine data saturation and improve structure of subsequent interviews (Kinchin & Streatfield, 2010). Daley stated that researcher constructed concept maps of the interview can be used to help the researcher analyze themes and interconnections.

Brightman (2003) explored the importance of the role of concept maps in investigating the researcher's perspective in relationship to the participant's perspective. Researcher generated concept maps at the time of data gathering not only help organize the data, the maps can also provide real time analysis of exploring understanding and start the beginning of the data analysis process. Rather than just mapping the interview, Brightman discussed concept mapping of researcher ideas in relationship to the interview as an important piece of meaning making for the researcher.

According to Morgan and Guevara (2008), concept maps produced by participants can provide an important piece of analysis when comparing the maps generated by two different groups of participants. These maps allowed the researcher to see relationships among a set of key concepts and can be an input into decision-making.

Campbell and Salem (1999) used concept mapping to collect data as well as for the analysis of data. Within action research and feminist research constructs, participant input on the concept maps constructed, brought people together for joint researcher – participant interpretation of the data (Campbell & Salem, 1999). In this case, the interpretation directly provided input into how community systems offer better support to rape victims. In a related approach, Meagher-Stewart et al. (2012) also collected and analyzed data using concept maps in a community and public health setting. In studies incorporating participants in the generation of concept maps and the analysis of concept maps, the participants as groups and the researcher teams collaboratively were able to clarify the connections between concepts and interpret data. Participatory research, such as the work of Burke et al. (2005) in public health, allowed for the qualitative analysis of themes with participants and then the quantitative analysis of themes using software solely done by the researchers.

For the instructor, concept maps can help the researcher evaluate learning (Daley, Canas, & Stark-Schweizer, 2007). The concept maps generated by students can help the instructor evaluate how students construct complex relationships between ideas and how the students analyze their own experiences and link it to new learning. Lastly, concept maps can help researchers with theory development (Maxwell, 2013). Through concept map construction, researchers can visibly see an abstract framework to create, develop, or clarify theory. The process can help the researcher understand the implications of theory, its limitations, and its relevance for a study. In experiential research, Butler-Kisber and Poldoma (2010) used concept maps to interpret data in collaborative research projects. These maps allowed for a visual dialogue among researchers and the processing of information and data in a way in which issues could be documented quickly.

5.3 *Use of Concept Maps for Data Presentation*

In the final step of research, concept maps can also be used to present findings in a visual manner (Daley, 2004). In her article, Morrison (2006), used concept maps to visually represent her ideas and theories. Several authors used concept maps within articles to present their findings. For example, Campbell and Salem (1999) presented a final concept map for improving the community response to rape as a visual presentation for the reader. Wheeldon (2010) used concept maps to articulate the construction and scoring process to the reader. Butler-Kisber and Poldma (2010) used participant hand-drawn and computer generated concept maps to present findings. Researcher synthesized and participant generated concept maps were integrated in these articles to

help the reader make connections through a visual approach. As researchers, we have used concept maps to present findings during paper and poster presentations at conferences, to display findings within research articles, to display a framework or theory, to present a visual of a process in a paper, and to compare findings through visuals. Researchers often used concept maps to present their research and findings, but they did not articulate this use as part of their research process. Additional research is needed to thoroughly examine the literature for specific ways in which concept maps are being utilized to present research data.

6 Advantages and Limitations of the Use of Concept Maps for Research

Based on our analysis of the publications found in our literature review, it was evident that there were many advantages of using concept maps as a tool to effectively conduct research as well as limitations. One major limitation is the complexity of the use of concept maps (Carnot, 2006; Trochim & Kane, 2005; Wheeldon, 2011). Butler-Kisber and Poldma (2010) proposed that concept maps can help situate the exploration in real time, create a visual dialogue, and document issues quickly. However, they have noted the lack of clearly documented steps integrating concept mapping into the research process, which can create challenges. For example, refining maps can change previous interpretations of data and if researchers do not have a process for documenting the changes in meaning, one can lose a documentation of the data analysis process.

Jackson and Trochim (2002) argued that concept maps provide greater reliability and validity over word-based and code-based methods when analyzing open-ended survey questions. Yet, the amount of data may overwhelm those sorting the data. Depending on the types of open-ended questions and answers, it might be difficult to code data. Wheeldon and Faubert (2009) found that the use of concept maps provided an alternate means of communication, but questions about how to treat a map that did not conform to the “concept map” definition were a challenge when collecting data.

When it comes to organizing information, Carnot (2006) thought it was beneficial in exploring ideas, conducting comprehensive literature reviews, describing key concepts and task in the subdomain, and describing relevant theory. However, the complexity of the mapping process might distract from higher order thinking for non-proficient users. Another limitation they found was when translating the map to the written form; it was important to do it carefully. Otherwise, the meaning can be lost.

Kinchin, Streatfield, and Hay (2010) found the use of concept maps as interview prompts to be beneficial to check data saturation, present data, and analyze the structure of interviews. However, the process was difficult if the interview was not exploring concepts or relationships or if the interviewee was unable to articulate the relationships. One limitation was if the respondent misrepresented relationships or if the interviewer did not fully understand the context of the participant. Another limitation was if the interview had a prescriptive interview process.

Wheeldon (2010) considered concept mapping as an important strategy for data collection in mixed methods designs. One limitation can be participant resistance because it can alienate certain populations. Another limitation is the difficulty in reading and interpreting concept maps. In addition, validity and reliability can be a problem because concept maps may not be repeatable.

Campbell and Salem (1999) used concept maps in their public health and feminist research through mixed methods. They said that concept maps gave voice to women and brought people together to generate and interpret ideas. For them, the researcher needed to be careful that other issues were not overlooked because of the researcher’s agenda, hierarchy, and focus. They suggest being careful selecting the sample and avoid having only similarly minded people in the study.

Three major interconnected limitations of concept mapping emerged from the literature: time consuming, demanding, and resource intensive. Though Meagher-Stewart et al. (2012) considered using concept maps meaningful for consensus building, they also thought they were time consuming. Hay and Kinchin (2006) identified the use of concepts as a demanding activity and inhibiting elaboration and change. Burke et al. (2005) considered concept maps resource intensive and time consuming when using software. They suggested that a researcher needs some specialized knowledge to be more efficient in the task.

When Maxwell (2013) used concept maps to explain a conceptual framework or theory, he said it helped pull together and make visible what the implicit theory was, or clarified an existing theory. In other words, it assisted in developing theory. One of the limitations of concept mapping was that it did not automatically create

a paper trail of the attempts. A trail could have helped understand how theory had changed and avoid repeating the same mistakes.

7 Implications of the Use of Concept Maps for Research

The literature review highlighted a variety of ways in which concept maps are being utilized in research. Researchers have used concept maps as a data collection tool. Wheeldon and Faubert (2009) found that using visual representations enabled participants to recall experiences in more depth and detail. Concept maps also provide an opportunity for participants to “give voice” to their experiences and offer insights into the meaning that participants ascribe to these experiences (Morgan, Fellows, & Guevara, 2008).

Concept maps are especially useful in data gathering from groups as it helps people think more effectively as a group without losing their individuality and it enables groups to capture complex ideas without trivializing them or losing detail (Pokharel, 2009). Campbell and Salem (1999) and Trochim and Kane (2005) utilized concept maps in a group setting to gather and organize the collective wisdom of the participants. The process allowed for the collection of a wide range of participant generated ideas (Burke et al., 2005) and using concept maps facilitated a participatory method of developing theory (Meagher-Stewart et al., 2012).

Researchers also use concept maps as a graphical tool in textual coding and interview analysis. Concept maps help researchers graphically illustrate concepts and connections identified by their study participants (Butler-Kisber & Poldma, 2010; Morrison, 2006). Since concept maps are not inherently goal or action oriented, they allow for free expression of links between concepts and the repetition of ideas by participants and can be seen as meaningful in itself (Brightman, 2003). Researchers also are able to provide summaries of their interviews through concept maps (Kinchin, Streatfield, & Hay, 2010), which help them condense data in a meaningful way without loss of essential information (Daley, 2004). In addition, concept maps provide a way for researchers to organize and synthesize large domains of information (Carnot, 2006; Richardson, 2007) such as in literature reviews.

Concept maps also have been used to understand the research process and help the researcher analyze data to identify major issues and categories of research; to look for “cross-cutting” topics and issues that were relevant across domains; and, make connections thereby leading to the identification of themes within the research study (Butler-Kisber & Poldma, 2010; Carnot, 2006; Daley, 2004). Like memos, concept maps are a way of “thinking on paper”; they can help see unexpected connections, or to identify holes or contradictions in the theory and figure out ways to resolve these (Maxwell, 2013).

This literature review highlighted the dearth of articles on using concept maps as a presentation tool in research. While researchers use concept maps in conference presentations, these concept maps are not represented in their published articles. Further research could consider the effectiveness of concept maps as a research findings presentation tool. In addition, the barriers that researchers face in using concept maps as a presentation tool can also be explored.

8 Conclusions

Concept mapping provides a tool for meaning making. Researchers can document and synthesize ideas to drive the analysis and the visual process allows for new ideas to emerge. Concept maps allow for the refining and honing of data collection processes from both individuals and groups. They facilitate meaningful data reduction, data display, and conclusion drawing. Concept maps offer the greatest flexibility in terms of expressing relationships between ideas, which lead to developing theory, and making the theory more explicit. It is also an effective tool for presenting research findings. The application categories of data collection, data analysis, and data presentation are interconnected and Figure 1 displays these connections and cross-links.

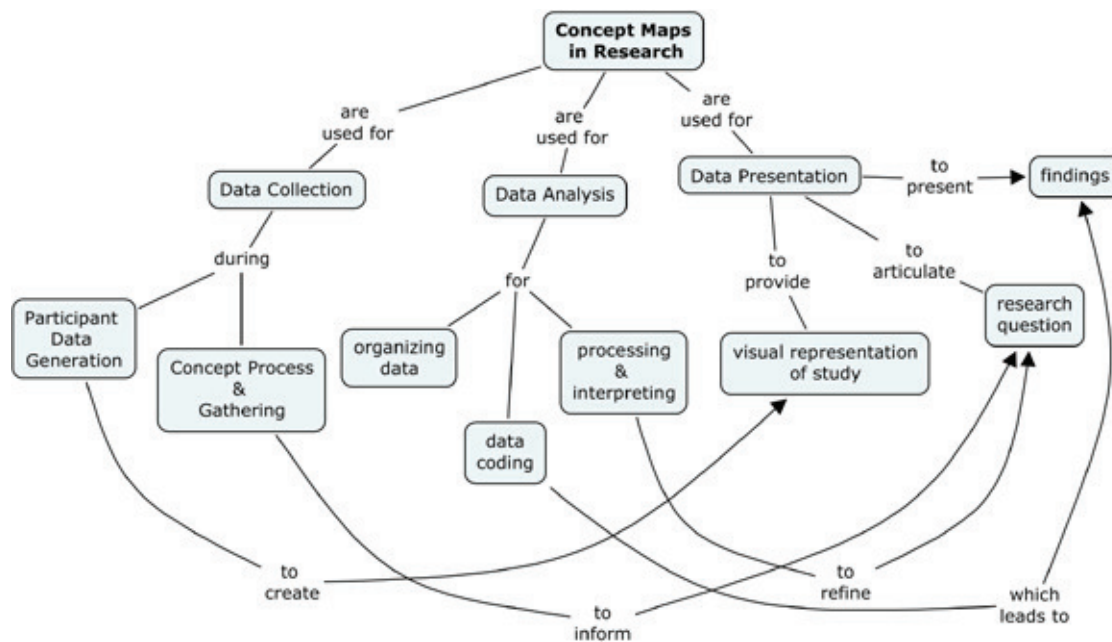


Figure 1: Use of Concept Map for Research

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