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Using Concept Mapping as a Tool for Conducting Research: An Analysis of Three Approaches

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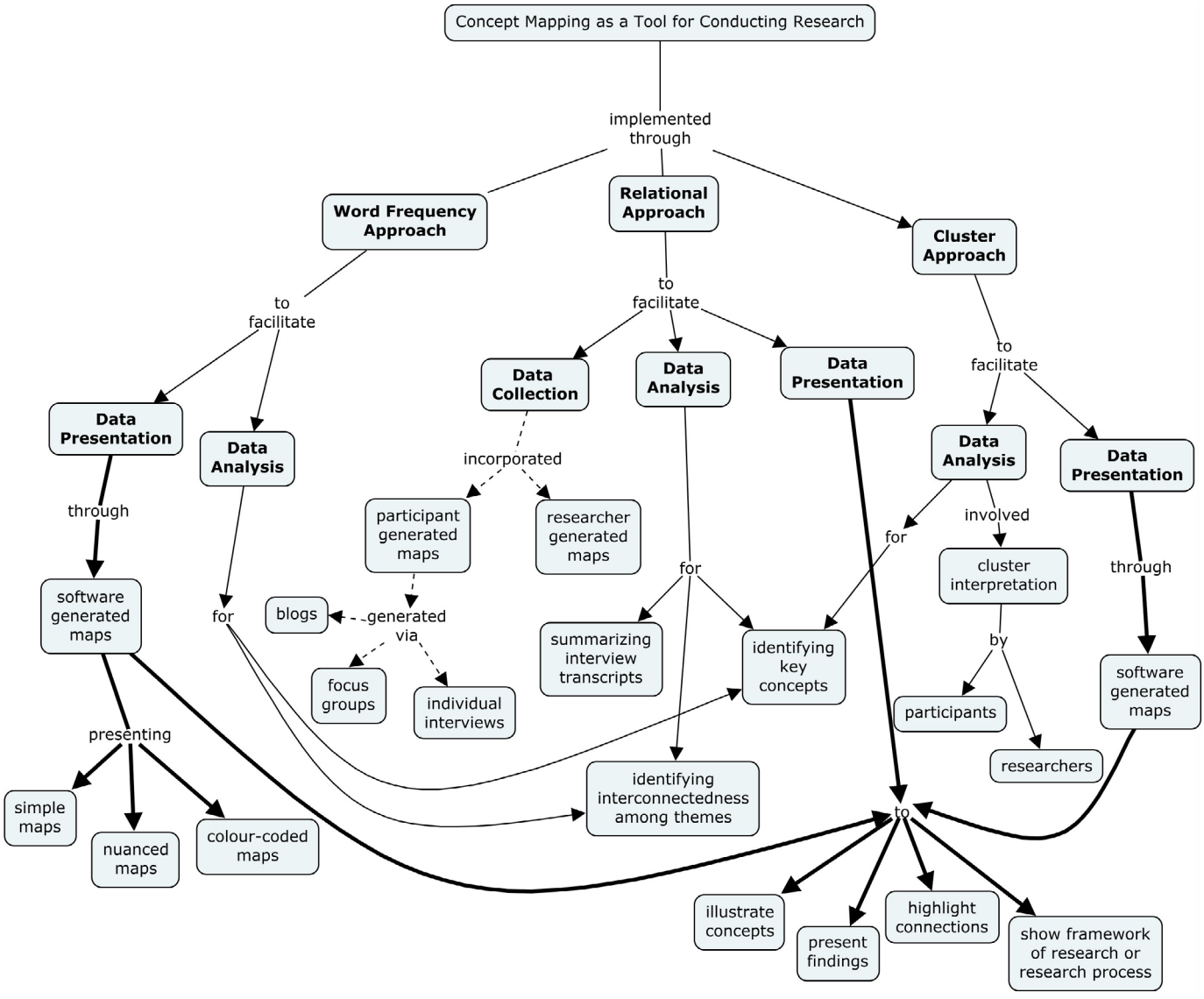

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Using concept mapping as a tool for conducting research: An analysis of three approaches

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Abstract: Researchers in a variety of disciplines pursue creative ways to explore complex areas of inquiry. This literature review examines the use of concept maps as a unique tool for conducting research. This study embraces an inclusive definition of concept mapping. Three main approaches for conducting research using concept maps as a tool emerged: relational, cluster, and word frequency. These approaches are included in the different phases of research process such as data collection, analysis, and presentation. Each approach revealed strengths and limitations that researchers need to take into account. This discussion broadens the lens of the meaning of concept mapping as a tool for innovative research approaches.

Subjects: Education; Adult Education and Lifelong Learning; Educational Research; Higher Education; International & Comparative Education

Keywords: concept mapping; research tool; data collection; data analysis; relational approach; cluster approach; word frequency approach

1. Introduction

Researchers continually seek innovative and effective ways to explore complex areas of inquiry. Visual approaches to gathering and organising ideas in practice and research can be an important

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ABOUT THE AUTHORS

Authors have worked as practitioners and researchers using concept maps together and on their own for different purposes within the last several years. The use of concept maps for research has intrigued them, so they decided to explore in depth how other researchers, in a variety of disciplines, have been using concept maps as a research tool as a way to inform their own practice. They discovered that concept maps have the potential to organize thoughts, ideas, and themes within a research paradigm and transform them into usable bits of theoretical and applied knowledge.

PUBLIC INTEREST STATEMENT

This study examined the use of concept maps as a unique tool for conducting research. Three main approaches for conducting research using concept maps as a tool emerged: relational, cluster, and word frequency. In the relational approach, graphical representations show relationships between concepts indicated by a connecting line linking two concepts. Linking words indicate the relationship between the two concepts. The cluster approach comprises six steps in which participant-generated statements are sorted and rated. The word frequency approach uses the Leximancer software tool to look for co-occurrence of concepts and develops concept maps to highlight key concepts. Concepts that co-occur are placed near each other; the distance between them indicating their frequency of co-occurrence. These approaches are included in the different phases of the research process: data collection, analysis, and presentation. Differences, strengths, and limitations between the concept mapping approaches as well as areas for future research are presented.

methodological tool. Collage making (Butler-Kisber & Poldma, 2010), mapping (Brightman, 2003), and matrices are strategies to assist researchers and practitioners in various fields individually and organisationally visualise interrelationships between ideas. The simple post-it notes on walls throughout brainstorming sessions at staff meetings; whiteboards filled with words, circles, and lines at research conferences; and computer generated visual organisers can facilitate meaningful understanding of new concepts.

A concept map is an example of a visual organiser used in teaching, research, and practice in diverse settings and can provide a tool for meaning making (Butler-Kisber & Poldma, 2010). The purpose of this article is to provide an analysis of the literature of the use of concept maps as a tool for conducting research. First, background on concept mapping will be addressed. Next, the study methodology and findings will be presented under three main approaches: relational, cluster, and word frequency. Finally, the discussion and conclusions will follow.

2. Background of concept mapping

Concept maps may be defined as a type of diagram (Umoquit, Tso, Varga-Atkins, O'Brien, & Wheeldon, 2013) or mind map (Wheeldon, 2011); however, concept maps are further delineated depending on authors' theoretical and methodological orientations. Novak and Gowin (1984) originally used concept maps to facilitate meaningful learning in science. Situated in a constructivist philosophical orientation, these concept maps are typically designed by students or practitioners by hand or through a computer program such as that through the Institute for Human and Machine Cognition (https://www.ihmc.us/cmaptools/). In this case, the concept map demonstrates how an individual or group builds on previous knowledge to incorporate new concepts into a mental schema. However, concept maps may also be generated through various computer programs in which the practitioner, student, or researcher would submit answers to questions and the computer program would automatically generate the schema (Trochim, 1989). This schema may help the practitioner and researcher understand how areas of inquiry are visually mapped.

Internationally, the contexts of concept mapping are diverse. Individuals (Daley, 2004) as well as groups and organisations (Trochim & Kane, 2005; Umoquit, Tso, Burchett, & Dobrow, 2011) have utilised concept mapping for various reasons. For instance, concept mapping can be used to organise survey responses for researcher or practitioner purposes (Jackson & Trochim, 2002). These visual approaches (Butler-Kisber & Poldma, 2010) are strategies to synthesise, organise, and document ideas in research and teaching. Within formal and nonformal education, concept maps are used to engage adult learners (Yelich Biniecki & Conceição, 2016) and children (Novak, 2010) in critical analysis.

Within professions such as healthcare (Meagher-Stewart et al., 2012; Trochim & Kane, 2005), school leadership (Pegg, 2007), and teaching (Daley, Canas, & Stark-Schweitzer, 2007), concept mapping has proven an important approach to organise ideas and facilitate learning. Concept mapping has been utilised as a strategy to teach students dentistry (Edmunds & Brown, 2012) and engineering and technology (Dixon, 2014). In generating a plan to use funds from a U.S. tobacco settlement, diverse stakeholders generated concept maps to create a holistic picture of the group's ideas, guide action planning, and development (Trochim & Kane, 2005). Particularly in teaching, educators have used concept mapping to present new ideas and students have utilised concept mapping to demonstrate new learning (Daley et al., 2007; Dixon, 2014; Hay & Kinchin, 2006; Yelich Biniecki & Conceição, 2016). We have noticed practical examples of the use of concept maps as a tool for research purposes in a number of articles within these varied contexts, disciplines, and professions; however, there are no studies assessing the value of concept mapping in research. The importance of new methodological tools in research prompts the interest in an in-depth and thematic analysis of the literature on concept mapping as a research tool. Therefore, the purpose of this article is to examine the use of concept mapping tools that assist with the research process.

3. Methods

This literature review focused on the following inclusion criteria: empirical studies that employed concept maps as a tool for conducting research; studies that used concept maps in the data collection, analysis, or presentation phases; and peer reviewed English language journal articles published between the years 1999–2015. The review was conducted using academic databases accessed through EBSCOHost using the keywords "concept map" and "research." A total of 317 articles were identified. Duplicate articles were removed resulting in a total of 53 articles. The initial review of articles revealed the use of Leximancer as a concept- mapping tool for data analysis. Another search was conducted with "Leximancer" as the keyword. Leximancer was released in 2000, thus empirical studies employing Leximancer spanned from 2005 to 2015. This second search resulted in 50 articles. After duplicates were removed, a total of 27 articles were added to the literature review. At the end of the data collection process, 80 peer-reviewed empirical studies were included.

Once the publications were identified, a matrix was developed for analysing the literature with the categories to extract from each article (See Table 1). Articles were distributed among the research team. After reviewing the articles, each member checked for themes and patterns within the matrix. Themes were cross-examined amongst the research team members and sub-themes further grouped to inform the final results.

4. Results

The analysis revealed that researchers adopted three approaches for using concept maps: relational, clustering, and word frequency. Researchers, in the reviewed literature, utilized these concept mapping approaches in a variety of ways to collect, analyze, and present their research. In order to provide an overview of these unique approaches and their implementation in research, brief summaries of some of the studies are included. Table 2 shows a summary of the main findings in this literature review where the three approaches for concept mapping are used as a tool for conducting research. A complete list of the articles referenced in this literature review can be found in Appendix A.

The results are organized in three sections representing the three approaches: relational, cluster, and word frequency. Each section begins with a brief overview of the specific concept mapping approach. This is followed by the data collection, analyses, and presentation strategies employed by the researchers in the literature review.

4.1. Relational approach

Of the 80 publications generated by the searches, 26 (32%) are categorised as empirical articles using a relational approach for concept mapping. The relational approach follows Novak and Gowin's (1984) method of organising and representing concepts. Graphical representations show relationships between concepts indicated by a connecting line linking two concepts. Linking words indicate the relationship between the two concepts. Researchers have used the relational approach as a tool to collect data, conduct analysis, and present findings.

4.1.1. Data collection

Studies that used the relational approach for data collection incorporated participant-generated and researcher-generated concept maps. Participant-generated concept maps were created via interviews, groups, blogs, and open-ended questionnaires to refine data, integrate and measure knowledge, identify participants' perceptions, and construct a framework. Researcher-generated concept maps were created to collect, reduce, and organise data.

Table 1. Matrix for analysing empirical studies using concept maps

#	Article	Study area	Method	Research phase	Advantages	Challenges/ limitations

Table 2. Summary of main findings

	Relational approach	Cluster approach	Word frequency approach
Data collection	Participant-generated concept maps	N/A	N/A
	Researcher-generated concept maps		
Data analysis	Identification of Themes	Participant interpreted clusters	Identifying main themes
	Summarizing interview transcripts	Researcher interpreted clusters	Studying inter-relationships
	Identifying interconnectedness among themes		
Data presentation	Illustrate concepts & connections	Software generated concept maps	Simple concept maps
	Show framework of research or research process		Nuanced concept maps
	Present findings		Concept maps in colour

4.1.1.1. Participant-generated. Researchers asked participants, individually and in groups, to construct concept maps. Wheeldon and Faubert (2009) used participant-generated constructions of experience in criminal justice with follow-up interview questions developed based on the concept map. Concept maps served as a useful means of recall for individual participants to capture experiential context cues of past experiences and prompted recall in ways that traditional data collection might not. This strategy was a useful means of refining subsequent data collection strategies.

Xie and Sharma (2011) used participant-generated concept maps (pre and post using a blogging-mapping tool) in higher education. Nine graduate student participants, throughout a semester, wrote blog posts, attached up to five keywords to each post, and linked the keywords on a concept map. This study aimed to seek patterns of participants' use of the concept maps, including evidence of reflective learning, identified as integration between concept maps and blogs. Data analysis included examining concept maps for knowledge integration over time.

Concept maps were employed as an open-ended questionnaire in health sciences by Nicholls, Polman, Levy, Taylor, and Cobley (2007). The sample consisted of 749 undergraduate athletes who completed two concept maps where they reported stressors and coping strategies. Each concept map consisted of six blank boxes in which participants entered data, allowing for a wider range of responses and the eliciting of participants without the limitations in surveys. A limitation of the study was that participants relied on retrospective accounts of coping, which meant the accuracy of this data collection technique was limited to participants' recall of an event that had happened weeks or months earlier.

Individual-generated concept maps were also used by Jones (2000). Study participants created 25 concepts related to public health in order to assess practical and holistic sanitation development tools in rural and urban Mexico. Participants were presented concepts and asked to develop a concept map using specific concepts. Concept maps provided a measure of structural knowledge especially higher order thinking.

Within business, Brandt and de Mortanges (2011) used concept maps to assess the relative saliency of image attributes associated with history, heritage, and culture in shaping the perceptions of students choosing a university town. Study participants created a personal concept map, using the pre-selected associations/cards, a blank poster containing the brand name in the centre and simple, double, and triple lines to connect the cards (all provided by the researchers). Participants placed the

cards with the attributes on the poster and connected them with simple, double, and triple links. In a second step, the researchers aggregated the individual brand concept maps in order to show the general perception of the city brand.

In order to represent the professional practice of Conservation-Restoration across Europe, Hutchings and Corr (2012) used concepts generated collaboratively by participants. Using concept maps elucidated the complex nature of the profession using a declarative system. According to Hutchings and Corr (2012), the hierarchical nature of concept maps and the use of links between different elements served as an aid to construct an intellectually robust framework.

4.1.1.2. Researcher-generated. Meagher-Stewart et al. (2012) used concept maps in community and public health to create visual representations of ideas, to analyse how concepts connected, and to integrate and display information from the brainstorming sessions. In healthcare, Panniers, Feuerbach, and Soeken (2003) used concept maps to conduct a systematic review of textbooks and clinical guidelines to elicit public knowledge. Generating knowledge from relevant print sources through concept mapping helped organise data into categories with illustrative depictions of attributes associated with each of the identified concepts. The relational concept map developed for this study represented a high-order map with only the most abstract concepts depicted.

Baugh, McNallen, and Frazelle (2014) used concept maps in historical research to explore the history of Mary Breckenridge's Frontier Nursing Service from 1925 to 1965. This study investigated how her experience could inform present day concerns regarding universal access to healthcare. To collect, reduce, and organise large volumes of historical data, concept mapping proved to be an efficient strategy.

4.1.2. Data analysis

Studies employing a relational approach for data analysis were used to identify themes, summarise interview transcripts, and identify interconnectedness among concepts. Concept maps helped with the process of data refinement, coding, and visualisation.

4.1.2.1. Identifying themes. Vanderheide, Moss, and Lee (2013) employed an online mapping tool to refine a literature review as a way to integrate new knowledge and identify themes. The outcome of the process revealed that some themes had extensive literature bases while others were just emerging. Likewise, in Pfau et al.'s (2009) study, participants were instructed to construct their own concept map on an issue in question. Upon completion of the concept map, participants assessed how strongly they felt about each of the themes in their concept map by rating it from 1 (very weak) to 7 (very strong). Meagher-Stewart et al. (2012) used concept maps to analyse core concepts and emergent themes. In this study, concept maps were used to enable consensus building, to create visual representations of ideas, and to integrate and display information from the brainstorming sessions conducted with public health practitioners.

Using grounded theory, Friedrich, Prasun, Henderson, and Taf's (2011) study on being a seasoned nurse in active practice, researchers used axial coding to identify relationships between the themes through concept maps. Sander, Wilson, Izzo, Mountford, and Hayes (2012) also used concept maps in data analysis to visualise the relationships among coded categories. The findings resulted in a single consensus map, which was sent out to participants for feedback. Concept maps were also used to illustrate the conceptual framework for the study and helped triangulate data.

4.1.2.2. Summarising interview transcripts. Kinchin, Streatfield, and Hay (2010) used concept maps "as a way of representing information gathered during research interviews to the interview respondents to stimulate further (or deeper) responses and to correct any areas of misunderstanding" (p. 64). A main concept map was created from all interviews and showed an indication of interview

saturation. Some of the challenges of using concept maps with interviews included: interviews not focusing on concepts and relationships, respondents not describing concepts and relationship clearly, respondents deliberately misrepresenting concepts and relationships, interpreters with insufficient understanding of the world of the respondent or of the topic under discussion, or the questioning process prescribing a pattern.

Concept mapping was used in the assessment of practical and holistic sanitation development tools using the rural and peri-urban case of Mexico by Tiberghien, Robbins, and Tyrrel (2011). The concept map was used to (1) reveal the complexity and the multidimensional nature of the issue without overloading the map and (2) highlight the uniqueness of each case study without neglecting macro-factors. The concept map developed for each case study showed the interconnectedness of all factors affecting sanitation development. Although the use of concept maps was valuable for the study as an assessment tool, the lack of significant perceptual patterns structuring the space, such as clusters, vertical, or horizontal structures proved to be limitations. Reading the map was difficult and hints for the reader were missing to note the zones of particular importance.

4.1.2.3. Identifying interconnectedness among concepts. Baugh et al. (2014) used concept maps in historical research to identify interconnectedness and development of a gestalt during data analysis. Like a coding system, using concept maps facilitated understanding the relationships among concepts and data comparison between researchers. As the concept map was developed, researchers identified the relationships among data. In this process, interpretation and synthesis of the data happened concurrently with data collection and organisation. Researchers communicated their interpretation of findings throughout the process; synthesis arose as they identified correlations and relationships among the data. They found that advantages of using concept mapping in this study were "facilitated conceptualisation, analytic clarity, and intellectual rigour. The maps became representations of the researchers' understandings, and interpretations of the data issued from it" (p. 4).

Henderson, Yerushalmi, Kuo, Heller, and Heller's (2007) study used concept maps created by participants' interviews to compare them to one another. Concept maps were useful because the "visual and explicit nature of the connections between concepts forces the research team to discuss, confront, and clarify their diverse interpretations" (p. 020110-5). For them, this process revealed different interpretations of an idea or term and allowed for clarification of the analysis.

Participant-generated concept maps were used by Egusa et al. (2010) to evaluate the knowledge acquired and knowledge structure changes as the result of information searches on the Web. Concept maps before and after users participated in a Web search were compared. Findings revealed the changes in the users' mental representations after conducting exploratory searches. The study focused on the participants' knowledge structure by statistically analysing the concepts and their relationships in the concept maps. One of the limitations of the study was that quantitative analysis was insufficient to understand participants' internal cognitive process.

4.1.3. Data presentation

Using concept maps for data presentation is often addressed with data analysis in studies. Researchers have used concept maps to illustrate concepts and connections, show frameworks of research or research processes, and present findings. Morrison (2006) used concept maps to graphically illustrate the concepts and connections identified by participants, which was a clear, easy to understand illustration, and effective tool for presenting research data. DeBlieck, LaFlamme, Rivard, and Monsen (2013) used concept maps to create a framework for conducting research. The mapping process allowed clinicians to understand the relationships, leading to desired outcomes through a standardised data-set specific to the topic at issue.

Table 3. Trochim's concept mapping research methodology

Step 1	Preparation	Identifying participants and the specific topic focus
Step 2	Generation	Participants generate statements/responses to the brainstorming prompt
Step 3	Structuring	Statements are sorted and rated
Step 4	Representation	Statements are represented as point maps which are then clustered and mapped by concept mapping software
Step 5	Interpretation	Clusters are labelled
Step 6	Utilisation	Discussion follows on how the concept map can be used to inform programme planning or evaluation

Baugh et al. (2014) presented their historical research findings as an aggregate map from the individual maps. As a way to visualise community-based food projects in Ontario, Mount and Andrée (2013) employed concept mapping. One challenge they found in presenting data was balancing "nuance and uniformity, as well as complexity and simplicity, while visually representing networks that often blur the lines between governmental, public, non-profit, cooperative, multi-stakeholder and private" (p. 578).

4.2. Cluster approach

Twenty-seven (34%) of the articles in the literature review utilised a cluster approach to concept mapping as proposed by Trochim (1989). Trochim's (1989) cluster approach comprised of six steps as summarised in Table 3.

In the cluster approach, participant-generated statements are sorted and rated. Multidimensional scaling (MDS) is then used to create a "point cluster map" (Trochim & Kane, 2005, p. 189). Statements that were sorted into similar piles appear closer together on the map while statements that were more sorted into different piles appear further apart on the map. Each statement is initially considered an individual cluster. The Concept System software performs a repetitive task of combining two nearby clusters till a researcher identified preset number of clusters is reached. Once the cluster map is created, participants are brought back to label the clusters. In this strategy, the cluster map that is generated is also referred to as the concept map as it is primarily a map of the concepts that appear in the research.

The cluster approach to concept mapping introduces concept mapping only in the data analysis phase of research. These maps are also used for data presentation. The inclusion of a concept mapping software allows for the production of quantifiable information. Burke, O'Campo, Salmon, and Walker (2009) contend that the utilisation of structured steps enables the analysis of complex ideas within a short period of time. Burke et al. (2009) also note that participants can easily understand the visual concept map. Brown (2007) defines the cluster approach to concept mapping as "a quantitative approach to the analysis of qualitative data" (p. 1237).

Researchers applying the cluster approach collected data through more common strategies such as surveys and interviews. Since concept maps were not used in the data collection phase of research, data collection is not addressed in this section.

4.2.1. Data analysis

In the cluster approach, the literature revealed that researchers decided on the level of inclusion of participants in the analysis process. Once the concept map was generated by the software, participants were not always included in the naming and interpretation of the clusters. Some researchers chose to name and interpret the clusters independent of participant input.

4.2.1.1. Participant interpreted clusters. Once clusters were identified by the Concept System computer software, Scahill, Harrison, and Carswell (2010); Reavley et al. (2010); and Baldwin, Kroesen, Trochim, and Bell (2004) brought their participants together to comment on the clusters, name them, and discuss areas of interest.

Some researchers elected to bring back a smaller subset of their participants for the interpretation and naming stage. Dawson, Cargo, Stewart, Chong, and Daniel (2012) brought together 16 of their participants; Campbell and Salem (1999) included 20 out of their initial 168 participants for the face-to-face interpretation of the cluster map developed by the Concept System software; van Manen et al. (2012) conducted a live session during which 19 of their 29 participants interpreted the data. Nalavany, Carawan, and Rennick (2011) on the other hand, introduced new participants at this stage and had 39 participants to assist with the naming of the clusters.

4.2.1.2. Researcher interpreted clusters. In some studies, the researchers elected not to include their participants in the cluster interpretation phase. Once the concepts had been plotted by the Concept System software, the researchers identified clusters and named them. In this review, the studies by researchers such as Brown, George, Sintzel, and St. Arnault (2009), Cash, Mathiesen, Barbanell, Smith, and Graham (2006), Kunkel, Cook, Meshel, Daughtry, and Hauenstein (1999), and Schuck and Liddle (2004) implemented this same data analysis methodology.

4.2.2. Data presentation

The studies in this literature review that used the cluster approach to concept mapping presented the concept maps that were generated by the Concept System software. The researchers used the maps to highlight the concept clusters identified by the software and to explain their interpretation of the clusters.

4.3. Word frequency approach

Twenty-seven (34%) of the articles in the literature review used concept maps through a word frequency approach. In this approach, qualitative data that have been compiled are input into the Leximancer software tool. Leximancer studies the frequency of words and their co-occurrence with each other and develops concept maps that highlight key concepts. Each concept in the map is represented as a dot. The greater the frequency of the concept, the larger the dot. Concepts that co-occur are placed near each other; the distance between them indicating their frequency of co-occurrence.

Studies that implemented the word frequency strategy were from a variety of areas including healthcare, organisations, education, and community settings. A majority of the studies using the word frequency approach was from business (30%) and healthcare (30%). Twenty-two per cent of the studies were from education.

The ability of Leximancer to analyse large and small data sets quickly and draw out key themes, concepts, and relationships has made it popular in research on online text and enabled researchers to analyse data from large participant populations. Bal, Campbell, Payne, and Pitt (2010) noted that in situations where data need to be scrutinized quickly, the concept maps created by Leximancer offer a fast overview of concepts and relationships. Martin and Rice (2007) and Pendergast, Garvis, and Kanasa (2011) analysed their data with Leximancer and with researcher content analysis. Both studies discovered "congruence" (Pendergast et al., 2011, p. 428) in the themes identified by Leximancer and the researchers proving the validity of the concepts identified by Leximancer.

Like the cluster approach to concept mapping, the word frequency approach incorporated concept maps only in the analysis and presentation phases of the research. Since concept maps were not used in data collection, this phase is not discussed here. However, some interesting points about

data collection in the word frequency approach need to be highlighted. The researchers incorporating this approach drew from large data sets that are available in the online public domain such as blog posts, community websites, and comments on online websites (Khalid, Helander, & Hood, 2013; Pendergast et al., 2011; Wu, Wall, & Pearce, 2014). Using Leximancer, Liesch, Håkanson, McGaughey, Middleton, and Cretchley (2011) were able to conduct a literature review of articles spanning the years of 1970–2008 while Poser, Guenther, and Orlitzky (2012) reviewed 165 journal articles. Leximancer's data analysis capability has also enabled researchers to gather qualitative data from larger participant pools, so Davies and Beamish (2009) could assess open-ended responses from 218 survey participants and Constantinou and Kuys (2013) examined the reflective journals of 131 participants.

4.3.1. Data analysis

Researchers used the concept maps generated by Leximancer to analyse data in ways that best suited their research questions. Some studies were interested in identifying main themes while others considered inter-relationships.

4.3.1.1. Identifying main themes. When the focus was on identifying driving forces or over-arching concepts, researchers fed all their primary data into Leximancer and adopted the concepts that were generated by Leximancer. For example, Khalid et al. (2013) studied the impact of terrorist attacks on people's attitudes. Their Leximancer-generated semantic maps revealed that the concepts of fear, anxiety, anger, and depression mapped closely together. The researchers, therefore, concluded that terrorist attacks "induce anxiety" (p. 678). Studies by Wu et al. (2014); Bell and Blashki (2013); Liesch et al. (2011); Noble, O'Brien, Coombes, Shaw, and Nissen (2011); and, Poser et al. (2012) similarly focused on using Leximancer to identify the main themes from their data sets.

4.3.1.2. Studying inter-relationships. When researchers wanted more nuanced understanding of data, they adapted their use of Leximancer. Fanaian, Lewis, and Grenyer (2013) employed a two-step analysis process wherein, initial data collected were analysed through NViVo and five main nodes were identified. These five nodes were then input into Leximancer as concepts in order to generate a concept map that illustrated relationships and strength of concepts.

Cretchley, Gallois, Chenery, and Smith (2010) used Leximancer to analyse data from different participant perspectives to reveal the differences in interactions between their participant groups of persons with schizophrenia and professional and home caretakers. Hostager, Voiovich, and Hughes (2013) used Leximancer to slice their data and present concepts from experts and novice participants in their study. Baker, Gallois, Driedger, and Santesso (2011) used Leximancer to draw out the broad concepts. They then used Leximancer again, to drill down into specific concepts. In all these studies, multiple maps were generated by Leximancer in order to study the relationships.

4.3.2. Data presentation

As with the articles in the cluster approach, the articles in the word frequency approach also presented the maps that were developed by the software. The maps allowed the researchers to explain their conclusions and provide a visual representation to the reader. These maps differed based on the information that the researchers wanted to convey to their readers. Some researchers presented only the concepts, others included relationship lines between concepts and multiple maps, and some elected to present their maps in colour.

4.3.2.1. Simple concept maps. Constantinou and Kuys (2013) and Davies and Beamish (2009) present basic maps of the main concepts identified by Leximancer. Their maps identify the relative importance of different concepts through the size of the concept circles, but do not include relationship lines.

4.3.2.2. Nuanced concept maps. Some researchers refined the maps generated by Leximancer by removing concepts and regenerating the maps to study differences. When multiple maps were generated to analyse the data, all maps were included in the article. Baker et al. (2011) incorporated both their maps in their article; Cretchley et al. (2010) and Chen and Bouvain (2009) presented four Leximancer generated concept maps to reveal the differences in interactions between their study groups; and, Hostager et al. (2013) include four maps with relationship lines to highlight the various observed differences. Adam, Gibson, Strong, and Lyle (2010) removed concepts from the original map to refine their results. They presented both maps and added relationship lines to their second map.

4.3.2.3. Colour coded concept maps. Some researchers presented their concept maps in colour to highlight frequency of concept occurrence. Freeman, Cottrell, Kyle, Williams, and Nissen's (2012) Leximancer-developed map identified the concepts and the lines of relationship between the concepts. The colour of the concept dots represented the frequency of concept occurrence. In addition to the concept dots and lines indicating concept relationships, Bell and Blashki's (2013) map also presents heat coded circles indicating the "relative frequency of concepts" (p. 97). The "warmer (redder) the circles" (p. 96), the greater the frequency of concepts. Fruhen, Mearns, Flin, and Kirwan (2013) also presented "heat coded" maps (p. 331) where red indicates high importance and blue low importance.

5. Discussion

This literature review found diverse conceptualisations of concept mapping intersecting in a variety of research areas in the academy as well as non-profit, for-profit, and governmental sectors internationally. Relational, cluster, and word frequency approaches were found to have research connections in business, healthcare, and education. Broadly examining and then categorising concept mapping approaches provided insights into potential avenues for future application and research. In this discussion section, we present key differences between the three concept mapping approaches, their limitations, the implication of these findings for other researchers, and directions for future research.

5.1. Differences between the approaches

Within each approach, the education necessary for participants and researchers is an important area of distinction. Within relational concept mapping, the participants need to participate in some form of training in order to create maps with hierarchical and propositional relationships (Wheeldon & Faubert, 2009). However, within the cluster and word frequency approaches, statement generation or the analysis of narrative text using software to create a concept map of relationships would not involve additional participant or subject training (Brown, George, et al., 2009; Fanaian et al., 2013). Only the relational approach utilised participant generated concept maps as a data collection source (Nicholls et al., 2007; Xie & Sharma, 2011), whereas the cluster and word frequency approaches utilised concept maps that were computer generated from the data of participants' responses, narratives, or interviews (Poser et al., 2012; Schuck & Liddle, 2004) or publicly available online data (Khalid et al., 2013; Pendergast et al., 2011; Wu et al., 2014). However, all three approaches provide an opportunity for the researcher to triangulate data from other sources in order to confirm, expand, or broaden data analysis, interpretation, and presentation.

The roles of the researcher and participant within studies utilising concept mapping approaches provide an area for further analysis. The participant and researcher may collaborate in reciprocity on certain aspects of data collection and analysis in the relational approach (Dawson et al., 2012; van Manen et al., 2012). This collaboration between participant and researchers is also possible in the cluster approach when participants are included in the cluster interpretation step of the data analysis phase. However, there are some limits in which this collaboration may occur within cluster and word frequency approaches because there are either pre-determined steps or a computer software tool serving integral roles in data analysis. The relational approach does not have this collaboration barrier, but is limited in the amount of time the analysis involves because the researcher is the tool of analysis (Meagher-Stewart et al., 2012), such as in a qualitative methodology, rather than software.

5.2. Limitations

Each approach has limitations. Although the researcher is very close to the data within the relational approach, a great amount of time is needed for the data analysis phase because the researcher serves as the main tool of analysis. For example, with 100 participants in a longitudinal study, using the relational approach to concept maps could require a significant amount of researcher analysis just in the creation of themes alone. Furthermore, participants require training to create effective concept maps for the data to be meaningful. It should also be noted that it can be challenging to present nuanced and complex information in a visually appealing and readily comprehensible graphic.

The challenge with the cluster approach is that there is a greater burden on participants as they are required to participate in all stages of the research. When different participants are used for the different phases, researchers need to identify and recruit a larger pool of participants (Nalavany et al., 2011). The research process then becomes time consuming. Furthermore, specialised knowledge of the use of the software is required. While the process in the cluster approach does involve participants in the different stages, the identification of the items is usually at the discretion of the researchers (Kunkel et al., 1999). Large numbers of items are reduced to a manageable level by the researchers. This also means that in some instances, researchers include items that they consider to be important even though the participants themselves never mentioned it (Burke et al., 2005).

In the word frequency approach, Cretchley et al. (2010) acknowledge that researchers' repeated reading of texts provides a nuanced understanding of themes and their relationships that are absent when tools like Leximancer are utilised. Noble et al.'s (2011) study highlights that a textual analysis can overlook key concepts, which then have to be introduced manually. Kyle, Nissen, and Tett (2008) caution that Leximancer's reliability is higher with single-word concepts. This reliability drops when multi-word concepts are included. Despite these limitations, Leximancer has been used as a data analysis tool that can identify high-level concepts and connections between these concepts (Bal et al., 2010).

All three approaches are limited by researcher subjectivity. In the relational approach, identifying certain concepts as key and establishing relationships between them is all dependent on the researcher/s perspective. The cluster and word frequency approaches try to alleviate some of the subjectivity by introducing statistical analysis software. However, as Bal et al. (2010) note, "Different researchers may arrive at different understandings of the same map" (p. 323). Yet these limitations are shared by other qualitative methodologies.

5.3. Implications for researchers

The findings from this literature review offer methodological suggestions to researchers who are considering incorporating concept maps in their research processes. When researchers want to analyse large amounts of textual data, Leximancer offers a practical approach in the analysis of word frequency. It can quickly generate concept maps that highlight frequency and co-occurrence of concepts. In addition, as some of the researchers in this review show (Baker et al., 2011; Fanaian et al., 2013; Hostager et al., 2013), these concepts can then be further dissected to provide more nuanced maps. Since the word frequency approach is only applicable in the data analysis and presentation phases of research, there is flexibility in the data collection methodology.

Researchers who prefer a more participatory approach, might lean towards the relational and cluster approaches. Within the cluster approach, the researchers have a specified implementation path to follow (Trochim, 1989). The cluster approach is the most prescriptive of the three approaches. It can only be implemented as a stand-alone methodology and has to adhere to the six-step process. The statistical element of the cluster approach could appeal to some researchers; however, the ability to have participants sort data and interpret clusters may make the process more inclusive.

The relational approach is the most versatile. This approach can be incorporated in any phase of the research process or in all three. The relational approach can also be used in conjunction with quantitative and mixed methods methodologies.

5.4. Future research

Additional literature reviews and empirical studies could examine sub-categories, like tourism and community development, in order to determine more specific uses in organisational and cultural contexts. Furthermore, this literature review examined only empirical research studies in peer-reviewed journals. To look at more specific uses of concept mapping, additional literature reviews may wish to look at government white papers or collect data through interviews with non-profit and for-profit professionals in order to gather information about concept mapping uses that currently may not be documented in peer-reviewed academic literature with regard to evaluation, training, and development. This research could give insight into "real world" use within an international scope and contribute to our understanding of the cross-cultural applications of concept mapping.

6. Conclusion

The analysis of concept mapping as a research tool categorised three main approaches: the relational approach, the cluster approach, and the word frequency approach. The analysis is important because it considered empirical studies and the use of "concept mapping" more broadly to inform future research. In other words, one methodology, philosophy, worldview, or pre-determined view of concept mapping was not used to create parameters for the inclusion of studies in this literature review. This scope of the analysis is a critical one to discuss. Scholars ground their work in specific conceptual frameworks, which guides research; however, we can limit possibilities for research by excluding methodological approaches because they are not within the scope of our own worldview. Although concept mapping approaches currently are situated within qualitative or mixed methodologies, the examination of the literature here may provide a base for discussion about how future inquiries might integrate a blending of approaches. Therefore, a main contribution of this analysis is that it explored all uses of concept mapping in research studies and categorised and sub-categorised them in order for the reader to determine how these approaches may intersect with their research needs. Through broadening the lens of the meaning of concept mapping, researchers have the opportunity to create new approaches building upon and perhaps integrating the ones we have identified here.

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Appendix A

Relational approach		
Research Phase	**Strategy used**	**Studies**
Data collection	Participant-generated concept maps	Wheeldon and Faubert (2009)
		Jones (2000)
		Xie and Sharma (2011)
		Nicholls et al. (2007)
		Brandt and de Mortanges (2011)
		Hutchings and Corr (2012)
	Researcher-generated concept maps	Meagher-Stewart et al. (2012)
		Panniers et al. (2003)
		Baugh et al. (2014)
Data Analysis	Identification of Themes	Vanderheide et al. (2013)
		Pfau et al. (2009)
		Meagher-Stewart et al. (2012)
		Friedrich et al. (2011)
		Sander et al. (2012)
	Summarizing Interview Transcripts	Kinchin et al. (2010)
		Tiberghien et al. (2011)
	Identifying Interconnectedness Among Themes	Baugh et al. (2014)
		Henderson et al. (2007)
		Egusa et al. (2010)
Data Presentation	Illustrate Concepts & Connections	Morrison (2006)
	Show Framework of Research or Research Process	DeBlieck et al. (2013)
	Present Findings	Baugh et al. (2014)
		Mount and Andrée (2013)
Cluster approach		
Research Phase	Strategy Used	Studies
Data Collection	N/A	

Data Analysis	Participant Interpreted Clusters	Scahill et al. (2010)
		Reavley et al. (2010)
		Baldwin et al. (2004)
		Dawson et al. (2012)
		Campbell and Salem (1999)
		van Manen et al. (2012)
		Burke et al. (2005)
		Burke et al. (2009)
		Ries, Voorhees, Gittelsohn, Roche, and Astone (2008)
		Nalavany et al. (2011)
	Researcher Interpreted Clusters	Kunkel et al. (1999)
		Schuck and Liddle (2004)
		Cash et al. (2006)
		Brown, Sigvaldason, and Bednar (2005)
		Brown, Bednar, and Sigvaldason (2007)
		Brown, Sintzel, Arnault, and George (2009)
		Brown et al. (2009)
		Brown (2007)
Data Presentation	Software generated Concept Maps	*All studies using this approach presented the software generated concept maps*
Word frequency approach		
Research Phase	Strategy Used	Studies
Data Collection	N/A	
Data Analysis	Identifying Main Themes	Khalid et al. (2013)
		Wu et al. (2014)
		Poser et al. (2012)
		Noble et al. (2011)
		Bell and Blashki (2013)
		Liesch et al. (2011)
	Studying Inter-relationships	Fanaian et al. (2013)
		Cretchley et al. (2010)
		Hostager et al. (2013)
		Baker et al. (2011)
Data Presentation	Simple Concept Maps	Constantinou and Kuys (2013)
		Kyle et al. (2008)
		Martin and Rice (2007)
		Davies and Beamish (2009)
	Nuanced Concept Maps	Baker et al. (2011)
		Cretchley et al. (2010)
		Bal et al. (2010)
		Middleton, Liesch, and Steen (2011)
		Pendergast et al. (2011)
		Chen and Bouvain (2009)
		Hepworth and Paxton (2007)
		Hostager et al. (2013)
	Colour coded Concept Maps	Freeman et al. (2012)
		Bell and Blashki (2013)
		Fruhen et al. (2013)

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