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Abstract

This paper offers an approach to enhancing trustworthiness of qualitative findings through data analysis triangulation using Leximancer, a text mining software that uses co-occurrence to conduct semantic and relational analyses of text corpuses to identify concepts, themes, and how they relate to one another. This study explores the usefulness of Leximancer for triangulation by examining 309 pages of previously analyzed interview data that resulted in a conceptual model. Findings show Leximancer to be an ideal tool for refining a priori conceptual models. The Leximancer analysis provided missing nuance from the a priori model, depicting the value of and connection between emergent themes. Dependability was also added to the findings by facilitating a better understanding of how participant quotes represent particular themes.

Keywords

Leximancer, Qualitative Research, Triangulation, Trustworthiness, CAQDAS, Employee Engagement

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This paper offers an approach to enhancing trustworthiness of qualitative findings through data analysis triangulation using Leximancer, a text mining software that uses co-occurrence to conduct semantic and relational analyses of text corpuses to identify concepts, themes, and how they relate to one another. This study explores the usefulness of Leximancer for triangulation by examining 309 pages of previously analyzed interview data that resulted in a conceptual model. Findings show Leximancer to be an ideal tool for refining a priori conceptual models. The Leximancer analysis provided missing nuance from the a priori model, depicting the value of and connection between emergent themes. Dependability was also added to the findings by facilitating a better understanding of how participant quotes represent particular themes.
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Introduction

Scholars have long argued in favor of qualitative research and its value in academic research in a variety of disciplines, including but not limited to, communication, business, management, psychology and nursing. The value of qualitative research is that it can help answer questions that address how or why things are, especially when it comes to understanding process-oriented phenomena (Leech & Onwuegbuzie, 2007). Qualitative research can clarify topics that have yet to be operationalized and possibly provide new insight into familiar problems or issues (Fairhurst, 2014; Merriam, 1995). In addition, qualitative research captures people's actual lived experiences, which leads to an in-depth and robust understanding of phenomena. Qualitative research uncovers truths at specific, local levels, with an emphasis on the native account and rich description (Kvale, 1995).

Despite the value of qualitative research, a narrative exists that it is harder to get qualitative work published because authors are not detailed in the methods and reviewers do not understand how to "trust" qualitative methods. The rigor challenges that face qualitative researchers mirrored the invention and use of statistical software in quantitative research (Morse, Barrett, Mayan, Olson, & Spiers, 2002). For example, quantitative scholars may rely on Statistical Package for Social Science (SPSS) to conduct a variety of statistical operations of large data sets. In response, scholars, such as Lincoln and Guba (1985), established new criteria to "judge" qualitative research. Researchers have continued to adapt and refine the criteria to ensure the quality of the data and findings.

One criterion offered by Lincoln and Guba (1985) is triangulation to enhance the credibility of the data. This paper offers an approach to establishing credibility of secondary data through data analysis triangulation using Leximancer, which is a text mining software that uses co-occurrence to conduct semantic and relational analyses of text corpuses to identify concepts, themes, and how they relate to one another (Smith & Humphreys, 2006). Extant literature, however, tends to compare Leximancer against other computer-assisted qualitative data analysis (CAQDAS) software rather than examining how similar programs might be used in concert to triangulate data analysis (e.g., Sotiriadou, Brouwers, & Le, 2014). Therefore, this study seeks to address this knowledge gap. The paper presents an overview of the foundation of trustworthiness in qualitative research and then transitions into the method section, which outlines the steps used to triangulate qualitative data analysis using Leximancer. The discussion section addresses how Leximancer can equip qualitative researchers with another tool to enhance the rigor of the research process.

Literature on Establishing Trustworthiness in Qualitative Research

Lincoln and Guba (1985) founded the trustworthiness criteria as a means to evaluate qualitative research. The authors asserted that using the same criteria for judging quantitative research with qualitative research did not make sense as the epistemological underpinnings of both approaches differ. Thus, "qualitative methods are not weaker or softer than quantitative approaches; qualitative methods are [simply] *different"* (Patton, 1999, p. 1207). Kvale (1995) argued the same sentiment by stating that the intricacies of ensuring the validity of qualitative research are not a weakness but rather, "rest upon their extraordinary power to picture and to question the complexity of the social reality investigated" (p. 30).

The five strategies to establish trustworthiness include credibility, transferability, dependability, and confirmability (Lincoln & Guba, 1985). The strategies are intertwined and interdependent and serve as alternatives to the conventional, quantitative measures for quality such as internal validity, external validity, reliability, and objectivity (1985). Credibility is the replacement for internal validity and is rooted in the truth value, which asks whether the researcher has developed and articulated a certain level of confidence in the findings based on the phenomenon under investigation (1985). The truth value derives from an in-depth exploration of the human experience as it is performed by the participants (Krefting, 1990). In other words, truth derives from the participant's lived experiences, which does not necessarily lead to universal truths, but rather an in-depth understanding of that person's unique reality. Transferability replaces the concept of external validity and generalizability, and thus, is concerned with the extent to which the findings from the study could apply to other contexts and settings. Dependability substitutes reliability and asserts that findings are distinctive to a specific time and place, and the consistency of explanations are present across the data. Credibility cannot exist without the presence of dependability, and credibility is truly the root of quality (Lincoln & Guba, 1985). Last, confirmability gets to the objectivity of the phenomenon under investigation and addresses whether the interpretations and findings are from the participants lived experiences and do not include the researcher's biases. When ensuring trustworthiness, researchers should use the approaches to explore and construct new knowledge (Kvale, 1995).

Lincoln and Guba (1985) offer many ways to operationalize each one of the trustworthiness criteria, all of which can be used in conjunction with one another. One of the primary activities used to enhance the likelihood of achieving credibility is triangulation, which is the focus of this study and is discussed in more detail next.

Triangulation

Triangulation is defined as "a qualitative research strategy to test validity through the convergence of information from different sources" (Carter, Bryant-Lukosius, DiCenso, Blythe, & Neville, 2014, p. 545). Those sources can include various methods or data, with the goal of considering a single point from at least three dissimilar and autonomous sources to corroborate the topic under investigation (Decrop, 1999). Specifically, the purpose of triangulation is to help identify inconsistencies or breaks in emergent patterns in the findings that can lead to deeper understanding of the phenomenon; inconsistencies are a strength, not a weakness (Patton, 1999). The end goal is to use triangulation to reduce systematic bias (Patton, 1999), which can improve the evaluation of the findings (Golafshani, 2003). Specifically, triangulation serves as an opportunity to reinforce the credibility and dependability of a study, which is one of the strengths of qualitative research as “fewer ‘layers’” exist between the researcher and the participants in the study (Merriam, 1995, p. 55).

Denzin (1978) and Patton (1999) offered four triangulation approaches, which are most often used in triangulating data. Method triangulation employs multiple methods to collect data. Investigator triangulation uses multiple investigators to collect and analyze data on the same phenomenon to enhance the depth of the findings. Theory triangulation relies on various theories to analyze the data. Finally, triangulation of data sources calls for the inclusion of individuals with varying backgrounds, diverse groups of participants, or documents in the study. Using these approaches requires the researcher to synthesize the similarities and differences to reach a conclusion that supports the findings (Carter et al., 2014).

This study illustrates a fifth triangulation approach: triangulation via multiple data analysis methods. As qualitative researchers continue to refine their triangulation processes to ensure the trustworthiness of the data, more nuanced approaches may be developed and applied to the research procedures. The constructivist would assume that knowledge acquisition and interpretation is never final, and therefore, is open to iterations as the approaches discussed above serve as guides (Loh, 2013). Decrop (1999) suggested that triangulation should be taken into consideration from the beginning of designing the research project. Leech and Onwuegbuzie (2007), further argued that the concept of triangulation could be extended to data analysis approaches and tools to improve representation, or the extracting of satisfactory meaning from the data, and legitimation, or the trustworthiness of the interpretations made. Such triangulation would be incorporating at least two types of data analysis tool. One such tool that is gaining popularity in data analysis is Leximancer and is discussed next.

Leximancer

Leximancer (www.leximancer.com) is a machine learning-based, data-mining tool that enables rapid visualization and interpretation of large, complex corpuses of natural language text data (Rooney, 2005). As opposed to manual coding, the statistical tool scans textual data, automatically identifying concepts and themes (Cretchley, Gallois, Chenery, & Smith, 2010). Both thematic and relational analyses are done (Harwood, Gapp, & Stewart, 2015). Leximancer reduces analytical biases based on preconceptions of the data developed during collection and enhances the analyses by allowing for stable, reproducible findings (Cretchley, Rooney, & Gallois, 2010; Harwood et al., 2015). Leximancer’s use is increasing across a variety of disciplines including communication (Rooney et al., 2010), tourism management (Tseng, Wu, Morrison, Zhang, & Chen, 2015), and health research (Cretchley, Gallois et al., 2010).

Leximancer has found growing interest among qualitative researchers. Penn-Edwards (2010) illustrated Leximancer’s value as an investigative tool in phenomenological research, allowing the researcher to examine large amounts of data without bias, identify more syntactic properties, enhance reliability, and enable reproducibility. Applying the approach to a grounded theory context, Harwood et al. (2015) further noted that, while not sufficient to substitute for human coding at the selective coding level, Leximancer illustrated good similarities to main emergent themes from grounded theory analysis and provided good cross-check of completeness in the open coding stage. To date, however, no research examines the usefulness and efficacy of Leximancer in the triangulation of qualitative data analysis. Given the gap in current literature on triangulation, this study proposes one research question: How can Leximancer be used to triangulate qualitative data analysis to enhance trustworthiness?

Method

To investigate how Leximancer could be used to triangulate qualitative data analysis, we relied on a previous qualitative data set that resulted in a conceptual model. The data set was part of a phenomenological study and was initially analyzed using NVivo. Other scholars have used Leximancer as a data analysis tool in phenomenological studies (e.g., Penn-Edwards, 2010), but none has used the platform to further investigate an a priori model. In using an a priori model, we investigated the potential usefulness of Leximancer in triangulating data analysis as the model provides a richer research context and enhances the theoretical foundation.

Data Collection

Data collection used previously analyzed transcripts that derived from in-depth, phenomenological interviews. To see how Leximancer could be used to enhance trustworthiness of qualitative data, it made the most sense to use data that resulted in an a priori conceptual model. Analyzing data solely from an inductive approach would not have been as helpful in answering the research question.

In total, 32 participants were interviewed in the initial study, 13 women and 19 men from 12 different organizations, which resulted in 309 pages of transcription. The 309 pages were uploaded to NVivo for initial analysis, which resulted in an employee engagement model rooted in meaning-making. Specifically, the previously generated a priori conceptual model that inductively emerged from the data visually depicts how employees perceived their employee engagement experiences using six themes (see Lemon & Palenchar, 2018). The themes are rooted in meaning-making and establish employee engagement as a complex and interactive process (Lemon & Palenchar, 2018). The six emergent themes from the a priori model include: (1) employee engagement experiences occur from non-work related experiences at work; (2) employee engagement is freedom in the workplace; (3) employee engagement is going above and beyond roles and responsibilities; (4) employee engagement occurs when work is a vocational calling; (5) employee engagement is about creating value; and (6) connections build employee engagement experiences. Those six themes are represented in a scaled Venn diagram, placing equal value on each theme. Below are the data analysis steps taken to answer how Leximancer can assist with triangulating data analysis to establish trustworthiness of the data.

Data Analysis

Prior to data analysis, the 309 transcription pages from the interviews were uploaded to Leximancer. We then followed Leximancer's two stages of extraction to interpret and visually depict the data: semantic extraction and relational extraction (Smith & Humphreys, 2006). In the first semantic extractions stage, the data was analyzed to identify concepts. Concepts are "collections of words that generally travel together throughout the text" (Leximancer Manual). Leximancer delineates two types of concepts: word-like and name-like. Name-like concepts are words often capitalized within the text that the software identifies as proper nouns; word-like concepts are all other concepts that correspond to everyday words. Using word occurrence and co-occurrence frequency, the software established concepts in a grounded fashion from the data and weighted the present concepts in a co-occurrence matrix based upon their frequencies in the data. A thesaurus was then constructed for each concept of words and phrases that were highly relevant to the concept within the text according to co-occurrence statistics, which created semantic meaning around the concept. Both explicit (i.e., directly stated words and phrases) and implicit (i.e., implied, but not directly stated in a set of predefined terms) concepts resulted (Harwood et al., 2015; Rooney, 2005).

The second stage of extraction, relational extraction, examined the data again, coding the text based on the semantic classifiers (concepts) identified in the semantic extraction stage. Statistics including concept count, concept co-occurrence counts, and relative concept co-occurrence frequency were computed and provided for the researchers. Themes were extracted using these statistical data to recognize related concepts. Themes were named for the most prominent concept (in terms of semantic significance and/or interconnectivity with other concepts) as opposed to the most frequently occurring concept (Harwood et al., 2015). A "concept map" portraying themes, their underlying concepts, and interrelationships was constructed (Campbell, Pitt, Parent, & Berthon, 2011).

Trustworthiness

To ensure the quality of this study, we too relied on the five criteria offered by Lincoln and Guba (1985) to establish trustworthiness. To ensure credibility, we are able to demonstrate an audit trail and memoed throughout the data analysis process. In addition, the same researcher who collected data in the initial study was also the lead researcher on this project. To ensure transferability, we used verbatim transcripts and thick descriptions in data analysis. We also provided a table of the step-by-step data analysis procedures so that other scholars can follow the same plan (see Table 1). To ensure dependability, coherent themes were reported across transcripts. To ensure confirmability, we completed several peer debriefing sessions. To ensure integrity, we remained committed to confidentiality and anonymity with the secondary data set.

Findings

To answer the research question of how can Leximancer be used to triangulate qualitative data analysis to enhance trustworthiness, we followed the primary two stage extraction process and poignant insights emerged throughout the process. The stages and subsequent insights are discussed next.

Table 1. Step-by-step description of Leximancer theme analysis and refinement process

Analysis Stage:	**Analysis Description:**	**Actions:**
Semantic Extraction	The initial scan of the text corpus is conducted, which identifies concept seeds by generating occurrence and co-occurrence frequencies for words and phrases in the text corpus.	• 57 word-like concepts identified • 13 initial themes identified
Concept Cleaning	The list of concept seeds is reviewed by researchers. Concepts irrelevant to research questions are removed. Concepts with duplicate and similar meanings are merged under the most intuitive and relevant concept.	• 32 concepts were removed and/or merged

Relational Extraction	The corpus is then scanned again based on the cleaned concept list to statistically identify concept counts, concept co-occurrence counts, and relative concept co-occurrence frequency. These statistics allow for mapping concepts in relation to one another and identifying themes.	• Analysis of 25 remaining concepts conducted • Two prominent themes emerged: Building Connections and Employee Engagement
Optimizing Theme Sensitivity	The concept map's theme sensitivity is adjusted to increase the number of themes allowed to develop in the concept map. This allows for added nuance missing from the a priori model by clearly depicting the value of and connection between each theme.	• Theme sensitivity is adjusted from 100% to 71%. • Four primary themes emerged: dialogue, organization, employee engagement and building connections • The concept map provides a precise visualization of the important of each theme.
Refining Themes	Themes from the a priori model that did not initially emerge via the statistical Leximancer analysis were probed for in order to understand their level of importance and the relationship to the theme depicted in the concept map. Based on the a priori model, user-defined and compound concepts were added. Relational extraction was then repeated to generate a new concept map.	• 21 user-defined concepts and 6 compound concepts were added • "Lanyard" theme emerged, and its meaning refined based on Leximancer analysis. • Dependability enhanced

The first stage extraction on Leximancer resulted in 57 word-like concepts and 13 themes. Word-like concepts included specific words from participant interviews that were frequently mentioned such as supportive, attention, and manager. From there, the initial concept list was cleaned prior to the second extraction stage removing concepts present not relevant to research questions and combining concepts with duplicate meanings within the corpus (e.g., "talk" and "talking" were combined under the term "talk"). Therefore, it is imperative that the researcher is heavily involved in data cleanup because s/he will know the context of the data and be able to hone the word-like concepts; an a priori approach also helps with this process since the researcher knows what to look for. For example, the word "able" emerged in the initial run, and on its face, the term does not hold much value. However, when removing it, the themes from the conceptual model completely changed, which meant the term was valuable, so we added it back in. This one example shows the imperative role the researcher plays when analyzing data using Leximancer.

The second stage extraction included 25 word-like concepts and the most prominent themes according to Leximancer's relational analysis. When the theme size was at 100%, the prominent themes were building connections along with employee engagement as demonstrated by the concept map (see Figure 1). Since these two themes were in line with the original conceptual model that emerged from the NVivo data analysis, this finding suggests that Leximancer can in fact be a tool to confirm emergent findings, which ultimately enhances the trustworthiness of the data analysis.

Leximancer provides the researcher the opportunity to adjust the theme size using a slider, where the slider can shift from a larger scale resulting in broader themes to the smaller scale, which shows more focused themes. For example, move the slider to the right to make fewer, broader themes, and move it to the left to make more, tighter themes. The slider function helps identify the most central concepts that occur within the data. In using the slider function in this case, the themes of creating value and work as a vocation emerged as word-like concepts within the theme employee engagement. This does not mean the other concepts do not have any value, but rather, the word-like concepts help provide detail and better define themes.

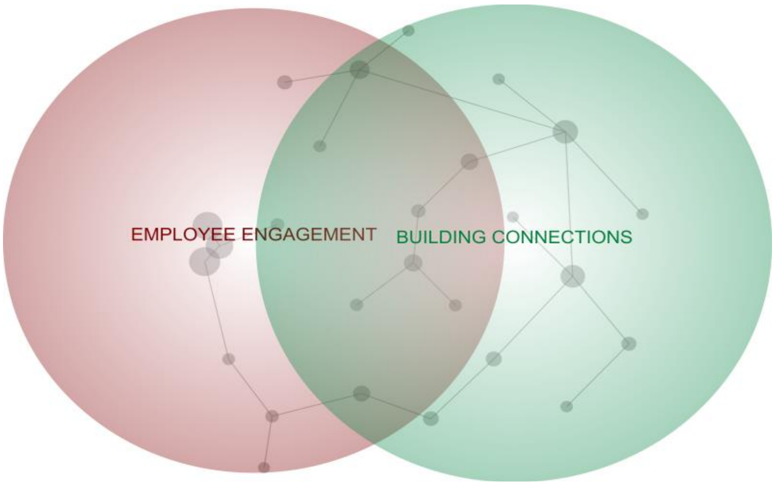

Figure 1. Themes from conceptual model

When shifting to the theme size of 71%, four primary themes emerged, which included dialogue, organization, employee engagement and building connections (see Figure 2). This additional level of analysis of the themes added nuance that was missing from the a priori model by clearly depicting the value of and connection between each emergent theme.

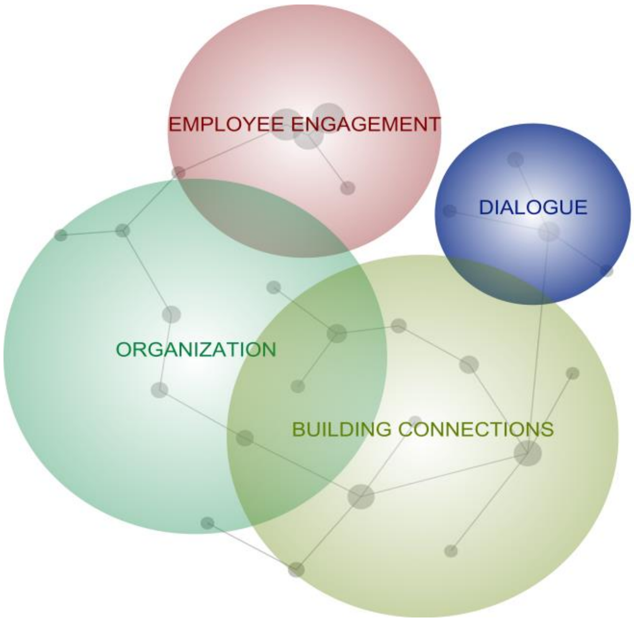

Figure 2. Refining themes

The third step was to see how Leximancer could refine themes, which in this case, were the other three themes from the a priori model we did not initially see in the concept map. To do so, we added 21 user-defined concepts, including six compound concepts. Themes from the a priori model that did not initially emerge via the statistical Leximancer analysis were probed for in order to understand their level of importance and the relationship to the theme depicted in the concept map. Based on the a priori model, user-defined and compound concepts were then added. Examples of user-defined concepts included trust, supportive, and proactive. Compound concepts examples included above and beyond or discretionary effort. Through this stage, we found that Leximancer could help refine the model but not the actual themes from the initial model. For example, through data analysis, the theme of non-work-related experiences was confirmed, and freedom in the workplace and disengagement, as part of the theme going above and beyond, were behaviors associated with the employee engagement theme.

One interesting aspect that emerged from stage three was that Leximancer can be used to ensure participant quotes are representative of the emergent themes. After adding in the 21 user-defined concepts, the word "lanyard" became a theme rather than a concept, causing us to dive deeper into what was going on with this concept (see Figure 3). When reviewing the participant quotes, it became apparent that, although on the surface, the word seems to be associated with non-work-related experiences, it was really about building connections. Therefore, Leximancer helps refine how participant quotes represent particular themes, which adds to the dependability of findings.

An important, often overlooked feature of Leximancer is interactivity (Harwood et al., 2015). While the automatic process described above allows for rapid extraction of key concepts and themes from the data, the researcher is also afforded the capability of directly searching for, adding, removing, and merging concepts. Indeed, as the software relies solely on co-occurrence statistics to identify concepts within the text, the researcher's knowledge of the research context and theoretical underpinnings of the research is vital in identifying and removing irrelevant concepts and combining theoretically-related concepts, referred to as compound concepts in Leximancer. This interactive component provides for human reflexivity in the analysis process.

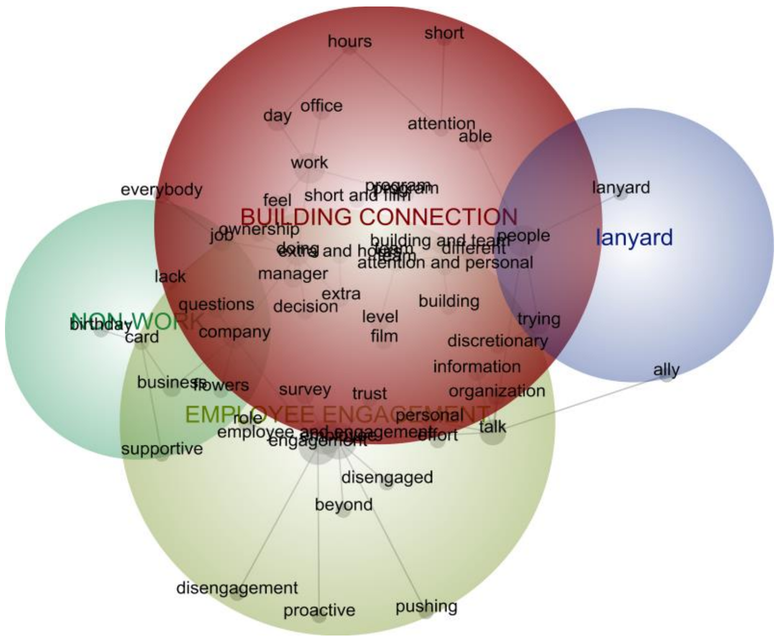

Figure 3. Refining participant quotes

Discussion and Conclusion

The purpose of this paper was to investigate the ways in which Leximancer could serve as a tool in data analysis triangulation to enhance trustworthiness of qualitative findings. In using an a priori model, we were able to revise and improve the initial conceptual model. Honing and refining an a priori model has the potential to lead to testing the model and enhancing theory development. In doing so, we demonstrated the value of using qualitative data analysis technologies in tandem to enhance the credibility and build trustworthiness. The findings also exhibit the important role of the researcher when using computer-assisted qualitative data analysis software.

Fairhurst (2014) argued that one of the main challenges for qualitative researchers is to show the rigorous steps used to arrive at the emerging patterns in the data. Similarly, Leech and Onwuegbuzie (2007) suggested that most qualitative method sections gloss over or simplify the data analysis procedures, which leads researchers to think there may be only one or two ways to conduct data analysis; the most frequently used method is the constant comparative method (2007), wherein concepts and ideas are compared and contrasted against one another to drive theory building (Corbin & Strauss, 2008). However, many data analysis procedures are available to qualitative researchers depending on the research project design and methodological orientation. The findings from this paper demonstrate the value of using various in data analysis, serving as an opportunity to triangulate data analysis. In using more than one approach to data analysis, the rigor and trustworthiness of the findings is strengthened (Leech & Onwuegbuzie, 2007).

Leximancer was an ideal tool to refine the a priori conceptual model that was used to depict the employee engagement experience in an equally-scaled Venn diagram. However, in using Leximancer, it became apparent that one of the six themes, building connection, had more value among the participant experiences. In addition, creating value was part of employee engagement, with vocation embedded within that theme. Freedom in the workplace and going above and beyond were behaviors associated with employee engagement. Further, non-work-related experiences was not as prominent as some of the other themes. The last important component that emerged from this data analysis process was the role of dialogue in building connections, which served as an outlier. Although this was not part of the initial model, it needs to be included in further applications. This second round of data analysis does not mean the a priori model was incorrect, but rather needed refinement, which is the benefit of data analysis triangulation.

This paper illustrated the value of using technology to enhance credibility. Although the researcher is the tool, using technology provides an opportunity to enhance the work and ensure the credibility of the findings. Technology does not replace the data analysis, but rather enhances it. The purpose is to demonstrate another step in rigor; such processes should be built into the research procedures (Morse et al., 2002). For example, one strategy that could be incorporated into the research process is to ask questions of the data. In phenomenology, this is called imaginative variation (Moustakas, 1994). Another strategy is looking for negative cases, or cases that do not align with emerging patterns or themes (Morse et al., 2002). Therefore, a tool like Leximancer could be used to confirm emergent themes as well as search for outliers that do not fit with identified patterns.

The findings from this paper also showcase the important role of the researcher when using CAQDAS. Programs such as NVivo and Leximancer assist in the coding process, but the programs do not actually analyze the data for the researcher (Leech & Onwuegbuzie, 2007); the researcher is still an integral part of the process. Some scholars voice concern that the researchers let the computers do the analysis (e.g., Fielding & Lee, 1998), which arguably defeats one of the greatest values of qualitative work, wherein the researcher serves as the tool.

However, the purpose of such programs is systematic data management to enhance creativity and insight (Dey, 1993). The organizing and storing of data provide an "indisputable record" of the decisions made by the researcher, which enhances the credibility of the research findings (Corbin & Strauss, 2008, p. 310). In using Leximancer, the researcher is not removed from the process, but rather leads the process using the qualitative data analysis computer programs.

Future researchers should consider using Leximancer in concert with other data analysis tools like NVivo to enhance the credibility and dependability of the study, which improves the quality of the study. We also hope those qualitative researchers who take on such a task, clearly document their steps so we have the opportunity to learn from one another.

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