Science Education Scholars' Views and Approaches to Qualitative Research

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Abstract—The guidelines for qualitative research have been established in previous studies. However, it is subjected to the interpretation of individual researchers due to its nature in explaining complex phenomena about human interactions. Many areas of social science research utilize qualitative research as a primary research method or in addition to quantitative research. However, the approach of science education scholars has minimal documentation. This qualitative study uses a phenomenological approach to explore the views of four science education scholars and their approach to how they use qualitative research in their published works. The finding revealed that science educators ventured into qualitative research due to the influence of professors and courses they took in graduate school. Additionally, they established the strength of qualitative data in explaining the numbers.

Keywords: Qualitative research, science education

1. INTRODUCTION

Educational research in science education is said to be more complex than research in physical or biological science (Berliner, 2002). Research in education started with quantitative research, which included a mathematical and scientific way of analyzing data that appealed to the existing structure of scientific research (Green & Stewart, 2012). This influenced the investigation of education research, which determined relationships between independent and dependent variables using qualitative methods (Levin & Wagner, 2009). Creswell & Garett (2008) noted that experimental and quasi-experimental methodologies are the most accepted standard for testing the relations between these two variables. In most cases, students' learning achievement is the dependent variable, while the instructional strategy is the independent variable. Further research revealed that human behavior comes with complexities and interdependence on the environment, creating a need for a new paradigm called qualitative research.

2. LITERATURE REVIEW

2.1 Comparing Qualitative and Quantitative Research Methodologies

The primary goal of quantitative research is to achieve an objective and generalizable representation of a phenomenon. At the same time, qualitative methods significantly benefit from providing a detailed and nuanced understanding of educational phenomena (Jun Jin & Bridge, 2016). According to Cohen, Manion, and Morrison (2000), qualitative research showcases the intricacies between human thoughts, behavior, and factors in environmental factors. This gives diverse perspectives of the population and sample rather than simply focusing on the numbers and scores generated from surveys and related instruments. In contrast, quantitative studies typically employ large sample sizes in experimental designs, with randomized control trials considered the standard, particularly in scientific research. In contrast, qualitative research focuses

on small, purposive, and non-random samples, including typical and atypical cases, to obtain an in-depth and nuanced understanding of the topic (Jun Jin & Bridge, 2016). Moreover, the qualitative researcher's training, perspectives, and assumptions can influence the research's design and outcomes. Consequently, the findings of qualitative studies may not establish a large-scale causal relationship between variables (Libarkin & Kurdziel, 2002).

2.2 Qualitative Research in Science Education

Lemke (1990) asserts that science education instruction is a complex communication between science teachers, students, and the learning environment. This encompasses verbal and nonverbal conduct of immediate social interaction. As science is conveyed through language, it is essential to comprehend the language of science, which can be acquired through face-to-face conversations with others. The effectiveness of classroom conversations in facilitating scientific understanding and the most productive conversational roles for both students and teachers warrant further examination. Microanalysis of classroom discourse, informed by sociolinguistic principles, has the potential to shed light on the acquisition of scientific knowledge (Erickson, 2012).

Over the years, qualitative research methods have gained popularity and acceptance in social science research. The use of language to facilitate science instruction indicates the presence of communication in an environment that is impacted by individual, social, and historical factors (Erickson, 2012). Exploring these factors provides a vital understanding of the complex interactions between science teachers, students, and other extant factors. These factors, which cannot be fully understood with quantitative research, are captured using qualitative methods (Elyisi, 2016). Previous studies have established using qualitative methods in science education research alongside quantitative methods in reputable science education journals (Devetak et al., 2010; Elyisi, 2016). Also, proponents of qualitative research have highlighted the importance of qualitative research in their field, especially in science education (Erickson, 2012) and pharmaceutical education (Anderson, 2010). However, minimal studies focus on science education scholars and explore their views about qualitative research and how they approach it as a research method.

2.3 Author's Positionality

This aspect of the course was introduced to us at the beginning of the course as an area that we perceive that we need to emphasize in our journey to becoming qualitative researchers. I chose to conduct a self-directed project on the perceptions of science education scholars on qualitative research. This is because the literature on science education that I have read focused on quantitative methods or mixed methods, which is unsurprising because science, especially physical science, is interpreted using mathematical concepts. However, as a doctoral student, I have interacted with professors and research projects whose methodology was either mixed methods or qualitative methods and whose survey is analyzed descriptively.

Additionally, qualitative research includes analysis that starts with data collection and coding. Documents, artifacts, visual materials, and other qualitative data sources are sorted into comprehensible information through coding (Saldana & Omasta, 2018). The coding process has different approaches, which seemed to overlap based on my previous experience. The self-directed project provided the opportunity to follow the readings

and other articles to research ways to code qualitative data using approaches that align with the research goals.

The requirements of the self-directed project provide the liberty to work independently. Therefore, I focused on getting interview data from prospective participants to practice the interview skills I gained from Rubin and Rubin (2012) and coding skills (Reissman, 2008; Rubin & Rubin, 2012; Charmaz, 2014; Saldana & Omasta, 2018).

3. METHODS

This qualitative research uses a phenomenological reflexive approach to capture the perceptions of science education scholars and explore their views about their interactions and use of qualitative research methods in their published works. In line with Watt (2007), the author utilizes reflexivity to showcase the uniqueness of this study as a research and as a learning curve in the journey to becoming a qualitative science education researcher. This project aims to get insights into how science education scholars at different levels in their career journeys view qualitative research and their perspectives. This purpose was directed by two research questions:

1. What are science educators' perceptions of qualitative research?

2. What influenced science educators' decision to choose qualitative research?

2.1 Participants

The participants are science education professors, and doctoral students working with qualitative research methodologies. The participants included a tenured science education associate professor, an early career professor, a new Ph.D. graduate, and a Ph.D. student who has defended a dissertation proposal (see Table 1).

Table 1. Participants' Pseudonyms and Level

Pseudonym	Gender	Level	Number of Publications (published and in review)
Bowman	Male	Associate professor	18
Jerry	Male	Assistant professor	13
Beau	Female	New Ph.D. graduate/Adjunct professor	3
Jane	Female	All but dissertation	11

2.2 Data Collection

This assignment uses interview data from four science education researchers. To ensure trustworthiness, I got approval from the institutional review board through course determination and the institutional review board (IRB) to publish the findings. The participants also gave their consent through email. The interviews ran for an average of 30 minutes. The questions to probe their perceptions of qualitative research include "What challenges, if any, have you experienced as a qualitative researcher/in qualitative research?" and "What human, social, or material resources guided your decision to get

into qualitative research?". During the interviews with science educators, they provided additional insights into their perspectives on qualitative research and how they navigated it. To ensure the accuracy of the data, member checking was conducted with two participants, and peer debriefing conversations were held with a research mentor to gain insights into potential emerging codes and opportunities for follow-up questions or interviews. While no follow-up interviews were necessary, these steps helped ensure the data's validity.

2.3 Data Analysis

The interviews were transcribed using Otter.ai and subjected to thematic analysis, following the approach outlined by Reissman (2008). The first round of coding utilized a grounded theory approach, which allowed for the emergence of codes such as influence, preferred methodology, perspectives, and qualitative research experience. The second coding round utilized an a priori approach, where the interview transcripts were analyzed for emergent themes identified in the first coding round. These methodological approaches allowed for a comprehensive analysis of the data, providing insights into the experiences and perspectives of science educators regarding qualitative research in science education (See Figure 1).
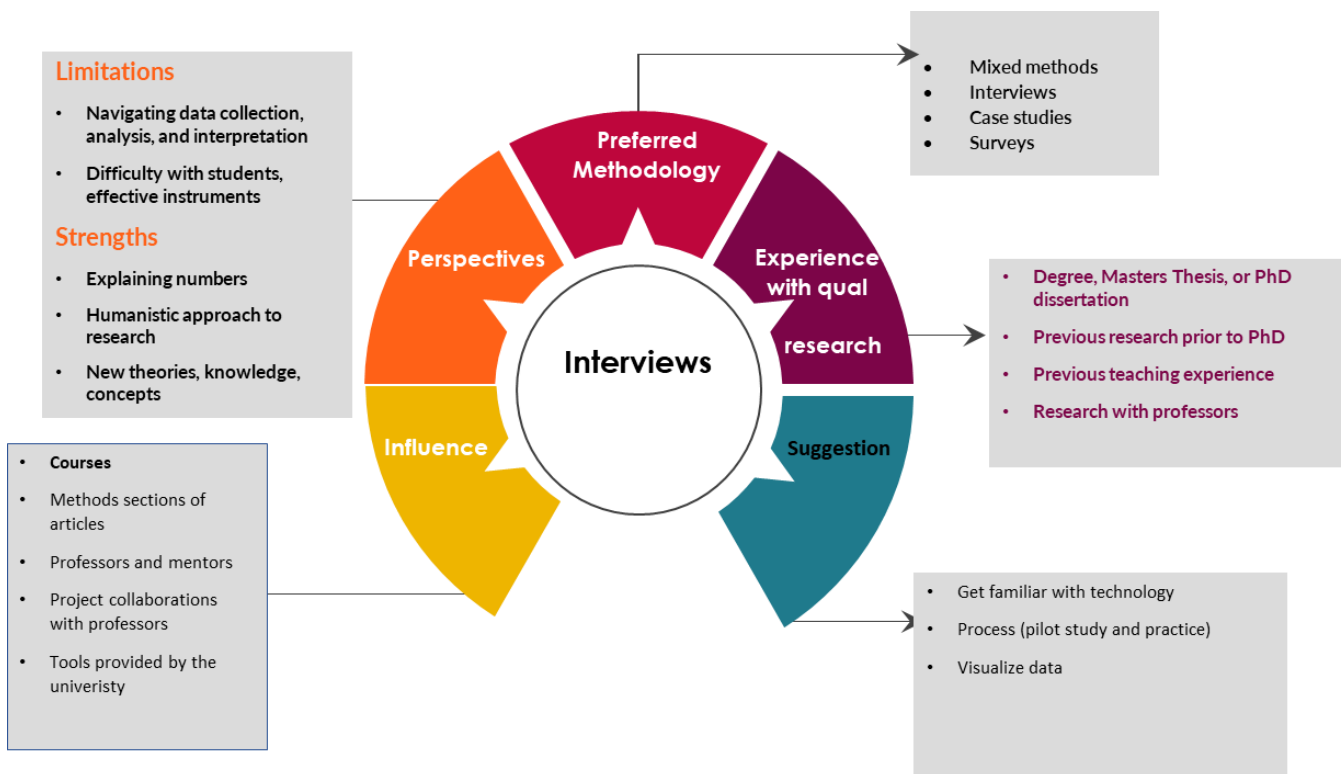

Figure 1. Image Showing Condensed Codes

3. RESULTS

Based on the focus of this assignment and the extension into practicing my coding skills, I decided to report my findings using the recommended layout by the American Psychological Association (APA), 7th edition, using a narrative approach.

3.1 Influence and Previous Experience with Qualitative Research

The data analysis from this study reveals that all interviewees were influenced by the methods sections of articles they read independently or by research or course professors. In addition, they were influenced by projects they collaborated on under the leadership or supervision of professors who used qualitative or mixed methodologies. The universities they attended also influenced their exposure to and use of qualitative research tools. Given that all four participants in this study were either Doctor of Science Education or doctoral students, it is unsurprising that their previous research experiences included bachelor's projects and master's theses where they utilized qualitative methodology. These experiences likely significantly influenced their choice to continue using qualitative research for their dissertations and scholarship as professors.

The findings suggest that exposure to qualitative research through coursework, collaboration, and independent reading can significantly impact one's research practices and approach. This highlights the importance of providing opportunities for students to engage with qualitative research early on in their academic careers and to have access to mentors and resources that can support their development as qualitative researchers.

For example, Beau, an adjunct professor of science education who has just completed her Ph.D. program, gave insights into her influences in her own words:

> "*The social resources have definitely been my professors and the classes I've taken; six of my master's were in science. So you don't really do any social research. So I did not have any background in social research. So it was not until I came to (college name) and took the classes to learn about qualitative that I did not want to do mixed methods and do some qualitative myself. So definitely say the classes here at (college name), the professors*" (Beau's interview)

Likewise, Bowman, who is an assistant professor and director of the science education program at his university, said in his interview:

> "*And so it was not until I had a series of three qualitative research courses at the (college name) that I had a better understanding of what qualitative research is, and all the rigor that's involved in it. And then actually getting experience with that in my research assistantship. Early on in the program, I would say I was one of the more skeptical students in the qualitative research classes, But it was the qualitative courses at (college name) and then the experience during the doctoral program that I think set me up for really valuing it and even prioritizing it in my research over quantitative methods*" (Bowman's interview).

3.2 Perceptions of Qualitative Research

Interview analysis revealed the strengths and limitations of qualitative research in science education. According to participants, qualitative research explains the number in a study that utilized mixed methodologies. Additionally, it provides a humanistic approach to science education research and pathways for developing new theories, knowledge, and concepts. For example, Jane, who is an international teacher with eleven published articles and is on the verge of completing her Ph.D. program, said in her interview:

> "*I think that qualitative research can tell the story that, that the numbers do not always reveal. So I think that it's able to dig in deeper, a lot of times, and I think it is also*

because quite often, I am looking at every subject matter that is about the person and their story. My emphasis in my dissertation is culturally responsive teaching. This is a very humanistic type approach that I want to take to find out how teachers utilize culturally responsive teaching. And so I think qualitative research is the best tool to find those things out. So, for me, it just, it's able to delve in deeper into the human psyche, which I am trying to find out about". (Jane's interview)

This was confirmed by Jerry, a first year science education professor whose dissertation utilized mixed methods. In his words,

"I see many benefits on doing qualitative research. Every time I do, like when I do quantitative research or create a graph, I think there's a piece in the puzzle that is missing. There is something that the numbers are not telling me, and that is when I think that qualitative research has a great impact and role in telling us more about those numbers. You know, providing us with more detailed information that the numbers cannot tell you. So I wouldn't say that my preferred method would be quantitative, especially in education. So I like this idea of having mixed methods and having the numbers tell you something. However, then you need to dig deeper into those numbers through qualitative research. So I value qualitative research in that sense." (Jerry's interview)

Another angle to qualitative research that emerged from the data is the limitations of qualitative research, including the intricacies of navigating data collection, analysis, and interpretation. Another limitation is the difficulty of getting research approval involving students while creating and validating effective instruments for each study, which the participants also mentioned. In the words of Beau,

"Not that I guess I have dealt with, but I know that it is harder to do some qual research on students particularly, so like I have stayed away from that, like I have not even tried to do qualitative research on students because I know that it's a higher level IRB or maybe more difficult to get the parents to sign. So that is something I think is difficult for qualitative researchers." (Beau's interview).

Table 2. Participant's Preferred Methodologies

Pseudonym	Example
Bowman	"So that has been the most common approaches that I've used are primarily qualitative or multiple methods where qualitative inform quantitative"
Jerry	"However, I would prefer mixed methods. The only thing is that I don't have a lot of background in quantitative research or mixed methods. But I definitely think that we can benefit from, you know, getting data from both types of research"
Beau	"I like survey methods and mixed methods. I really like surveys because I like data, and I like being able to get a large pool of participants like for my dissertation"
Jane	"I think as I learned about all these different types of research methods, in my mind's eye, I wanted to really be mixed methods"

3.3 Preferred Methodology

During the interviews, the science educators and scholars mentioned that the preferred methodology is mixed methods, while the qualitative part utilized interviews, case studies, and surveys as data collection tools. Table 2 shows quotes of all participants on their preference for mixed methods.

3.4 The Process of Qualitative Research in Science Education

During the conversations with the participants in this study on qualitative research in science education, several codes emerged that shed light on the research process. Notably, technology was strongly emphasized to enhance productivity and effectiveness during the coding and analysis. The participants mentioned a few software tools they found particularly helpful, including otter.ai, Teams Transcription, and Nvivo R1. In addition to using technology, the participants also emphasized the importance of practice in developing skills as qualitative researchers. Specifically, they encouraged emerging qualitative researchers to engage in class projects and pilot studies as a means of consistent growth and development in this genre of research.

Interestingly, one participant pointed out the need for the methods section of qualitative research articles to better visualize the codes that emerge during analysis. Specifically, they suggested using images that show connectivity and rigor between codes rather than simply describing them in text. This feedback highlights the potential for innovation and improvement in presenting qualitative research findings and points to the ongoing evolution of this methodology in science education.

4. DISCUSSION

Qualitative research is gradually gaining prominence in science education research either as the sole methodology or the methodology that informs the numbers that are characteristic of science education research.

4.1 Science Education Researchers' Perceptions of Qualitative Research

The first research question, "*What are science educators' perceptions of qualitative research?*" was designed to shed light on the perceptions of science educators regarding qualitative research. This study provides insights into science educators' perceptions regarding using qualitative research methods in science education. According to the findings, science educators view qualitative research as a methodology that can help explain the numbers while providing a humanistic approach to understanding quantitative data. Furthermore, findings suggest that some areas in science education research may be better studied using qualitative methods. Previous research on the importance of qualitative research supports this finding. Anderson (2010) found that using qualitative research in pharmaceutical education research helps give details and depth to the results. They found that they are perceived as a valuable approach for exploring complex issues and providing a more nuanced understanding of quantitative data. Similarly, Zeidler and Nichols (2009) argue that qualitative research methods are essential for investigating students' understanding of the nature of science. This area has traditionally been challenging to measure through quantitative approaches. By incorporating qualitative methods, educators and researchers can gain a more contextualized and humanistic understanding of complex issues related to science education.

4.2 Influence on Science Education Scholars

The second research question, "*What influenced their decision to choose qualitative research?*" probes participants' influences in qualitative research. The findings from this assignment reveal that science education researchers rely on graduate school courses and previous experiences with qualitative research to shape their methodology choices for

current and future research projects. This finding aligns with previous research on using qualitative research methods. Akesson and Thomsen (2018) found that exposure to qualitative research in graduate school courses can shape researchers' attitudes and beliefs about the value of qualitative methods. At the same time, Watt (2007) noted that collaboration with experienced qualitative researchers can provide valuable mentorship and support for novice researchers.

Together, these studies suggest that graduate school courses, previous experiences, and mentorship can all play essential roles in shaping science education researchers' perceptions and choices of methodology for research projects. The findings of the given assignment support this idea and provide further evidence of the importance of these factors in the use of qualitative research methods in science education.

5. CONCLUSION

In this self-directed assignment, I gained a deep appreciation for the time-consuming and immersive qualitative research process. The study's results confirmed the importance of spending adequate time with the data to comprehend it and uncover potential gaps for future research fully. Additionally, I increased the rigor of my data analysis by using software for coding and analysis, as Saldana and Omaste (2020) and the researchers recommended. I ensured a more thorough examination of the data.

Furthermore, the study introduces a foundation for reducing the dissonance between theory and practice in how emerging science education researchers view and approach qualitative research. As Rubin and Rubin (2011) suggested, the practical application of qualitative research methods can significantly enhance one's understanding of the methodology. By implementing the participants' suggestions, I gained valuable insight into the analysis process and produced a more robust data analysis.

This self-directed assignment provided valuable opportunities to apply theoretical knowledge and align my findings with previous research (Rubin & Rubin, 2011). Through software for analysis, adequate time spent with the data, and practical application of qualitative research methods, I produced a comprehensive analysis of the data and further my understanding of qualitative research methodology.

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