How Do Science Graduate Students Benefit from Qualitative Educational Research?

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Abstract

Scientists who teach in informal settings or at the post-secondary level are increasingly called upon to apply best practices that have been demonstrated to be effective through educational research. However, in order for scientists to apply such research findings, they must perceive the research as valuable and reliable. Thus, scientists who do not see value in qualitative research are not likely to apply its findings. The goal of this study is to engage two science graduate students in qualitative analysis of educational data and track the progression of their ideas about the value of educational research. This poster presents the summarized reflections of these graduate students over the course of an academic year, highlighting their ideas about the nature of educational research, the value of qualitative research methodologies, and the likelihood of applying educational research to teaching practices. These reflections suggest that engaging future scientists in qualitative analysis of educational data may …

Problem Statement

Teachers at all levels are expected to employ evidence-based teaching methods that arise from educational research. This expectation applies to K-12 science teaching, evidenced by the recent publication of new science standards that apply decades of educational research (NGSS Lead States, 2013). This expectation is also growing at the post-secondary level, where professors are encouraged to employ active learning techniques as they move away from the traditional "sage-on-the-stage" model. These trends require that future teachers, including science professors, be willing and able to consult educational research, understand it, and apply it. Current practices do little to train science graduate students in understanding and applying educational research.

There are several barriers that university faculty must overcome to consistently implement evidence-based teaching methods in their courses. When asked, faculty state that barriers to adopting evidence-based teaching methods include lack of knowledge of such methods (Borrego 2007; Borrego & Henderson 2014; Henderson, Dancy, & Niewiadomska-Bugaj 2010; Prince et al. 2013). While there are several other barriers preventing faculty from implementing such methods, this study address this issue. Because evidence-based teaching methods arise from educational research, exploring how science graduate students become familiar with educational research is one way to identify ways that the larger graduate student population might receive training in evidence-based teaching practices and the research that gives rise to them.

Research Objective

This project engaged science graduate students as members of an educational research team to examine the progression of their experiences as student-researchers and their ideas about qualitative research. This allows documentation of the progression of science graduate students' ideas about the nature of qualitative educational research and its value to their future careers. Given these students' future careers as educators, we feel they are well positioned to gain substantial benefit from participation in educational research. Their participation provides a unique context in which we can examine how future science educators come to understand the process and value of educational research, particularly qualitative research. This study can inform future studies that examine how to prepare educators in applying educational research to their practice and ultimately strengthen the quality of post-secondary science education.

Methods

To accomplish this objective, two science graduate students worked as student-researchers and analyzed qualitative data collected for a large NSF-supported research project entitled Project EDDIE (Environmental Data-Driven Inquiry & Exploration; www.projecteddie.org). The NSF project sought to examine how data-driven laboratory activities support students' development of experimental design, sampling, randomness, and statistical variation concepts in the context of environmental science investigations. This data analysis required qualitative methodology that is best accomplished by a team of researchers who hold diverse perspectives. The first author recruited two science graduate students (second and third authors) who were pursuing graduate degrees in a natural science. The second author is a graduate student studying toward her master's degree in biology; she is scheduled to graduate in May, 2016. The third author was a graduate student studying toward a master's degree in hydrogeology; she graduated in May, 2015. Students from these departments were chosen because the student-researchers analyzed data from geology, aquatic sciences, and biology courses, so knowledge of these disciplines was necessary to make sense of students' responses.

Our research team met weekly to conduct qualitative analysis of open-ended responses questionnaire that probed conceptions of experimental design, sampling, randomness, and statistical variation. These responses were provided by undergraduate and graduate science students across various levels of post-secondary courses. During initial meetings, we discussed relevant literature to the project and qualitative data analysis. We collaboratively conducted the qualitative data analysis of transcripts using grounded theory (Corbin & Strauss 2008).

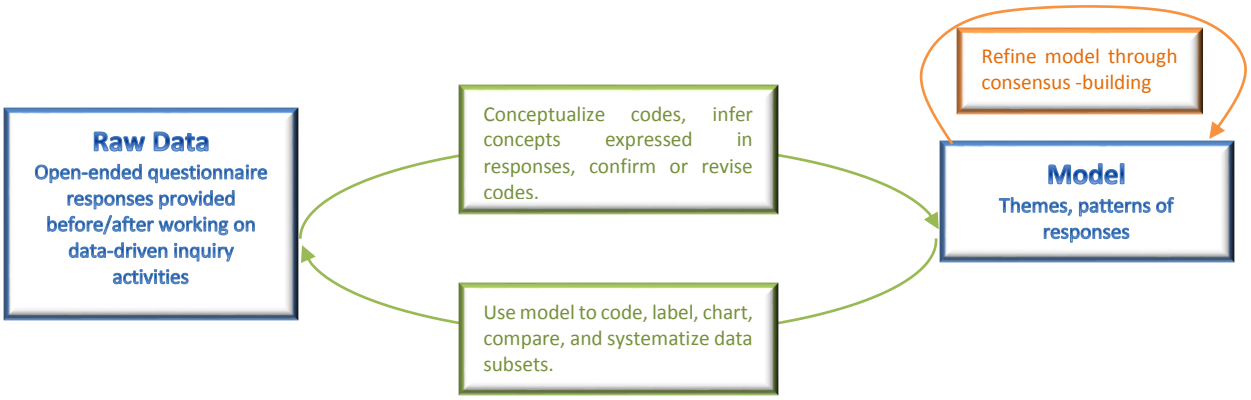

Figure 1. Schematic representation of how grounded theory (Corbin& Strauss 2008) was conducted by the research team. A subset of data is used to create a working coding scheme that was continually refined using additional subsets of the data. Activities performed by individuals of the team are represented in green. Activities performed collaboratively in meetings are represented in orange. Raw data and the model developed from the data are represented in blue.

Throughout this analysis, student-researchers kept reflections on the process, prompted by questions designed by the first author using NSF's *User-Friendly Handbook for Mixed Method Evaluations* (Berkowitz 1997) as a guide (Table 1).

Table 1. Reflection prompts provided to student-researchers throughout the year they participated as members of an educational research team conducting qualitative analysis.

Date	Reflection Prompt

September 2014	When doing qualitative research analysis, a primary goal is to identify themes or patterns across cases or within cases. (Here, "cases" is broadly defined. In our study, a "case" is one student's response to a question, and we're looking across cases/students to find patterns). What can we do when we find cases that deviate from the observed patterns? How do we attempt to deal with or explain these atypical responses?
October 2014	"Every field of science has a shared culture regarding standards of rigor for research done in that field." Explain the degree to which you agree or disagree with this statement. Give examples from our educational research or research in your scientific field of study that illustrates your points.
November 2014	The goal of most research is to make generalizations to a larger number of cases than what was studied in the research. How can qualitative data be generalized, if at all, to larger groups, and how can it have significance beyond the specific cases studied?
January 2015	Reflect back on your reflections so far. Are there comments you find surprising or things you would or wouldn't have said now? Please explain.
March 2015	In qualitative analysis, "validity" refers to whether the conclusions being drawn from the qualitative data are credible, feasible, defensible, warranted, and able to withstand alternative explanations. How, given our interpretation of students' responses on surveys, do we establish validity?
April, 2015	In our analysis of students' survey responses, what interesting stories emerge from the responses that do not specifically align with our research objectives? How can these stories help to illuminate broader study questions? Could these insights have been gained from quantitative data collection? If so, what would the quantitative data collection tool have looked like?

In spring of 2015, student-researchers consolidated their reflections on becoming acculturated into an educational research team and summarized their reflections on this acculturation process, using their own written reflections as documentation of their progressions. Summaries were constructed around three themes:

- How has your understanding of the nature of educational research changed throughout this experience?
- What is the value of qualitative research methodologies and have your ideas about this changed throughout this experience?
- If you were to teach science in an informal or university setting, how likely would you be to apply educational research to your teaching practices, given your experience as an educational researcher?

Outcomes

Student 1

Emergent themes resulting from Student 1's reflections centered on skills developed through participation in the research process and the nature of educational research. Regarding skills, she felt she had gained skills in learning how to generalize from qualitative data:

> *I never knew how to assess qualitative data in order to determine what is significant. I always thought it was analysis of qualitative data was highly subjective. Therefore I thought it was debatable and nearly impossible to prove … I realize there are ways to interpret qualitative data. I learned how the use of qualifiers and coding can be used to generalize subjective data.*
>
> - May 2015

This student provided an example of her developing skills in an early reflection in which she stated:

> *It is interesting to see how an answer for one question helps the others make more sense. And also how the answers correlate with each other … Watching for correlations can help us create themes to investigate.*
>
> - September 2014

And about halfway through the academic year, she felt more confident in her ability to generalize from qualitative data:

> *I don't think it is so hard to generalize anymore. We can create a coding scheme based on what we expect the answer to be. Then we can alter it slightly based on a sampling of answers or report how we received answers we didn't expect. There will always be answers we can't interpret and other we think we understand but are from left field. The best we can do is go with the masses and report the radicals. Only then can we have significance.*
>
> - November 2014

She recognized the importance of transparency and clarity in coding procedures early, and this was reiterated in later reflections:

> *We just have to be as detailed as possible and record everything we did and why.*
>
> - October 2014

> *It all comes down to recording exactly what we did and why we chose to do so. These reflections I feel are a good resource to get some of that out in the open.*
>
> - March 2015

Student 1 came to understand educational research's focus on conceptual development and understanding, rather than grades and correct answers:

> *Education isn't all about the numbers or grades that the students get. The understanding the students gain is just as important. The change in understanding over time is probably even more important than the grades they receive. But that understanding is the trickiest part to measure since it is subjective. I always thought that the researcher's only option was to use the grades the students received to represent their understanding of a subject. Unfortunately, as previously stated, there are many factors that can affect grades. Variables such as pervious knowledge, off days, varying curriculums and more can affect a student's performance.*

- May 2015

Student 2

> *As with the open-ended responses we received, it is often hard to code the first time around. Responses are open to some interpretation and therefore evaluating them is arguably subjective. Going through these various steps allowed me to see the rigor that should be put into educational research and also its flexibility at the same time.*
>
> - May 2015

Student 2 seemed to experience a shift in how she thought about science due to the experience working as a member of an educational research team:

> *Actively working in educational research … has greatly changed my understanding of it as far as the science that is involved. By science, I mean the procedures involved with attempting to answer research questions through assessment, instrument creation, and subsequent coding. The tentative nature of this type of educational research is … challenging in that you don't know what you will end up with as far as student answers.*
>
> - May 2015

Value of Qualitative Research Methodologies

At the beginning of the academic year, both graduate students had not considered how educational research might be relevant to their practice:

> *I never thought much about educational research before starting this project. I thought of it mostly in the context of something other people did, since I mostly worked with quantitative data. As many of these variable as possible need to be controlled in order for any data qualitative or quantitative to be useable. That means a controlled curriculum and way to measure previous knowledge. These controls allow us to quantify and measure qualitative data.*
>
> *Qualitative research methodologies allow us to tell a groups' story or narrative, and express points of view. These thoughts may be related to conceptual material or perhaps opinions or views on other things, and those things overlapping. My ideas about methodologies have changed throughout this experience in that I wasn't sure how I felt about constructivism or phenomenological studies. I think our study might fall under phenomenological because we are attempting to examine why students don't understand certain concepts as college students and if they have misconceptions or not. There may be a suite of things in each student's lifetime that leads them to believe one thing or another. Overall, I feel that our study has helped me to understand longer term research with qualitative means and how it can help answer certain research questions.*

Application of Educational Research to Teaching Practices

The most likely scenario for me to teach would be in a K-12 classroom or a one-time presentation to a community. I doubt I would conduct research during a one-time presentation. However, if I were to work in a classroom with children over the course of a school year, that would a great opportunity to conduct educational research. I don't think I would ever use that research to submit to a journal for peer review, instead I would use it to track the impact my teachings may have (for the benefit of the organization I would be working for). I do think that my experiences over the past year would influence how I would conduct this research.

I would most definitely utilize survey-style assessments as we have with Project EDDIE, and draw upon other instruments (validated) to align with my specific research questions. I would want to make sure that the concepts I am trying to drive home for students are evident to the students and get their take on the relevance of those to the subject matter and their daily lives. I could see myself using interviews and a survey approach, something close-ended. I would also attempt some purely observational research and then see if what I am observing about my classroom fits with student perceptions (through surveys and interviews as needed).

Conclusion

The two science graduate students who spent an academic year conducting educational research gained research skills throughout their experiences, and their ideas about education seemed to shift toward a greater emphasis on understanding and conceptual development and away from over-emphasis on correct answers. While science graduate students may never conduct educational research, these case studies indicate that participating as a team member on an educational research team positively influences their philosophy of education. This is a positive outcome, given likely future careers as post-secondary science educators.

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