Emerging Mathematics Education Researchers' Conception of Theory in Education Research

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While some faculty follow a traditional path into mathematics education through a graduate program or post-doctoral studies, some enter mathematics education research without formal training. These emerging mathematics education research faculty face unique challenges in setting up a research program. In this paper we explore the challenges that theory poses to emerging mathematics education researchers. We articulate three ways that emerging mathematics education researchers struggle with theory, and suggest that learning about theory and overcoming this struggle can be transformative to their work within and perspective on mathematics education.

Keywords: Professional-development, faculty, perspectives, theory

Introduction

Mathematics education research interests many faculty - both with and without formal backgrounds in it. Faculty may have studied mathematics education in graduate school or pursued post-doctoral work in the field before obtaining faculty positions. This prepares them for research through formal training in and practical exposure to ideas, theories, methods, and common practice within the field.

Many faculty, however, become interested in mathematics education after obtaining a faculty position (often, but not always a teaching-focused position) (Bush et al, 2017) sometimes after tenure and promotion. These faculty rarely have formal training in mathematics education, nor do they have much practical experience in the education research field (even as they may have varied experience as educators). As a result, they struggle to catch up with the field's understanding of theory, methods, and research practice. These emerging mathematics education faculty may have unique struggles as they attempt to set up a research program within the field. In this paper, we focus on a particular area of concern: theory. Despite attempts within the field to make theory more accessible (which we discuss more in the next section), theory remains a significant challenge for emerging mathematics education faculty.

Many emerging mathematics education faculty express confusion or worry around the complexity and usage of what researchers term theory, theoretical frameworks, analytical frameworks, and theoretical perspectives. In this paper, we discuss these terms and the literature surrounding them as part of our discussion of confusion among emerging education researchers. We present three ways in which participants in the Professional development for Emerging Education Researchers (PEER) program (Franklin et al, 2018) struggle with theory. For some faculty, learning about theory is transformative for their research within and perspectives on mathematics education.

Conceptual Framing and Literature

Cresswell and Cresswell (2018, p. 95) quoted Kerlinger to provide a definition of theory within social sciences as "a set of interrelated constructs, definitions, and propositions that presents a systematic view of phenomena by specifying relations among variables, with the

purpose of explaining natural phenomena." As argued by Stinson (2020), our choices of theory and how we use it are strongly influenced by our philosophical perspectives and worldviews as researchers. Many have attempted to write concise introductions to particular theories and theoretical frameworks, as well as attempting to distinguish between their various uses and how they all fit into the broader literature (e.g. Simon, 2009, Spangler & Williams, 2019, Lester, 2005, Silver & Herbst, 2007). Others have made an effort to make theory more accessible to emerging education researchers (e.g., Doroudi (2021)). For example, Schoenfeld (2000) offers a practical set of standards with which to judge theories and results in mathematics education, grounded in the notion that research and theory in mathematics education is more similar to the physical and life sciences, as opposed to the proof as the standard in mathematics. Even as these authors work to provide detailed introductions to the theory of mathematics education research, they all recognize, as do we, that the roles theory plays in research can vary. The process of making decisions about what role theory plays in your research, and which theory or theories to use can be very confusing and intimidating to emerging mathematics education researchers.

The authors of this paper take a parallel process view of research, seeing the selection of theory, literature review, data analysis, writing, and formation and revision of claims as ongoing, overlapping parallel processes. Different parts of research are not conducted in separate stages, but occur together and inform each other. Theory is considered at all stages of a research project, and choices of theory and its place within a project are constantly deliberated, in line with Simon (2009). We also agree with Stinson (2020) that personal worldviews and philosophical alignment play an important role in the selection and interpretation of theory and data. As we present our findings here, it is important to note that the PEER program teaches theory as something that is inextricably attached to researchers' worldviews, personal and academic philosophies, and which influences and is influenced by their whole research programs.

Study Context: The PEER Program

This study was conducted as part of a grant for improving and expanding the Professional development for Emerging Education Researchers (PEER) program (Franklin et al, 2018). The PEER program brings together emerging education researchers at an extended, experiential workshop for intensive writing and thinking about research questions and research design. The program also covers selected topics in research based on participants' needs (e.g. workshop sessions focused on particular methods or theories, authorship, ethics, etc.). The bulk of the program centers on participants working together and sharing and refining research ideas together with the support of PEER coordinators. PEER facilitators intersperse groupwork activities with instruction and guided discussion around subject matter and research design.

Our data for this paper are drawn from participants in the PEER-Chicago 2021 workshop. This workshop occurred over Zoom through spring 2021 and was attended by 45 emerging mathematics and physics education researchers from a variety of research and teaching institutions across the country. The workshop consisted of a kickoff session, three two-hour sessions spread over 6 weeks, and then a three-day intensive at the end of June. Before the workshop we conducted pre-interviews with fourteen participants. During the workshop sessions all participants were encouraged to record their "burning questions" about workshop topics in a Padlet[1] document, which we collected. Finally, during post-interviews with 8 participants we followed up on their experiences during the workshop.

[1] See their website for more information https://padlet.com/.

Results

Using the data drawn from PEER we were able to identify three different ways in which participants are confused about theory. We also noted that learning about theory appears to be transformative for PEER participants. Our analysis is presented below.

Participants are confused about theory

In the pre-interviews, discussion of theory by participants was rare. Because the semi-structured interviews focused on participants' past experiences, we didn't initiate discussion of theory. Several participants discussed theory during their pre-interviews. It's worth noting that all participants had prior experiences in projects conducted by mathematics education researchers. Ryan and Lily[2] piqued our interest with their comments on theory.

In his pre-interview, Ryan stated: "[There are so many] different theoretical perspectives that one can adopt when you're looking at your data…" and went on to say: "Where you just kind of do what you know and if you don't know it, you can't do it." Ryan's statement was early confirmation that participants find theory overwhelming to confront. In particular, he struggled with finding theory that is a good fit for his project because there are so many kinds of theory**. If you don't know what you're looking for or where to look, good theory is hard to find.**

Ryan continues, asking for: "[A] handful of references that I can go to in the literature and read some more about over the next, you know, three or four months [would be very helpful]." This statement highlighted the value of linking Ryan to the community's conversation on theory. Many emerging mathematics education faculty expressed a similar sentiment to Ryan: having a few curated sources to look at would be highly valuable. Several examples of such sources can be found in the paper's citations and were provided to participants at the workshop.

References may not be sufficient, however. As Lily said about theory: "... [A]t the beginning, the whole idea of a theoretical framework was totally mind boggling to me." and "I was talking a lot with like my grad student friends at the time in sociology and things like this, and like that's their bread and butter". Lily highlighted the importance of having someone to hold a conversation with and bounce ideas off of when trying to understand theory. She also showed a second way in which our participants struggle with theory: **participants aren't sure what theory and all of the terminology surrounding it means within mathematics education.**

When the interviewers (in pre-interviews) explicitly asked participants about different parts of a research project/design in mathematics education research, theory rarely came up. Lily and Ryan provided us with our first glimpse into why interview participants so steadfastly avoided the topic: because it is overwhelming. The meaning of theory and the web of terminology surrounding theory in mathematics education can be very confusing to emerging education researchers. Secondly, even for those who have developed an understanding of what theory is in mathematics education, it can be very difficult to source theory and learn about new theories without guidance.

Echoing Lily and Ryan's challenges in the pre-interviews, participants expressed similar challenges in their Padlet questions during the workshop; however, the Padlet questions also illuminated a third kind of challenge. During the workshop, theory and its role in education research became an emergent topic in response to participants' questions and facilitators' observations of participants' ideas. This focus on theory afforded robust conversations and

[2] All names are pseudonyms chosen either by participants themselves or by researchers to reflect participants' pronouns and ethnicities.

elicited many confusions and concerns from participants, some of which were recorded anonymously in the "burning questions" Padlets.

Within the Padlet data, a common confusion was how and where to source theory. One Padlet question was “How much of your theories should be based on other work (lit review) vs. your own new ideas?” Participants are often uncertain about how their own ideas interact with theory in mathematics education research. They wonder whether theory comes from other published research or if they should develop it themselves. Others similarly wonder where theory should derive from, and how to appropriately build one’s own ideas into theory. One Padlet question said “How is it distinguishable from a lit review? Don't the theories come from published research?”, and another asked, “How does one *develop* a theory from data?” It is clear to our participants that theory must be generated by someone somewhere, however, participants are uncertain about community norms around who is allowed to generate theory and how. Where to source theory and how to do it appropriately is a stumbling block for participants.

Perhaps one of the most illuminating questions asked by a participant was “Does the "theory" for a paper necessarily need to be a complete ~theory~, or can it be a framework or even just a Frankenstein of ideas you were thinking about when looking at your data? Does every paper need a "theory"?” The first part of this comment echoes confusion that we had already heard about from Lily and Ryan. The asker is uncertain about what theory is, what theory means in mathematics education. They are also (as a consequence) uncertain about where it comes from, who makes it, and how. However, this participant is not merely confused about what theory means, or where it should be sourced. The second question here “Does every paper need a theory?” speaks to a deeper concern: what is the purpose of theory?

A participant asks this explicitly: “Why do you even need a theory? This theory stuff is super intimidating, what’s the best way to ease yourself into it?” **Our emerging education researchers struggle to understand the role of theory in our research.** What do we use it for?

The questions asked by participants during the workshop reinforced comments by Ryan and Lily. Participants are confused about where theory comes from, and what theory means. However, the Padlet questions also made clear a related confusion. Participants struggle to understand the role of theory in mathematics education research.

PEER can transform participants' thoughts about theory

After the PEER-Chicago workshop we conducted follow up interviews with 8 participants. These interviews focused on their experiences during the PEER workshop, and the development of their understanding and perceptions of education research as well as their professional identity. Several participants spoke about the how learning about theory during PEER-Chicago had impacted their understanding of education research.

In discussing learning about theory, Peter noted: "The idea of using part of this theoretical framework and combining it with that one, I'd never considered it before". Learning about theory at PEER transformed how Peter thought about implementing theories in his own research. Earlier in his interview he commented: "I know enough about theoretical frameworks to know that there are constructivist theoretical frameworks, and you know there are varieties of those, and then there are other theoretical frameworks which are not constructivist. And I can read about both of those, and I can see what I'm doing in each, and that just doesn't make sense to me." During PEER his thinking on theories moved away from an image of theories as mutually exclusive descriptions of the world to theories as potentially complementary descriptions of the world.

Another participant, Olivia discussed how learning about theory has transformed her view of mathematics education research: "Well I think the most pointed, that first reading specifically

addressed the value of a more theoretical approach to math education, how that can inform a more practical approach." Olivia goes on to say: "I tended to come at things as I want to know if this works, I want to know how to tell if it's going to work. Which is implicitly dismissive of people who want to simply ask questions like, you know 'exactly what do students leave with from this particular approach to describing a logical construct?' and I am less dismissive off that [now]." Olivia has become more open to questions which aren't directly about measuring classroom success, and curriculum implementation.

Finally Penelope commented: "The theories, I still don't have a good handle on the theories, but I found that for me, [...] my focus is more like 'let's make this really good' versus some people who are like 'let's make theory really good' if that makes sense. And so I did get some understanding of where I am and why I'm there and being ok with why I'm there." Penelope's view of their own place in mathematics education research and the acceptability of what they do was transformed by taking the time to learn more about theory.

These comments from our post-workshop interviews suggest that for some participants learning about theory is transformative. It has a large impact on their views of mathematics education, and their understanding of how to conduct research. It's very exciting for us to see that learning about theory can have a deeper impact on participants than simply providing a theory paragraph in their paper.

Concluding Remarks

Theory is deeply important to math education research, informing research projects at all stages of development. A researcher's use of theory is impacted by their own worldviews, personal philosophies, and experience. For many emerging math ed researchers, theory is very intimidating, and difficult to approach or understand. In this paper we have explored several ways in which emerging math ed researchers participating in the PEER program struggle with theory. These researchers struggle with 1) understanding what theory means in math ed, 2) what role theory should play in their research, and 3) where and how to source theory.

We also found that after participating in PEER a number of our participants discussed how learning about theory has impacted their engagement with math education. While it was unsurprising that some participants discussed the application and use of theory in their research, their discussion was not limited to this. Some of our participants discuss an important and transformative effect on their personal identity or perception of math education research. Thus, we find that while emerging education researchers may struggle with theory, the process of learning about theory and attempting to overcome that barrier can be transformative.

Questions for the audience.

1. What does theory mean to you? How do you use theory in research?
2. Do our participants' journeys with conceptualizing theory resonate with your personal journey? With what you've noticed in your students / colleagues?
3. Do you have comments or suggestions for us as we extend this work and analysis?

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