

Research development of STEM faculty as part of a disciplinary professional
development program

by

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B.Sc., University of Calgary, 2018

AN ABSTRACT OF A DISSERTATION

submitted in partial fulfillment of the
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Department of Physics
College of Arts and Sciences

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Abstract

Over the past 50 years physics education research (PER) has grown into a thriving sub-discipline of physics. PER grew out of a desire to approach education research and development from a disciplinary perspective, operating under the assumption that good physics education is deeply rooted in the disciplinary knowledge and practices of physicists. As a result of its disciplinary focus, many physics education researchers have informal education research or practice focused backgrounds, in addition to formal backgrounds in traditional physics sub-disciplines such as nuclear physics, AMO physics, condensed matter physics, etc. While there are institutions that offer graduate programs in PER, there are still many new and emerging PER researchers who do not have backgrounds in education research. In an effort to welcome these people to the field, and provide them some formal training in education research practices the professional development for emerging education researchers (PEER) program was born. Over the years, this program has expanded to include researchers from other STEM disciplines as well, making it one of a few programs in STEM available for discipline based education research (DBER) professional development.

In this dissertation I will discuss the needs of emerging discipline based education researchers (EDBERs), and how we can better support them in their growth. I will approach this problem through the lens of the PEER program. I will present findings based on iterative thematic analysis of interviews with EDBERs (many of whom were PEER participants). The results of these thematic analyses will be presented across three different projects.

The first project focuses on how the community can come together to support EDBERs, and how community connections and support can be built into professional development programs (using PEER as an example). This project covers a thematic analysis that turned up three roles which our EDBERs depend upon community members to fill in order to support their growth and engagement in education research. I begin by interpreting these

roles through the lens of behaviour and decision making, in order to explain how these roles fit into a professional development program. Afterwards, I go on to explain the next iteration of the thematic analysis which focused on how EDBERs develop a sense of belonging within the education research community. I tie their sense of belonging back to the roles that community members play in their development as education researchers.

Having discussed how EDBERs are linked to the education research community, I move on to their access to the community. In the second project I examine themes around isolation, fear, and stigmatization that emerge in interviews with EDBERs. Here I characterize communities as networks of people, and use Barzilai-Nahon's theory of network gatekeeping to examine EDBERs access to the education research community, and how the community controls that access. I propose moving explicitly and thoughtfully towards a culture of groundskeeping to help mitigate the negative impacts of gatekeeping on EDBERs.

Finally I will examine themes that emerged around the difficulty of engaging with theory in education research. Many faculty EDBERs lack a background in education research, and struggle with theory in interesting ways. In this project I first elaborate on how their struggle with theory manifests in my data. I then go on present case studies of EDBERs thinking explicitly about what theory is in research. In these case studies I present an example of an EDBER sensemaking about theory, a counter example of someone who already has strong but incomplete ideas about theory, and finally an example of an experienced education researcher's reasoning about theory within education research.

These three projects come together to demonstrate the challenges faced by EDBERS, and the support they need from established education researchers in order to thrive. I examine their needs across issues of community support, community access, and understanding of community knowledge in order to provide a multifaceted picture of challenges faced by professionals engaging with a new (to them) field.

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Approved by:

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Abbreviations

- CoP: Communities of Practice
- DBER: Discipline Based Education Research or Discipline Based Education Researcher
- EDBER: Emerging Discipline Based Education Researcher
- FLC: Faculty Learning Community
- FoLC: Faculty online Learning Community
- ISLS: International Society of the Learning Sciences
- PD: Professional Development
- PER: Physics Education Research
- PEER: Professional development for Emerging Education Researchers
- SFES: Science Faculty with Education Specialties
- TNG: Theory of Network Gatekeeping

Acknowledgments

Writing a dissertation has surprised me coming and going. It surprised me how hard it was, it surprised me how many parts were easier or shorter than I anticipated, it surprised me how much work goes into the various parts, and it surprised me how often it was hard for reasons that I just never anticipated. In writing the final product for submission and graduation, I'd like to acknowledge all of the people who have helped me overcome my surprise and tackle this enormous task.

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Dedication

In loving memory of

Tadeusz and Krystyna

Hass

Francis and Patricia

Swartzlander

Adele

Hilkewich

With the loving guidance of those who have gone before we undertake great journeys.

Thank you for opening the way.

Chapter 1

Introduction

1.1 Emerging STEM education researchers

In many disciplines, journals dedicated to education research within that discipline have been established in response to the growth of discipline based education research (DBER) (e.g. Physical Review: Physics Education Research, CBE: Life Sciences Education, the Mathematics Education Research Journal, and the Journal of Nursing Education). DBER as a field values education research that is deeply grounded in the disciplinary knowledge, practices, and culture of a discipline (for instance I am a physics education researcher (PER)). Faculty who are involved in DBER have highly varied backgrounds. Some may have begun conducting education research projects as undergraduates or in graduate school and received formal training, through institutions which offer graduate programs in discipline-based education research (DBER) for example. Others may have completed graduate work unrelated to education research, but conducted education research as part of a postdoctoral program. Still others may not have begun conducting education research until they were faculty at an institution. Some are hired as science faculty with education specialities (SFES)¹, while others grow into this role as part of their engagement with the pedagogical mission of their unit.

Regardless of their origins and background, these DBERs are becoming increasingly im-

pactful in the development of pedagogy within their disciplines²⁻⁴. In order to support high quality research, and continuing stable growth of DBER fields it is important to address the shortage of PD opportunities available to emerging discipline based education researchers (EDBERs). This is especially true for those who do not have a formal background in education research, and therefore may lack training in formal education research practice. My work in this dissertation will focus on understanding the needs and growth of EDBERs through iterative thematic analysis of interviews with EDBERs. The goal of this work is both to expand our understanding of how EDBERs grow into their careers, and how PD programs can be designed to better support that growth.

1.2 SotL vs DBER vs the Learning Sciences vs Science Education Research

In this dissertation I am primarily concerned with emerging discipline based education researchers (EDBERs). That said, there exist a number of closely related fields which may involve discipline based education researchers. While in this dissertation I will primarily discuss DBER, and will not explicitly distinguish between these neighbouring fields and DBER, this is only because EDBERs exist within each of these fields, and often are a part of multiple of them. Here I will acknowledge these fields so that the reader is aware the DBERs and EDBERs exist as part of several overlapping communities within education research.

The first field I am concerned with is, obviously, DBER. I am in physics education research (PER), which is a DBER field (discipline being physics). DBER is a set of overlapping discipline specific education research fields, which value educational pedagogy and research that is deeply rooted in the subject specific content and norms of a discipline. These fields include mathematics education research, physics education research, chemistry education research, biology education research, and more. In their 2017 paper, Henderson et al discuss the importance of building connections between different DBER disciplines, to strengthen and better define the field⁴.

Another closely related research area is the scholarship of teaching and learning (SoTL). Not originally conceptualized a research field, and arguably not a single research field, SoTL originated from Boyer's models of scholarship, in his 1990 work *Scholarship Reconsidered: Priorities of the Professoriate*, Boyer defines four different kinds of scholarship, one of which is the scholarship of teaching⁵. From this work SoTL grew as an independent area of scholarship, widely recognized across many disciplines. It is strongly practitioner oriented, focusing on the testing and development of teaching practice, as opposed to generating theories of learning in a cognitive, psychological, or emotional sense.

The Learning Sciences are a field of interconnected researchers who approach research on learning from the perspectives of cognitive psychology, social psychology, cultural psychology, and critical theory. The International Society of the Learning Sciences (ISLS) defined the field in the following way "Researchers in the interdisciplinary field of learning sciences, born during the 1990s, study learning as it happens in real-world situations and how to better facilitate learning in designed environments – in school, online, in the workplace, at home, and in informal environments. Learning sciences research may be guided by constructivist, social-constructivist, socio-cognitive, and socio-cultural theories of learning"⁶. This field is not discipline specific, but often attracts discipline specific researchers, and DBER has a great deal of overlap with the Learning Sciences.

Finally Science Education Research is a broad term which mostly refers to K-12 level education in the sciences. Though there is not a good standard reference for this, Wiley's journal *Science Education*, and the report from the Committee of Ten⁷ both provide a definition of the sciences involved, and the focus on K-12 education. Broadly this field of research is committed to ensuring high quality science education for all K-12 students to improve their contributions as citizens of a nation, and quality of life.

While all of these fields overlap, for the purposes of my dissertation all that matters is the EDBERs themselves, who may be participating in any of these fields. I will not further distinguish between these fields, as comparing and contrasting these fields is not the purpose of my dissertation. In my dissertation although I will only refer to DBER or to education research communities, the reader should keep in mind that EDBERs may be linked to more

than just DBER fields.

1.3 Who is the author?

I'm Christopher Hass, I'm a 27 year old physics student. I received my undergraduate degree from the University of Calgary, a research focused, Canadian institution in 2018. I received an honours degree in physics, with a fairly traditional background in things like linear algebra, differential calculus, classical and quantum mechanics, and electromagnetism. At Kansas State University my degree has focused on traditional physics courses.

In 2018, during the summer between my undergraduate and graduate programs, I attended the Professional development for Emerging Education Researchers (PEER) program. As a first time participant I experienced PEER, a program that is very focused on taking participants research ideas and helping them build those into functioning research projects. PEER was smaller then than now, and at the time participants self-sorted into groups and worked together on a research project (in groups of 2-5 people). For the two weeks of the program participants worked together to design the project and plan how they would move forward with it, and over the year following the program participants continued to meet bi-weekly over zoom and work together to complete the project and publish results.

My experience was a bit different because the project I joined was actually continuing from the previous year's PEER, and I had joined the project partway through as an undergrad. At PEER 2018 we worked to finish our project planning, and plan paper publications. Since that time I have studied PER as a graduate student at Kansas State University, and in 2020 we received a grant specifically to conduct research on the PEER program. I jumped at the opportunity to work with the PEER program, this time not as a participant, but as a part of the program research team.

In this dissertation I am presenting the work I have done as part of the research team. That said, my work comes from a place of personal interest in professional communities and their members, and is informed by my experiences as a PEER participant. The principles and ideas of PEER are reflected in my research, my decisions, and even the questions that

I have decided to ask. Even as I write this dissertation I rely on the papers I have written as a graduate student, activities which link back to the communicative principle of PEER (see section 3.2). The ideas that formed this dissertation were generated through a typical combination of “yes and” and generative writing, and the whole dissertation and its research are based upon the principle of responding to the needs of present and future PEER participants.

My identity as both a PEER participant and PEER researcher are inseparable in the writing of this dissertation. The principles and practices of PEER have formed the basis for this dissertation’s writing. At the same time my identity and background as a physicist have played a major role in how I conceive of what research is, how it should be conducted, and inform how I approach both interviews with research participants, and interpreting what is important or interesting in my results.

1.4 Outline of the dissertation

If you need an outline of the dissertation, I would strongly encourage you to visit the table of contents. Having said that, if for some reason you feel the need to delve into the god-forsaken depths of this dissertation, perhaps in the hopes of learning something from the gory details presented herein, then you are welcome to read this summary of what comes next. This dissertation is broadly broken into 5 parts across it’s 8 chapters: the set up of the problem (chapters 1 & 2), a discussion of the context for the work (chapter 3), understanding how EDBERs are connected to education research communities of practice (CoP) (chapters 4 & 5), understanding barriers to EDBERs participation in education research CoP (chapter 6), and investigating how EDBERs engage with theory in education research (chapter 7). There are, of course, some miscellaneous additional bits to be found in the front matter (hint: check out the list of abbreviations), conclusion, and appendices, but who would read those?

I’ll begin my discussion with a review of the literature around faculty professional development (PD) in physics and surrounding disciplines. Arguing for a holistic approach to PD, and the importance of considering factors beyond just workplace skills when implementing

PD programs. In chapter 2 I will discuss the literature around emerging education research faculty and their role in STEM departments. The goal will be to highlight the importance of providing PD opportunities for EDBERs.

Chapter 3 will be dedicated to the professional development for emerging education researchers (PEER) program. PEER is one attempt to fill this gap in available PD opportunities for EDBERs. I am a researcher on the PEER team, and have been involved in developing the PEER program and its curricula through conducting research and providing feedback and suggestions to facilitators based on results. The goal of this chapter is to introduce the PEER program and its purpose, explain the collection and context of my data, and give the reader a sense of my role in the program.

Next I will discuss one of the earliest results from my research, the emergence of themes about community support in my data. EDBERs in my data universally expressed a need for stronger ties to education research communities. In chapters 4 & 5 I will focus on what this means and what education research communities might do about it. The goal of these chapters will be to introduce a framing of community, and put names to the kinds of ties that EDBERs are seeking, as well as explain the theoretical need behind those ties. In chapter 4 I shall address the question “*What roles can education researchers take up to support EDBERs engaging with education research communities of practice?*” In chapter 5 I will extend this work by answering the question “*What does it mean for EDBERs to feel a sense of belonging within an education research community of practice?*”

In chapter 6 I will discuss a second aspect of EDBERs struggle with communities: their limited access to education research communities. Research communities control who can access their communities, and who can spread information within their communities through a variety of explicit and implicit mechanisms. This control regulates the quality of research, and missions of individual research communities. While this control is a necessary feature of research communities, it is important to consider how we minimize its negative impacts on new and emerging researchers. In chapter 6 I will address the question “*How do EDBERs perceive experiences of gatekeeping in DBER?*”

Finally I will discuss how EDBERs engage with theory in education research (chapter

7). Although there are many topics which EDBERs struggle with in my data, EDBERs struggles with theory in education research struck me as particularly interesting. In this section of the dissertation I will discuss how EDBERs struggle with theory in education research, how PEER is attempting to address this problem currently, and how recent data about EDBERs sensemaking around theory lends valuable insights into the learning journey that EDBERs are on. In chapter 7 I will address two questions “*How do EDBERs struggle with understanding and implementing theory in education research?*” and “*How are EDBERs making sense of theory in their disciplines and education research?*”

I will conclude the dissertation with a brief reflection on the work that has been done, and thoughts on how that grows into future work and projects. The final sections of the dissertation include summaries of my participants (appendix B), my interview protocols (appendix A), and a summary of modules available through the PEER program (appendix C, more information in chapter 3 section 3.3.1).

Chapter 2

Faculty professional development in the literature

2.1 Introduction

My research in this dissertation focuses on faculty professional development (PD), a topic which is surrounded by a great deal of literature across several disciplines. Much of the literature on faculty PD in higher education has focused on how to improve faculty teaching skills, as teaching in higher education has come under greater scrutiny over time. Most faculty members at higher education institutions do not have formal training as educators, rather they are hired due to their backgrounds in disciplinary research. However, there is a noticeable gap both in available PD programs and in the literature addressing how faculty develop as researchers.

This lack of PD programs and literature addressing faculty research PD is especially noticeable within discipline based education research (DBER). There are many faculty who become engaged with DBER, especially in STEM, who do not have formal training in education research. They become engaged with education research after being hired into disciplinary positions as faculty. This can occur for many reasons including balancing job pressure (in teaching focused positions for example), personal interest, engagement with departmental

change initiatives, etc. As these faculty become involved in education research, the lack of available support for them in developing research skills becomes a barrier to producing high quality and consistent work.

In this chapter I will discuss career development of faculty, and the critical importance of filling this niche for research focused professional development. I will begin by expanding upon the unique position of faculty PD and research in DBER and STEM education research in higher education. I will then provide the reader with a review of PD programs that are available within physics and neighbouring disciplines. I will close out the chapter by discussing critical elements of PD identified in the literature, and how my goals in this dissertation support the development of stronger research PD for DBER faculty.

2.2 Faculty in STEM education research

Over the past decade, Seth D. Bush along with their collaborators, has published a great deal of work about science faculty with education specialties (SFES). According to Bush et al SFES are STEM faculty whose specialty is education, but this can include faculty who are hired primarily as teaching faculty, faculty who are hired to help improve departmental teaching overall, and faculty who are hired with education research as part of their portfolio⁸. Further studies from Bush et al show that there are actually a wide variety of pathways into SFES positions, and that the purposes of these positions vary widely based on institution type^{1;3;9;10}. This wide variety of job descriptions and expectations means that many SFES have an uncertain idea of the expectations and scope of their positions before they take them. Coupled with SFES highly varied backgrounds, it also means that others are often uncertain about what they can expect from faculty hired into these positions.

Even so, Bush et al have argued that SFES have a strong impact as change agents in STEM education at all levels^{2;11-13} (K-12 and post-secondary). In spite of this SFES are often underappreciated by university administrators, and their work in improving education is undervalued and often not considered science³.

This work shows that SFES face uncertain expectations, and a lack of professional de-

velopment (PD) opportunities to help them meet expectations within their hiring departments^{1;9;10}. Further administrators undervalue the work and research done by SFES³. This combination of their work being undervalued, and a lack of opportunities for PD and career support put SFES positions at risk, which in turn would cost STEM departments valuable support in developing and improving education. Addressing these two problems is of critical importance if we wish to ensure that SFES remain features of STEM departments long term, and are able to continue promoting and improving science education practices.

My work in the rest of this dissertation will be discussing how we can support new and emerging discipline based education researchers (EDBERs). I will discuss PD for EDBERs in the context of the professional development for emerging education researchers (PEER) program (chapter 3). The main goal of my work will be to expand upon this call to support SFES by researching the needs of EDBERs, and how their needs and interests can be addressed by PD programs.

2.3 Supporting career development

Providing opportunities for continuing professional development is the critical key to supporting EDBERs as they seek to fill SFES roles within various departments. PD can support EDBERs in adapting to the situations they find themselves in, and can help them to develop consistent best practices in order to be better noticed and supported by administrators. PD as provides opportunities for faculty to show administrators their continuing efforts to grow and support the department, and evolve as professionals. I note the importance of *continuing* PD, as stressed by Caffarella and Zinn¹⁴. Continuing PD needs to allow for self-directed learning experiences, formal PD experiences, and organizational development strategies¹⁴. Caffarella and Zinn are particularly focused on the importance of treating faculty as whole people. PD can't focus solely on building specific skills, it needs to acknowledge interpersonal relationships, institutional structures, personal commitments, and psychosocial characteristics. As I continue in this dissertation these holistic ideas will become particularly important. At the same time it is important to recognize that my work is focused on formal PD oppor-

tunities, and community engagement. I do not address all of the aspects of Caffarella and Zinn's holistic approach (for instance I do not address institutional structures). This work is beyond the scope of my project.

Considering how to build programs that treat faculty as whole people, and attempt to respect the individual needs and concerns of participants is no small task. Facilitators and program designers can't be realistically expected to anticipate every possible need, idea, and experience that participants may have. As such it is important to design programs in such a way that they give participants a certain level of agency. People know their own situations best, and granting participants the agency to make decisions about program content, activities, and goals is very important in designing successful PD activities. It's absolutely critical PD programs not be thought of as black boxes that take in untrained faculty and put out trained faculty¹⁵. Indeed, since PD is a continuing process it is reasonable to assume that participants in PD programs come with varying levels and kinds of expertise, and may also leave at different levels as part of their career journey.

In actually building a faculty PD program many factors that influence faculty change must be considered. While faculty should possess agency in their change, the point of a PD program is to guide and support that change, that is to say that it's not a free for all. When guiding faculty change it's important to first consider important dimensions of faculty PD, and which a program may be addressing. From the work of Toombs I would present 3 major dimensions of faculty PD to consider¹⁶:

- The professional dimension: faculty are practicing researchers and academics within their field.
- The curricular dimension: faculty are expected to be teachers, sharing their knowledge with students at their institutions.
- The institutional dimension: faculty are the keepers and stewards of their institutions.

As these are the major dimensions of faculty's professional practice, PD opportunities must consider each of these aspects. Even if one or more of the aspects isn't the focus of the

program, programs must still help faculty connect what is happening in the program to each of these aspects of their practice. This is part of treating faculty as whole people.

Finally if faculty are to be engaged in continuing PD then programs must foster motivation in faculty to pursue continuing development of their practice. Robert Davis establishes 6 major factors contributing to faculty motivation in change, which remain dominant factors in current PD literature. These are divided into internal and external factors¹⁷:

- Internal factors:
 - *Energizers*, which drive faculty change and develop their practices.
 - *Expectations* of change outcomes.
 - *Skills* which a faculty member possesses that are related to the change effort.
- External factors:
 - *External motivators* such as departmental norms or expectations.
 - *Resources* such as time and funding for PD opportunities.
 - *Definitions* of faculty's role in their department and institution.

If your PD program isn't responsive to these priorities of faculty, then faculty are unlikely to participate. Although program designer's level of control over each of these factors varies, it is critical to help faculty understand how your program engages with each of these motivating factors. For instance, programs should make clear the outcomes of development that faculty can expect, and what skills they should have before attending. Providing supplementary funding to faculty from underprivileged institutions could be another way in which program coordinators motivate participation in change efforts. As we continue into the chapter on PEER (chapter 3 I will discuss in more detail how PEER addresses faculty change and motivation.

More recent work supports and builds on these ideas. Small studies such as Beach et al's analysis of a case of co-teaching¹⁸ which discusses the importance of integrating skills faculty are learning into their daily practice, and ensuring that faculty have mentors and peers to

work and discuss with. Larger work in physics from Cox where they discuss the importance of having a community to support you in your learning¹⁹. Fanghanel who proposes the Scholarship of Teaching and Learning (SoTL) as a professional development model, highlighting the importance of a “dialogic and democratic” method which discusses professional skills in a more holistic manner, helping to transfer broad knowledge into discipline specific contexts²⁰. Some authors have gone as far as to present comprehensive theoretical models for faculty professional development, such as Drummond-Young et al²¹ and Lewellen-Williams et al²², which frame faculty PD as an ongoing activity involving mentors, mentees, interdisciplinary activities, peers, and different levels of organizations and insitutions with which faculty interact.

Faculty PD is a complex process, involving factors which go beyond simple professional skills and knowledge. Faculty are part a complex organizational structure, and serve in multiple capacities as experts, researchers, teachers, and organizational stewards and administrators. A faculty professional development program needs to be designed with these many roles and pressures in mind. Making faculty agents of their own change, involving them in the process of deciding what skills they wish to develop, what parts of their practice to focus on, and how it will interact with their life as a whole is critical to achieving lasting and meaningful change.

In this dissertation I will be working under the following assumptions:

- Faculty are the agents of their own change, PD programs are intended to help faculty explore and understand their needs and contexts, and develop the skills and connections to pursue self-directed learning and development.
- Faculty are embedded in complex contexts and their PD cannot be completed separated from the contexts in which they work.
- Faculty operate as part of a community of peers, mentors, mentees, and additional coworkers and administrators, and supporting them in their interactions and relationships with this community is an important part of a PD program.

The primary goal of this dissertation is to present my research on how these principles can be leveraged to support EDBERs, in response to concerns presented by Bush et al in section [2.2](#).

2.4 Disciplinarity in faculty professional development

I am a physics education researcher, what might be more generally classified as a discipline based education researcher. Among education research communities, the question of whether disciplinarity is important in education is an open one. In this section, I will explain why I take a disciplinary approach to education, and more importantly why this should expand into a disciplinary approach to faculty PD. I'll begin by looking at three positions from the literature.

Alan Jenkins in his 1996 paper examines this issue of disciplinarity versus adisciplinarity in faculty professional development in higher education^{[23](#)}. He gives three reasons why disciplinarity matters in faculty and educational development in higher education. First it's a practical way to engage faculty, who often identify strongly with their discipline. Faculty often feel that adisciplinary pedagogy is not relevant to them. Secondly, the central purpose of a university is the creation and diffusion of disciplinary knowledge. Thirdly, research supports that teachers' disciplinary knowledge is vital to students' learning.

Alan Jenkins settles strongly in favour of a disciplinary approach to faculty PD, by contrast Pat Young is more cautious. In his 2010 paper Young details a study in which he led with the assumption that faculty had specific disciplinary concerns about their teaching^{[24](#)}. He goes on to say that this assumption proved incorrect, and most of the pedagogical and teaching concerns that faculty raised were generic, adisciplinary concerns. He finds that concerns about teaching and learning, as well as internal and external pressures, are generally consistent across disciplines, thus providing no basis for discipline specific approaches. He further points out that while all forms of teaching are not used across all disciplines, most pedagogical styles are shared across multiple disciplines (for instance the prevalence of experimental labs in the sciences). Once again, discipline specific approaches to education

do not seem to be necessary. Young continues to argue against the validity of a number of concerns in this way, before finally concluding that principled claims that we need a disciplinary approach to education and education research are dubious at best, and unfounded at worst. Having said all of this, Young still claims that disciplinary approaches to education and PD are important. The reason, Young posits, is that faculty are situated within specific disciplines, and thus PD must also be situated within disciplines. Further, Young acknowledges that the specifics of pedagogical implementation do vary between discipline, and warrant disciplinary specialists.

Finally in their 2017 paper Henderson et al discuss the benefits of DBER, and the importance of enshrining DBER as part of disciplinary research and practices⁴. They argue through review of literature that DBER and disciplinary PD has been instrumental in departmental change within the last decade. DBER acknowledges disciplinary cultures, history, and the complexity of departments as part of the work that it does. This in turn results in more appropriate pedagogy and changes tailored to specific disciplines and departments.

Although there is some disagreement among the above papers about whether there are deep, principled reasons for a disciplinary approach to education research and faculty PD, they all agree that it is important for practical reasons. Disciplinary culture, the specifics of different departments and their approaches, the fact that faculty are deeply immersed in their discipline, and the fact that universities are disciplinary teaching environments all serve as practical reasons why we should consider embedding faculty PD and education within disciplinary programs. All of these arguments actually hark back to my argument from section 2.3 that programs must attend to faculty's needs as whole people, and their motivational needs in order to engage them successfully, continuing career development. Respecting faculty's desire for disciplinary PD is an opportunity to address faculty's personal needs and interests. In this dissertation I will therefore work with the following principle in mind:

Faculty PD cannot be completely separated from the context in which they work, as such faculty PD programs should take a disciplinary perspective.

2.5 Professional development programs in physics and STEM

In this section I'll discuss some faculty development initiatives that already exist within STEM. The goal of this section is to give the reader a sense of what disciplinary faculty PD looks like within STEM, and what its primary goals are.

I'll begin with my home discipline of physics and astronomy. Currently in physics and astronomy there are two major educational development programs for faculty, the New Faculty Workshop for physics and astronomy (NFW)²⁵ and the Center for Astronomy Education's faculty workshop (CAE workshop)²⁶. These two educational development programs have been operating since 1996²⁷ and 2004²⁶ respectively.

Funded by the National Science Foundation, NFW is part of a collaboration by the American Association of Physics Teachers, the American Astronomical Society, and the American Physical Society. NFW is offered twice a year, and is focused on supporting the implementation of research based teaching practices in physics and astronomy. Presenters are well recognized researchers in the fields of physics and astronomy education research because research shows that this positively impacts faculty uptake of ideas, according to Henderson et al²⁷. Recently they have begun to add community aspects the program with their inclusion of faculty learning communities (NFW-FOLC)²⁸. Dancy et al²⁸ outline NFW-FOLC program, telling us that the FOLC has been added to address what they perceive as shortcomings in the NFW model. Particularly the NFW-FOLC is designed to support faculty in developing a community of fellow practitioners with who to learn and develop their practices.

The CAE workshops are similarly interested in encouraging the uptake of research based teaching practices among faculty, though specifically within astronomy²⁶. Over the course of the workshop faculty engage in discussions of the research surrounding Think-Pair-Share

(TPS) and it's effectiveness. They then critique some TPS questions provided by organizers, before carrying on to develop their own TPS questions in groups. The final phases of the workshop have groups "teach" their TPS lesson to the class, and receive constructive feedback from the class about their implementation.

Beach et al present a program from Western Michigan University¹⁸. In their paper, Beach et al. present a case of co-teaching at their university involving two physics faculty. The physics faculty taught a course together, one faculty member was an instructor experienced with reformed teaching methods, the other was a new tenured track faculty member in their first year. The two instructors taught the course together by teaching alternating weeks. The two instructors met weekly to reflect upon the previous week and discuss plans for the upcoming week. The purpose of the course was to train the junior faculty member to implement reformed teaching methods in an introductory calculus based physics course¹⁸.

Next I will introduce some programs from outside of physics and astronomy. Other disciplines have produced disciplinary professional development programs for their faculty, and conduct extensive research on these programs. Research and publications surrounding these programs give us insight into how these disciplines are thinking about faculty professional development. Here I will take up three examples of faculty P.D. programs drawn from mathematics education, chemistry education, and multidisciplinary education.

Cox¹⁹ writes about the Miami University Faculty Learning Community (FLC) program. Cox defines an FLC as "a cross-disciplinary faculty and staff group of six to fifteen members (eight to twelve members is the recommended size) who engage in an active, collaborative, yearlong program with a curriculum about enhancing teaching and learning and with frequent seminars and activities that provide learning, development, the scholarship of teaching, and community building"¹⁹. The FLC program at MU is focused on involving faculty in a community that supports their teaching and teaching development needs and concerns. To better support their specific concerns, faculty are actively involved in deciding what activities to pursue through the FLC. MU offers both topic and cohort based FLCs. Cohort based FLCs bring together a number of faculty at a similar stage in their career to work together and think together about specific change projects of their choosing. A topic based FLC

focuses on a particular issue or interest. Topics can be submitted by faculty to the FLC program coordinator, who then sends out an invitation for applications to the wider faculty community.

Barton's et al in their 2015 paper²⁹ review a 2 year program involving a mix of mathematics lecturers (researchers and instructors). During the program a subset of the members agreed to video tape and share (at least) two of their lectures per year. These videos were used as a source of discussion material for the group. Lecturers volunteered this video (it was not required), and the volunteer chose a 2-4 minute segment of their video to share and discuss with the group. The program consisted of about three 1 hour meetings per semester to discuss lecturing. This discussion group provides the lecturers a space to discuss their teaching and perceived weaknesses with colleagues. The instructors typically shared moments where they were uncomfortable with the material, to get feedback from the researchers. Conversely, the researchers typically shared moments where they were uncomfortable with pedagogy, to get feedback from instructors²⁹.

Finally in chemistry education Gillian-Daniel et al present a program focused on preparing future faculty, that is it is professional development for graduate students who are considering faculty positions³⁰. The program is a joint effort between University of Washington Madison (UWM) a 4 year research institution, and Madison College (MC) a 2 year college. Graduate students are paired with faculty mentors, and then work with their faculty mentor to design, implement, and evaluate a teaching-as-research project. These projects have developed new labs for undergraduate courses for example. In addition in meeting weekly with their mentor, the mentees also meet as a peer group on a weekly basis to discuss their projects. The whole experience covers at least one semester, but sometimes more.

All of the above programs share a common goal: developing faculty teaching practice. In fact this is typical of formal faculty PD programs, most are dedicated to teaching practices. In section 2.3 I noted that literature has repeatedly emphasized the importance of taking a holistic approach to PD, we need to recognize that faculty fulfill multiple roles. In spite of this fact, there is little formally organized support for faculty research programs. Many of the PD opportunities for research available to faculty are workshops through conferences on

specific methods, approaches, or techniques. Very few programs are available to help faculty developing a research program.

The Mathematics Association of America is unusual for offering just such a program, Project New Experiences in Teaching (NExT) is a program designed to support new mathematics faculty in developing practices to support their teaching, research, and service³¹. It recognizes the complex challenges of being new faculty, and that new faculty require support in all aspects of their career. You can go out of your way to show faculty new teaching practices, but if they feel that they can't implement those practices while maintaining an effective research program, they may not take up those practices. Project NExT seeks to address this issue by supporting faculty in connecting the various parts of their work, and teaching them how to balance that workload.

While not all programs need to do all things, and Project NExT is an ambitious and highly successful if unusual case, it would be good if we had a mix of programs available so that faculty had support in all aspects of their careers. The programs reviewed in this section show how heavily faculty PD efforts focus on teaching. This may be in response to a tacit assumption that faculty already have a strong disciplinary research background, and thus don't require PD support in research. Especially within DBER, this represents a serious gap in available PD opportunities.

2.6 Advancing to an education research PD program

STEM education has come under increasing scrutiny over time, and much work is being done to improve higher education in STEM. As part of this work DBER has grown and flourished, resulting in many classically trained STEM faculty becoming involved in education research. For these faculty with limited background in education research support is needed to help them in developing successful and sustainable research programs.

Programs to support faculty development in research are complicated to implement, and require a high degree of focus on faculty agency. Faculty have unique needs and positions within higher education institutions, and often identify deeply with the disciplines in which

they were trained. Therefore in order to fill this PD gap research must be conducted to understand the unique needs and motivations of emerging DBER faculty.

In this dissertation I will present the research I have conducted in an effort to address this gap. I will examine the unique needs and concerns of EDBERs, and I will situate these in the context of the PEER program, a program that is designed to address this gap in PD opportunities. To provide context for the work to come, I will next explain the PEER program that I work with.

Chapter 3

The PEER program and interviews with EDBERs

3.1 Introduction

My research has focused on how STEM researchers become involved in education research. It never ceases to be surprising and fun to learn how differently people in different disciplines see and understand the enterprise that is research. At the same time, in spite of all their differences people across academic disciplines see and identify much in common in the research enterprise. One of the things that both STEM and education researchers value is context. All research occurs in some context. That context determines what kinds of data are available, what kind of methods are appropriate, what kinds of collaboration occurs, how research is communicated, and so much more.

Here in chapter 3 I will discuss the context for my research: the Professional development for Emerging Education Researchers (PEER) program¹. I'll talk about how I'm involved with this program, and what kind of hats I wear as a researcher with PEER. I'll tell you what the program is, and what it is meant to do, and how it is designed. And of course, last but not least, I'll introduce you to my interview participants, the people who make up my data set.

¹Portions of this chapter appear in Hass et al 2023³²

3.2 The philosophy and why of PEER

In order to better understand both the context I work in, and the way in which I conduct and present my research we should first discuss the philosophy behind the PEER program³³. PEER is strongly grounded in two theoretical perspectives: responsive teaching, and communities of practice. Responsive teaching is a model of teaching in STEM education that places high importance on centering and responding to the ideas of students and the connections they are making³⁴. The idea behind responsive teaching is that people already have many good ideas and opinions about what they are learning, and that those ideas can lead to different interests and insights as people learn and grow. Thus it is important to make space for people's unique insights in learning environments. Empowering students to pursue their interests, develop their ideas, and share their unique understandings of what they are learning supports learner engagement and diversity.

PEER embodies this responsiveness at a workshop level by centering individuals' research interests and questions in its activities. Activities at PEER are all designed to support participants in exploring and discussing the questions that interest them. Activities encourage substantial writing, discussion, and feedback to support participants in developing and growing their ideas. Modular, multi day workshops are organized based on the interests of incoming participants. Over the course of the workshop facilitators meet several times a day to reevaluate and tailor workshop activities to center participants' research interests and projects as a subject for development.

PEER workshops also seek to develop a local community of practice among participants³⁵. Many EDBERs are still developing their identity as education researchers, and a community of fellow researchers is critical to supporting that development (I'll discuss this more in chapters 4 & 5). As a theory of education, communities of practice highlight learning as engaging in shared practice³⁶. By engaging in legitimate practice, emerging education researchers build necessary skills, and more importantly for our participants, confidence in their skills. They also get a chance to meet collaborators and support from knowledgeable mentors.

PEER’s community of practice consists of EDBERs and facilitators engaged together in researching education and instruction. As we will discuss in more detail in section 3.3, PEER engages our EDBERs in the practice of education research together. It grounds all of its modules in EDBERs own research projects and ideas so that learning can be situated in their real practice^{37;38}.

The theoretical grounding of PEER has led to four core guiding principles: PEER is responsive, collaborative, communicative, and playful. These four principles are summarized in table 3.1. These principles have guided everything from PEER’s modular design, to the focus on participants’ research, to the available PEER workshop modalities. Here we will discuss what the principles are, and in section 3.3 we will get into the details of how they influence PEER.

Responsiveness comes directly from PEER’s theoretical grounding in responsive teaching. PEER believes that program activities need to be designed to respond to the needs and interests of participants. This is important to maximize engagement, maximize PEER’s utility for participants, and to maximize participant learning. All of PEERs principles also extend to PEER’s philosophy on how research is conducted. This means that PEER also takes a view that research must respond to the needs and interests of those involved. As research projects move forwards and participants interests and needs grow and change, the project must also evolve to match those needs and interests. This naturally makes research questions living things, that grow and change over the course of a project. It also means that research becomes non-linear, and researchers must revisit the different parts of a project again and again. Decisions about theory, analysis, methods, literature, and publication must be revisited and reconsidered iteratively over the course of the project, rather than being attended to one at a time in sequence.

Collaboration follows naturally from the ideas of communities of practice. Working in a community means working with other people. Learning is framed as engaging in shared practice, that is collaboration is a part of learning. Beyond that, the point of engaging in a local community of practice is so that one can eventually engage confidently as a member of the education research community. Researchers do not work alone, or in isolation, and

so the importance of collaboration extends well beyond the PEER workshop and into daily research life. PEER strongly emphasizes the importance of collaboration, not only during PEER, but afterwards.

Communication is a necessity for learning, collaboration, and research. PEER incorporates communication as a constant part of the program, through discussion, writing, role play, questions, surveys, and other activities. Communication of ideas, confusion, and interests facilitates responsiveness, and the generation of knowledge. The communicative principle extends to research as part of collaboration, but also as a critical part of engaging with the research community. Research relies on presentations, publications, and discussion. The sharing of knowledge with colleagues is how we further the work of our fields, how we seek promotion, how we establish ourselves, how we train and graduate students, research is fundamentally communicative.

Playfulness is an idea that arises from a combination of the rest. We engage in ideas and learning together. At PEER people all come with questions, ideas, and interests. Supporting each other, riffing on each others' ideas, building on each others' suggestions by saying "Yes! And..." is vital for making sure that our interactions promote more learning, rather than stifling ideas. PEER is playful in that it encourages us all to take up and play with each others' ideas, to engage with each other in a positive manner. Discussions and activities should be engaging, generative, and enjoyable. This principle extends naturally into research, as picking up and playing with each others ideas is what researchers do. Though some researchers treat ideas as a very limited, high value currency, the principle of playfulness encourages thinking of ideas as things that are plentiful, that should be shared and built on.

3.2.1 PEER's Principles in my Research

The principles of PEER are used to ground and direct the program, and also form the core of the research philosophy taught at PEER. They are also the core of my research philosophy. I incorporate PEER's four principles throughout my research process to guide my thinking, support my interactions with colleagues, and ensure a coherent research process.

Table 3.1: *The guiding principles of PEER, for professional development and research practice*

Responsive	Research responds to the needs and ideas of researchers, subjects, and the community.
Playful	Research is play, engaging with each others' ideas in an actively positive way to encourage idea building and research development. There are no bad ideas, only incomplete ones.
Collaborative	Research is better with friends. More minds and perspectives means more ideas to play with, and more research and collaboration opportunities.
Communicative	We communicate our research ideas at all stages of the project via different media (posters, talks, publications, etc.), and actively think about how we will do that.

My research incorporates communication throughout the process. This dissertation began through conversations with my advisor and research colleagues about an interesting feature of DBER, the large number of STEM faculty who become involved in education research without a background in education. In our initial discussion we wondered about these "boundary crossers" and what kind of challenges they might face, crossing that boundary between traditional STEM research and STEM education research. These conversations gradually evolved into a research question, and then into an interview protocol. This work is discussed in chapter 4.

As the project continued I maintained regular meetings with my research colleagues to discuss what was emerging in the data, new ideas, themes, and questions. As a part of these conversations we produced posters, talks, and short papers to share our evolving work with the community and get feedback. This constant conversation and communication led to the emergence of three distinct projects from our original work, which I present in chapters 5, 7, and 6. An important aspect of communication is that it allows for the constant refining and growth of ideas.

Much of my communicating was done with my collaborators. As mentioned previously, I spend a great deal of time in conversation with my research colleagues. My collaborators include a mix of graduate students, undergraduates, and faculty, as well as PEER facilitators. This project started in conversations with collaborators from project SUPREME, which be-

came PEER-Chicago 2021. This project was a collaboration with established math education researchers, and was a PEER fieldschool designed to grow PEER's interdisciplinary support. This collaboration later led to what we colloquially called the "What is Theory?" project (work which I shall discuss more in chapter 7). Collaboration is critical for the development of new ideas in research, the continuation of old ideas, and the incorporation of new expertise. My colleague Shams has brought critical expertise in identity and agency development to the PEER research team, for example, and has been instrumental in the development and publication of my work.

Research responds to the interests, needs, and expertise of the people involved. This project began as a small project investigating the challenges faced by EDBERs. At that time we had new graduate student, an undergraduate researcher completing a senior project, a new faculty member pre-tenure review, and senior faculty member. Our project was designed to produce presentations and short term preliminary results to support a bunch of junior people in their work. With time the project came to support PEER facilitators who had questions about how their participants were engaging with new subjects, various faculty and students seeking publications, and me a graduate student moving further towards their dissertation. As the research collaboration underwent changes in composition and people's needs so too did our projects. Roles became a pet project of mine to better understand how community impacts new and emerging members (you'll see more in chapter 5), Theory became a project which addressed needs of the PEER program around new curricula (chapter 7), and Gatekeeping pursued the collaboration's developing interest in how DBER can more actively and mindfully support new and emerging researchers (chapter 6).

The final principle of PEER says that research is playful. My work has indeed been playful, in many ways. Conversations with my colleagues are engaging, generative sessions in which we bounce ideas off of each other, pick them up, and develop them. My research represents ideas that I enjoy pursuing, questions that are interesting and enjoyable to learn about. I use primarily interview data as my research questions are about digging into people's experiences and needs. In no small part this is because I enjoy conversing with people about their thoughts, opinions, experiences, and goals. My research is my work, and it is also often

enjoyable. My research isn't enjoyable by coincidence, or by accident, rather the questions, project, and writing plans have been developed through conversation and shared effort to be enjoyable, generative, and of course publishable.

3.3 A program to address EDBERs needs

The Professional development for Emerging Education Researchers (PEER) program began in 2014 as small effort by Scott Franklin, Mary Bridget Kustus, and Eleanor Sayre to provide a little professional development for their undergraduate students. Since then it has grown in scope, winning a multiple grants to develop and grow the program. As of 2023 the program has hosted 22 in-person field schools ranging from as few as 10 to as many as 54 in person participants. There also been 4 online workshops that host anywhere from 50 to 300 people.

PEER's main activity is hosting workshops that support participants in developing their own research ideas and projects. As mentioned in section 3.2 this activity is guided by principles of responsiveness, collaboration, communication, and playfulness. These workshops come in several different forms, which I will discuss in more detail in a moment. Regardless of the type of workshop, the goal is always to present participants with valuable information and support grounded in and applied to their own project. In each modality the workshop opens with a basic summary of the principles of PEER and workshop norms. As the workshop continues participants do substantial writing on their projects, part of a practice known as generative writing. The workshop typically ends with riffing on ideas, where participants (and/or facilitators) engage with participant ideas, play "Yes, and" and offer feedback on the idea.

3.3.1 PEER curricula

The PEER program is build upon a series of modules. Each module covers a topic of interest, and is designed to be largely self contained. The PEER program has a variety of available

modalities (section [3.3.2](#)), and each modality is structured based on these modules. Each module covers a topic of interest to emerging STEM education researchers (for example ethics review boards, authorship, data collection, etc). These modules have been iteratively refined and improved over time best meet the needs and interests of program participants. In any given field school a number of modules are selected based on the interests of the participants. The modules are then tailored by facilitators to best suit the current field school (this may include updating activities, trying new interventions, or simply updating presentation slides and notes).

Each module has a flow, which as I said before is designed to be largely self-contained (i.e. modular). They start off by orienting participants to the topic. In this phase their tends to be a brief introductory presentation, and opportunities for the participants to generate questions and ideas about the topic. They then move into a learning phase, where participants spend more time learning about the topic. Next is a practice phase where participants implement their learning in their own research projects. The final phase is the connection phase, where the facilitators help participants to connect what they have learned in the module to previous and future field school content. The exact activities and content often vary slightly depending on what other modules have been included in a given field school, so as to make the field school coherent and focused. An example of the flow in the “What is Theory” module can be found in section [3.3.1](#).

The main goal of PEER is to help our participants build necessary research skills for education research. Two things that are a part of all PEER field schools are generative writing, and research process models. Generative writing is considered a fundamental research skill in PEER’s research model. Generative writing is a model of writing claims that writing helps to generate and refine ideas. By writing frequently and copiously one captures ideas as they are generated, refines ideas that one already has, and generates new ideas. This is a fundamental skill that participants build through frequent writing activities. Generative writing is also a critical part of the communicative nature of research, as it creates a lasting record of ideas that can be used for communication in the future. Further, it makes the writing of papers easier, as you already have a base of writing to draw from.

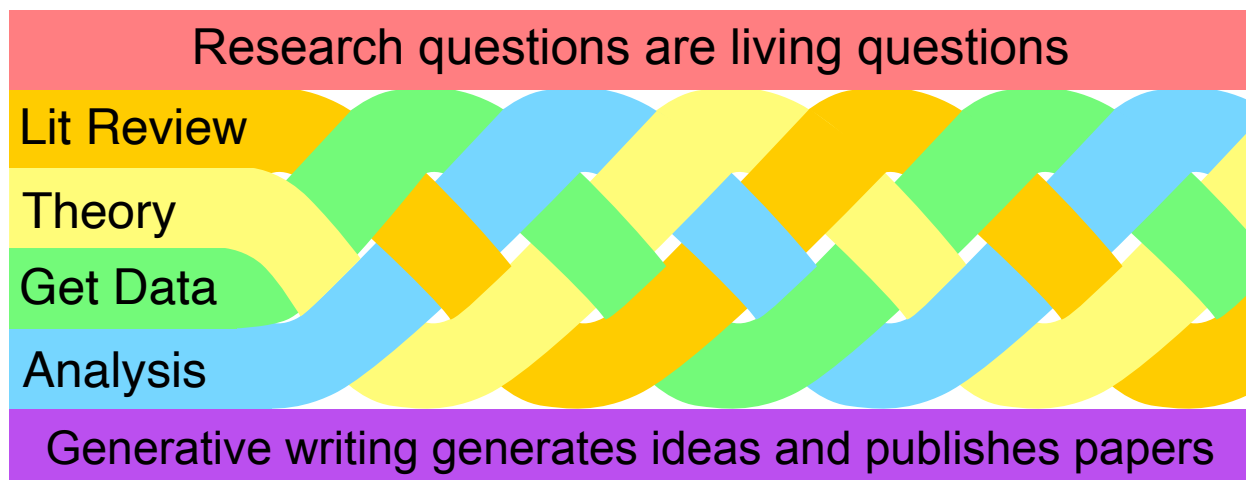


Figure 3.1: *Research is a highly non-linear process. The research braid captures the importance of revisiting the different parts of a research project throughout your work. Constantly reconsidering your approach, ideas, questions, and writing as the project, its participants, and the state of research change.*

The second thing that all PEER field schools discuss is a model of research process. We discuss two: the linear model of research, and the research braid (see figure 3.1 for the research braid). A linear model of research takes research in several parts. It begins with the identification of a question or hypothesis, and a review of existing literature. One then proceeds to identify appropriate theory and methods for your study, collects data, analyses data, and finally writes up and publishes a paper. The order is straight forward, and this ordering is typically captured by the structure of standard publication. In fact, however, research is not so linear. The linear structure that we see in papers isn't really how things happen in practice. Research is a highly non-linear process, and we revisit different parts of the research process over and over again as we generate new ideas, learn new things, and encounter challenges or setbacks. At PEER we emphasize the importance of being open to changes, and revisiting different parts of your research throughout the process. Generative writing is especially helpful here, as it integrates writing into the rest of the research process, rather than leaving it until the end. This allows us to leave the linear model behind, and encourage steady progress throughout a research project.

PEER module: What is theory?

From the research that will be presented later in this dissertation (section 7.5) the PEER facilitation team created a new module for the program with the goal of developing EDBERs understanding of and comfort with theory in education research. This theory module has been in use since early 2022 and has undergone a series of iterative changes and refinement. In this section I will describe the theory module, and demonstrate how the principles of the PEER program (see section 3.2) and insight we have gained into the struggles of EDBERs with theory have been integrated into this new module.

PEER modules are constructed with 4 phases: orient, learn, practice, and connect. Broadly speaking the orient phase offers participants a chance to get familiar with a topic and start thinking about it. The learn phase typically involves presentation, exercises, and whole group discussions as facilitators introduce ideas about the topic, and build a repertoire of information for participants to work with. The practice phase gives participants a chance to put their new knowledge and skills into practice in the context of their own project. Finally the connect phase is focused on summarizing and connecting the information from the module with the rest of the field school.

The theory module's orient phase begins with responding to burning questions and a summary of what is to come and why. This is an opportunity to respond to the needs and concerns of EDBERs before facilitators launch into the content. Once the introduction is complete, the orientation phase turns to a case study and role play activity. The idea is that facilitators wish to move participants away from asking "What theory should I use?" towards "What can theory do for me?". Case study and role-play provide an opportunity to engage playfully with confusion around theory and its purpose before getting into the details of the module. Participants express two major kinds of confusion about theory: principled concerns and practical concerns (see chapter 7. One of the major goals of this exercise and the theory module is to have participants think more about their principled concerns. The reason for this is that it's not practical to talk participants through lists of particular theories or the details of operating search engines. By helping participants begin thinking about the

role and definition of theory in their work, it paves the way for participants to more easily seek help from colleagues when searching for theories in the future. A major part of this orient phase activity is the process of collaborating with other participants to generate ideas about theory and identify questions that participants have about theory. It ends with a synthesizing lecture and discussion about what theory can do for researchers as part of their project.

In the learning phase the major work of the theory module is to introduce a framework that participants can use to think about and broadly classify theories. The framework splits theories into four broad categories

- idea-level: how ideas are changing and growing
- individual: how ideas interact in people
- communities: how individuals interact with each other
- systems: how communities behave within a larger eco-system

these categories represent one way in which you could group theories, and allow EDBERs a way of conceptualizing how theory connects to their project. No examples are provided at first, instead participants are invited to spend time engaging with their own projects to determine what level they think they are operating at. After participants have done this the facilitators introduce participants to an example of what it looks like to reframe a research question based on the different levels of theory.

This leads into the practice phase, where participants now work in groups to reframe a number of research questions to fit different levels of theory. In this activity several research questions are given to participants in a handout. Their job is to take each research question and reframe it for each of the four different levels of theory. The exercise allows participants to familiarize themselves with the framework they have just learned about, generate questions about the different categorizations of theory, and develop a more concrete idea of what theory

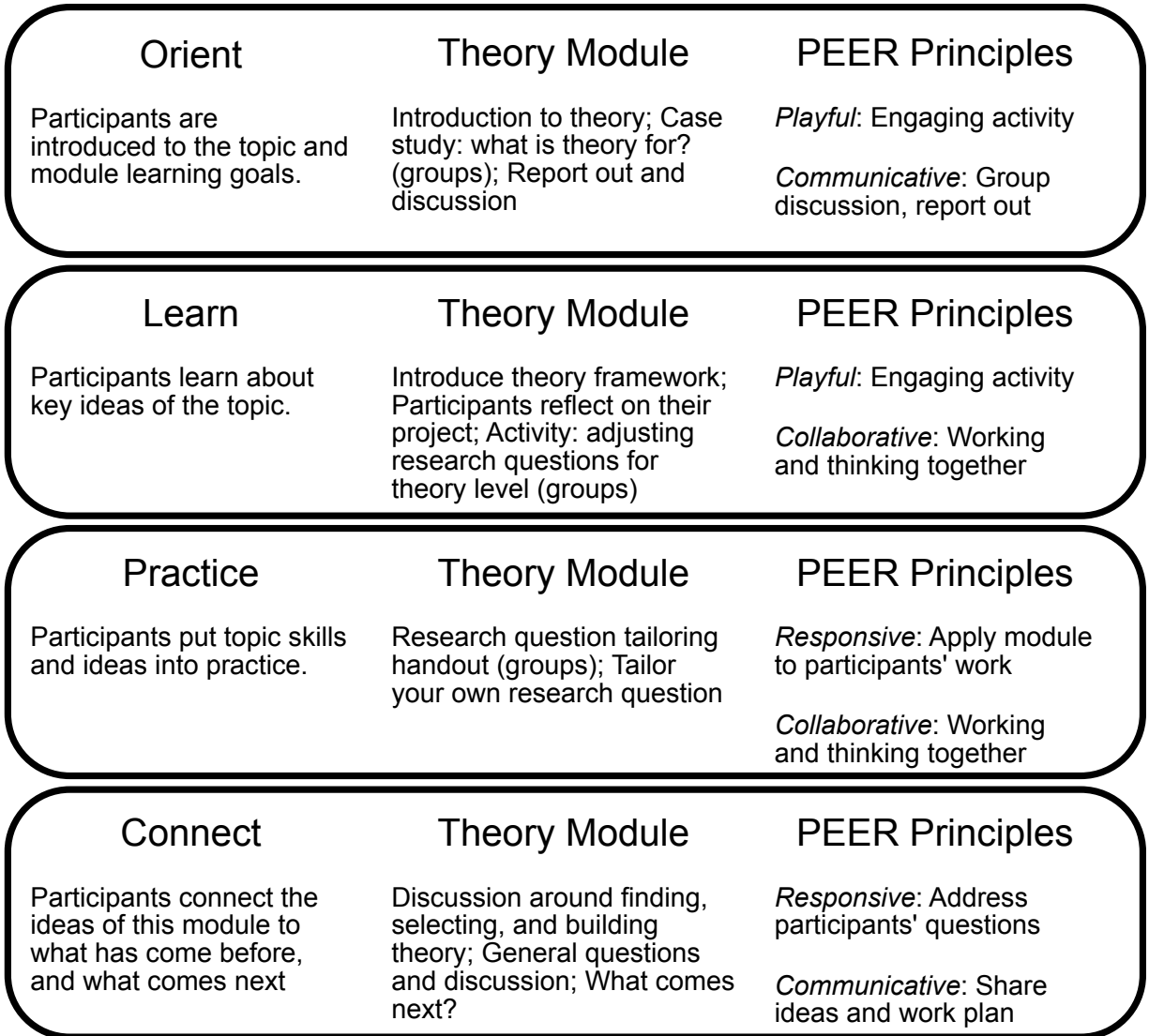


Figure 3.2: *The flow of the theory module developed to help participants learn more about theory in education research. This module is designed to help participants think through the role of theory in their research projects. Beginning by orienting participants to the topic, it moves through a learning phase, and then a practice phase where participants apply the ideas they are developing to their own research. In the final phase participants discuss their ideas, ask questions about the topic, and connect this module to what is coming next.*

can do for them in research. In the last part of this phase the participants then go and work individually to do this activity for their own project (reframing their research question for each different level). This allows participants to get a better feel for what they want from their research project, and contextualizes what they are learning within their own practice.

The connections phase focuses on tying off loose ends. One of the major jobs of this phase is to address the practical confusion discussed in section 7.5.1. The connections phase has a dedicated discussion of how to locate particular theories once you have an idea of what you want theory to do for you. This discussion involves discussing norms around reaching out to experts within the field, choosing keywords for search engines, and strategies for searching through papers and literature quickly. The facilitators also spend time on developing one's own theory, what that means, and the different forms it can take. The connections phase ends with collecting and responding to questions from the participants, and preparing for the next session.

The theory module is designed to address the concerns that I described in section 7.5.1. It aims to first address principled concerns, so as to help participants focus on their needs and consider what theory might do for them. In this way participants actually do most of the work of choosing a theory without having to confront an intimidating and large collection of literature. Once participants have thoroughly addressed the role of theory in their project, the facilitators give participants tips and tricks for connecting their needs and the role of theory in their project to particular theories available within the literature. The actual definition of theory is actually addressed relatively briefly. During the learning phase facilitators acknowledge that there are no universally agreed upon definitions of theory, and so they aren't going to worry about that too much. They settle for a functional definition of theory: theory tells you why something is happening.

3.3.2 Modalities of PEER

Work on PEER over the years has resulted in three modes for the workshop: introductory extended in-person field schools (4-7 days), advanced extended in-person field schools (4-5

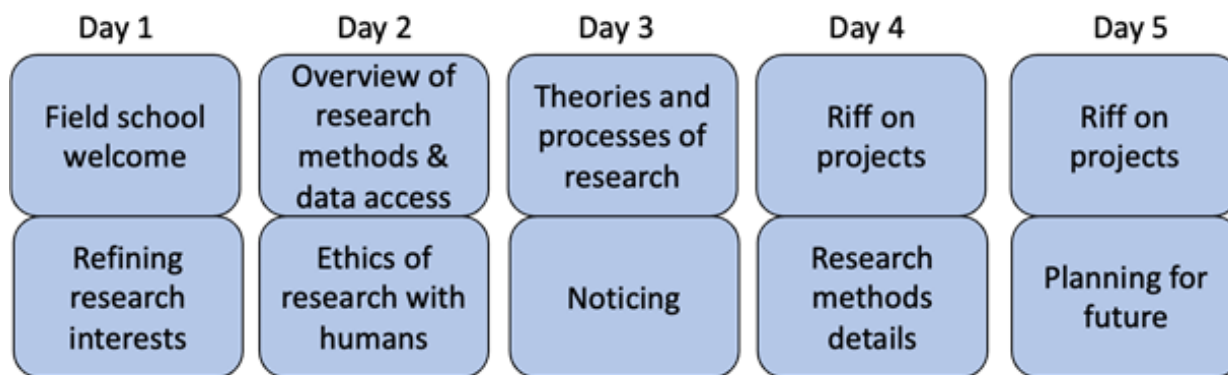


Figure 3.3: *Here is a typical set up of topics covered over 5 days at an introductory field school. The library of available modules means that these topics can be easily changed and rearranged based on the needs and interests of participants.*

days), and the online or in-person gateway workshops (1.5-3 hours). In spite of their different forms and focus, all three modalities focus on collaborative work among participants and center participants' research ideas as the subject of the workshop. Participants ideas become the basis for discussing and developing foundational education research skills. Additionally, during the pandemic, there were several introductory field schools offered online only, these followed a special set up and are no longer offered. I mention them here because a significant portion of the data presented in section 3.4 is drawn from the PEER-Chicago 2021 online field school. Though the pandemic workshops had a different mode of operation, they followed all of the same principles as the currently available modalities. In my work I will use data drawn from interviews within the context of PEER to identify and draw attention to the needs of EDBERs. As such the particulars of the modality, while certainly relevant, don't prevent us from drawing conclusions about the humans involved.

The in-person field schools, introductory and advanced, both run for several days. Participants attend a virtual kickoff meeting before the field school (about a week in advance) at which they meet other participants, the facilitators, and learn more about PEER and it's goals, as well as the plan for the field school. The content for a field school is drawn from a library of content modules that have been created and iteratively refined over the years to respond to the interests of participants. For example, there are modules on ethics, IRB, authorship, noticing, different data types, survey validation, and more. A typical module

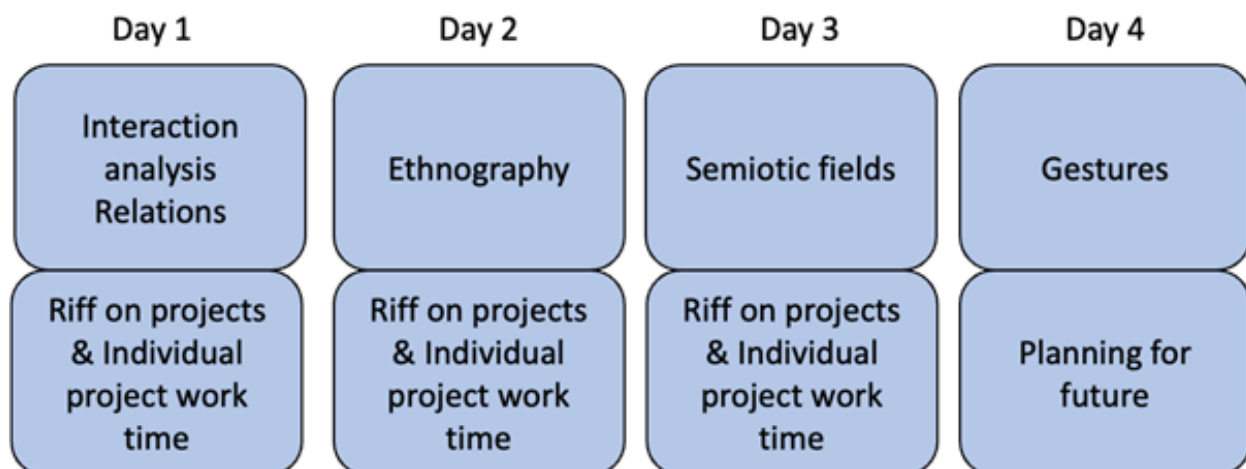


Figure 3.4: *Here is the 4 day setup of the first advanced extended in-person field school. This advanced school was focusing on qualitative methods. These schools invite an expert in particular methods as a guest facilitator, who helps both design and facilitate the field school.*

takes between 1-3 hours to cover (depending on the module) and each day of the workshop is divided into a series of modules and participant activities. For instance you may cover modules on video data and data noticing in the morning, with sessions set aside in the afternoon for participants to discuss their data access and what they see in their data in groups in the afternoon. The primary difference between the introductory and advanced field schools is content, with the advanced field schools being focused typically on particular methods and analysis (for instance qualitative research methods). Figures 3.3 and 3.4 offer examples of a typical workshop setup.

The online and in-person gateway workshops follow a very different format (obviously due to time constraints, and the number of participants involved) than the in-person extended workshops. The gateway workshops are designed to be condensed introductions to education research. They are designed as entry points into STEM education research, and feature high level overviews of a series of topics to get all participants thinking about critical issues in education research, and perhaps what their appetites for an extended field-school. A typical example of a gateway workshop is captured in figure 3.5. It's worth noting that the gateway workshops continue to feature participant interaction and group discussion, as well as generative writing, as core parts of workshop activity, in spite of their short duration.



Figure 3.5: *Here is a typical set up of topics covered during a 1.5 hour gateway workshop. As you can see it is quite dense, giving participants an overview of important ideas in education research, so that they can have an idea of where to focus their energy.*

These gateway workshops are new, and are the subject of substantial continuing development as part of the PEER program, though they do not feature in my data sets and research in this dissertation.

Finally, in this dissertation a significant portion of my data is drawn from the PEER-Chicago 2021 online field school (more details in section 3.4). During the COVID-19 pandemic all things happened online, or not at all, and so the PEER-Chicago 2021 field school had to move online. This meant a very different set up for the field school, although the principles and much of the material were the same. The field school, which would have been an extended in-person school over 4-5 days, was instead held online and divided up over a period of about 6 weeks. An initial, 4 hour, online kickoff meeting (the first ever instantiation of online kickoffs) was held a month before the first session of the workshop. The workshop then occurred in three, 2 hour sessions held biweekly, followed by a single weekend long (Friday, Saturday, Sunday) intensive. The intensive was held Friday afternoon, all day Saturday, and Sunday morning, for a total of 12 hours over the three days. The whole experience involved a total of 22 hours of contact time. All sessions were held over zoom, and participants were given some reading in between sessions. The field school was divided up in this way in part to help reduce Zoom burnout. It was also out of consideration for people's other daily and weekly commitments. At an in person field school you book time off and travel to a different location for a week, so you have nothing to interfere with the field school. In an online field school however, many people are at home with family, their regular job, and other commitments preventing them from being heavily engaged for 8 hours at a time.

3.4 Interviews with EDBERs

My research attempts to illuminate the needs of EDBERs so that we can provide better support for them as they move into education research. It turns out that if you want to better understand a person's needs and interests, one of the best options is to ask them. So I set out to interview EDBERs about their needs, the challenges they face when engaging with education research, and their interests in education research. The PEER program provided a perfect opportunity to access my population of interest.

We collected interviews over the course of several years, and as part of several different collaborations and research projects regarding PEER. As we learned more, refined our questions, and modified things at PEER we developed new or revised versions of interview protocols to better target our emerging research questions as guided by theory and ongoing analyses. These protocols can be found in appendix A. In table B.1 you'll notice a column that names the interview protocol used for each participant. There are 5 different protocols in that column, and they broadly break down into two categories: general protocols for learning about EDBERs needs and interests, and a protocol for specifically probing how EDBERs think about and understand theory in research.

There are 4 protocols in the general category. The EDBERs Original Protocol, as its name might suggest, is the oldest and first of our protocols. It was designed for learning about the needs and motivations of EDBERs. It is a general protocol that does not directly reference PEER activities. The Revised General Protocol is an updated version of the EDBERs Original Protocol, which changed mainly for reasons of clarity, and a shift in our theoretical approach to the project. As you will read more about in chapter 4 we originally approached EDBERs needs using the Reasoned Action Approach, but moved to belongingness as a theoretical framing for understanding their needs later as discussed in chapter 5.

The other two protocols in the general category are the Pre and Post PEER Interview Protocols. As their names may suggest, they are designed to be used in series. One protocol designed to assess the needs and interests of registered participants before PEER, and the

other to assess the same things after attending PEER. They are very similar in design to the Revised General Protocol, the only significant difference being explicit references to the PEER program, and a few program specific questions. These protocols were made from the Original EDBERs protocol in order to generate valuable feedback on the operation of the PEER program, and to inform decisions going into the PEER-Chicago 2021 workshop (which we discussed in section 3.3.2) in addition to generating research data. The Revised General Protocol was made based on the design of the Pre and Post PEER protocols shortly after first round of Post-PEER Chicago 2021 interviews was complete.

Finally there is the What is Theory Protocol. Specifically only the pre-PEER Chicago-2022 attendance version is included in our dataset. No that isn't a typo, from our PEER-Chicago 2021 data we did some early analysis on how EDBERs conceptualize and struggle with theory in education research. Our analysis revealed new ideas about how they are confused about theory, and this lead to the development of a new module for the PEER program. It also lead to the emergence of new questions about why they were confused, and what the underlying cause of their struggle with theory might be. So we designed an interview protocol to investigate this explicitly as part of PEER-Chicago 2022 (which occurred in December of 2022, and I'll talk about how that investigation is going in chapter 7).

All of these interviews were conducted via zoom, they range in length from 30-70 minutes depending on the protocol and participant (what is theory tended to be short, the other protocols tended towards an hour). The interviews were conducted with a primary interviewer (asking the questions), a secondary interviewer (taking notes and observing), and of course an interviewee (answering questions). These roles shifted based on the availability of interviewers. On these interviews I was supported by a team of my fellow graduate students, as well as my advisor, and in some cases an undergrad researcher. I was often but not always the primary interviewer, and in some cases I was not involved directly in the interview at all.

All of the interviews were recorded (both audio and video). The recorded data was stored on a secure server where the entire research team can access it as required (since

our team involves more than a dozen people from several different institutions). The data was transcribed by a professional transcriptionist, and these transcriptions combined with interviewer field notes and the recordings formed the basis of my analysis in this work.

3.5 Thematic analysis

The heart of qualitative research is observing and describing human interactions, behaviours, and experiences in various settings. Qualitative methodologies attempt to describe or capture narratives of humans in the world. In this section I will describe a number of common qualitative methodologies within education research, and then explain my particular methodological choice and how it has guided my work.

In their 2003 work Pole and Morrison introduce ethnography for education³⁹. In the late 90s and early 2000s ethnography had become one of the most widely and commonly used qualitative research methods within the field of education(see chapter 1 of *Ethnography for Education*³⁹). It had also acquired a wide variety of sometimes inconsistent uses and definitions among researchers. In their 2003 work Pole and Morrison sought to reintroduce a formal discussion of what ethnography is, and is not, in education research. Their book explores a variety of education research using ethnography.

Pole and Morrison acknowledge that providing a simple formula for ethnography is a difficult, or perhaps impossible task. Ethnographies are often as unique and individual as the settings they occur in, and the individuals who write them. This individuality is a feature of ethnography, rather than a bug. They go on to present 5 principles which are consistent across ethnographies (see pg 3 of *Ethnography for Education*³⁹).

1. Ethnography focuses on a discrete location, events, or setting.
2. Ethnography is concerned with the full range of social behaviour in the location, events, or setting.
3. Ethnography may be combined with a other qualitative or quantitative methods, but is focused on understanding the social behaviour from a position within the location,

events, or setting (that is to say the researcher should be positioned within the setting).

4. Ethnography emphasizes a data analysis which starts from detailed description of social behaviour within the setting, and moves to identifying concepts or theories which are grounded in the data collected within the setting.
5. Ethnography emphasizes thorough and rigorous research, where the focus is on the particulars of the location, events, or setting as opposed to generalizations.

Ethnography is a methodology which focuses which prioritizes the researcher being embedded in a discrete setting which they are studying (such as a particular classroom). It emphasizes rich description of the behaviour in a setting, and an effort to explain conceptually what is occurring in this setting. This method is not appropriate for my work, as my research is not located in a discrete setting.

Closely related to ethnography is autoethnography. According to Reed-Danahay “autoethnographies place personal experience within social and cultural contexts and raise provocative questions about social agency and socio-cultural constraints” as stated in their 2009 article⁴⁰. Autoethnography shares a much in common with ethnography, however it is unique in that it relies on the personal experiences of the researcher. In an ethnography a researcher typically inserts themselves into a setting to study it from within. Autoethnographies study the personal experiences of the writer within their own discrete setting, for instance autoethnography has become a powerful tool for black scholars to reflect on their position within academic settings^{41–43}. Although I am an EDBER and therefore my own experiences could be considered as data on the experiences of EDBERs, I wished to capture the experiences of EDBERs from different settings and with a variety of backgrounds.

In the last decade, grounded theory has become one of the most prominent qualitative research methodologies⁴⁴. There are many different versions of grounded theory, Stough and Lee identify 5 prominent schools of grounded theory⁴⁴. All of these schools seeks to produce theories grounded in observational data, though the level of importance they place on actually producing a theory varies. The methodology (regardless of school) focuses on the collection of rich observational data which can include field notes, video, personal memos,

artifacts, interviews, surveys, etc. It relies on making use a variety of different data types to deeply and thoroughly explore an issue. Researchers spend time deeply digging into the data, and coding ideas or concepts that they find within the data. They then refine these codes through an iterative process of conversation and reflection into themes. These themes may then be taken and built into a theory of what is happening within the data. Although grounded theory is a powerful qualitative approach, I did not have access to the variety of data preferable to use such an approach. Further, it was not my intention to build a theory of EDBERs.

In my work, which is interested in understanding shared experiences of EDBERs, phenomenology and phenomenography may both appear to be relevant, and perhaps appropriate methodological approaches. These two cousin approaches share much in common, beyond just the syllables in their name, and have a long history of confusion and controversy. Much of that history is nicely captured by Stolz⁴⁵ in their critique of phenomenography in education research. Phenomenology as a methodology pays special attention to the subjectivity of experiences in an effort to isolate oneself from confounding factors (a process called bracketing), and trace back experiences to the essence of a phenomenon^{45;46}. The practical upshot of this is that phenomenology in education research involves analysing qualitative data of people experiencing an phenomenon, while searching for shared themes within those experiences, in order to determine the essence of the phenomenon (what does it mean to experience a physics lecture, what is the essence of physics lectures). Phenomenography, a close cousin, aims instead to understand the variation in peoples experience of a phenomenon^{45;47}. Phenomenography maintains that there is a finite number of qualitatively different ways to experience a phenomenon, and aims to identify those different kinds of experiences (what are the different ways in which students in my class perceive what a physics lecture is). This leads to two critical distinctions in the kinds of research question I might ask using these different methods:

1. Phenomenology is focused on what is similar across experiences of a phenomenon, while phenomenography is focused on the different ways in which a phenomenon can

be experienced.

2. Phenomenography is has a first order focus: what is the essence of experiencing this phenomenon? Phenomenology has a second order focus: in what distinct ways do other humans experience this phenomenon?

I am not investigating the essence of experiencing being an EDBER, so phenomenology is not appropriate. While it is true that I am interested in the various experiences that EDBERs have, the phenomenon is not associated with a localized setting, and this makes phenomenology impractical.

All of the work in this dissertation emerged from my study of the PEER program. I set out to explore the needs and experiences of EDBERs. When conducting an explorative study you want a method which allows information and ideas to emerge from collected data, rather than taking an a priori approach. The method I ultimately settled on for analysing the interviews discussed in section 3.4 is thematic analysis. I follow the work of Braun and Clarke⁴⁸ who describe thematic analysis as powerful method for noticing and pursuing patterns in qualitative data, without having to know precisely what you are searching for ahead of time. This shares some common features with grounded theory, but it's requirements are not as strict, since the end goal is not theory production. I also shares much in common with phenomenology and phenomenography, as they all focus on noticing patterns arising within your data, however it is more open in the research questions which can be asked.

Braun and Clarke describe thematic analysis in 6 stages, and it is a non-linear process. Although I will list the stages in order (a limitation of written work), the stages overlap, and it is common to circle back and revisit prior stages. The work that goes into supporting the one stage often returns in a later stage (or an earlier stage). The process of thematic analysis is generative, and as such my thematic analysis involves a lot of generative writing. Throughout my process writing, discussions with colleagues, presentations, memos to myself, and other activities support my work. The work described in this dissertation was conducted over 3 years, and so it has involved a wide variety of collaborators, conferences, publications,

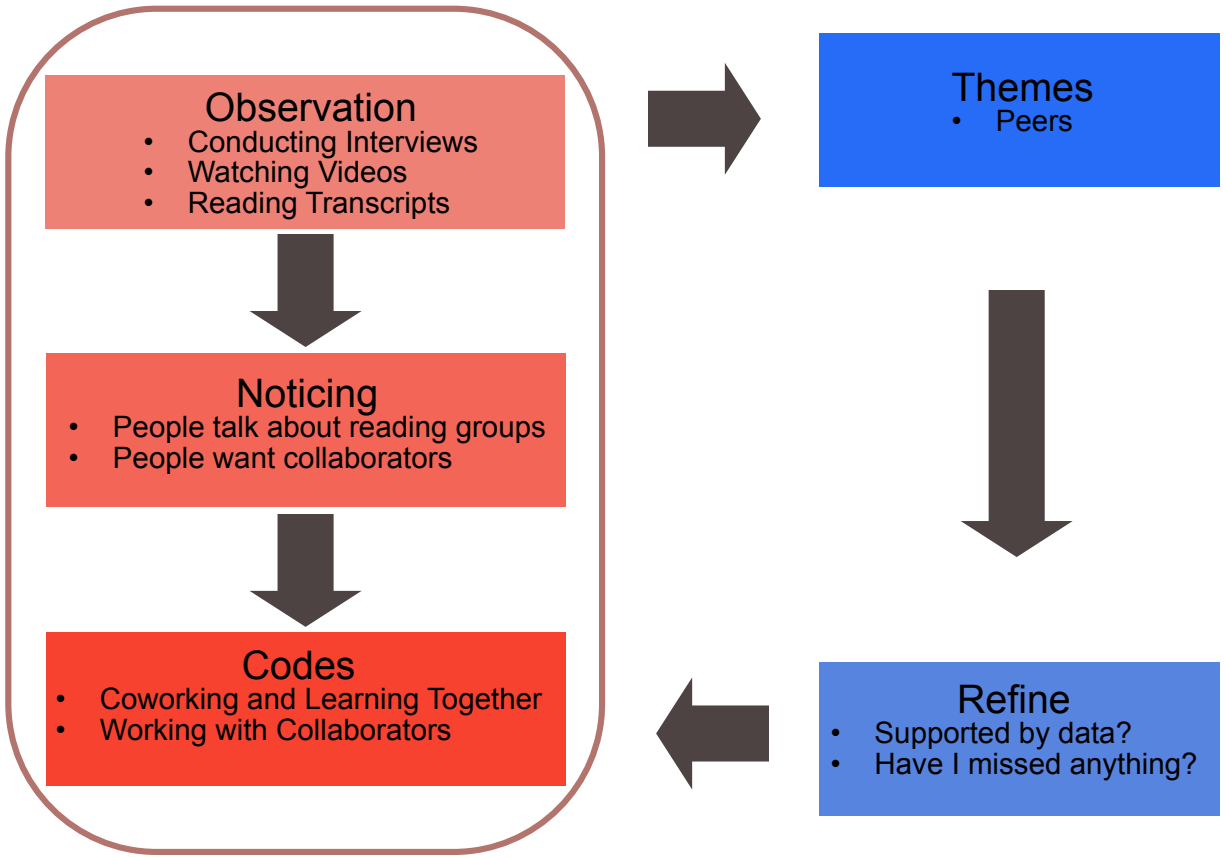


Figure 3.6: *In general thematic analysis involves going through cycles of observing, noticing, and generating codes. After I have generated enough codes that I’m not seeing new ones, I begin clustering those codes into the themes. I then refine my themes by going back over data and seeing how well the themes capture what I am observing. I then return to a cycle of observing, noticing, and coding. This cycle generally repeats until my themes well capture the breadth of what I am noticing in the data.*

private notes, presentations, rounds of data collection and analysis. I have considered and worked with multiple theories, and they have changed over time as my research has moved forward. This non-linear process of noticing and refinement is at the heart of my research process.

The first step of thematic analysis familiarize myself with my data, and decide what might be interesting to pay attention to. I was directly involved in interviews during each round of interviews (even if their were individual interviews that I did not participate in) so I already had a strong idea of what was happening in the data, what I was noticing, and what I might like to focus on. I went back to my interview data and read through

transcripts, and watched recordings of interviews that I hadn't participated in, or couldn't remember clearly. In this stage of analysis I spent most of my time absorbing information and generating ideas. I took notes about what was happening in the data, what kinds of ideas were emerging. These notes typically included high level overviews of interviews, and which interviews had which features. Occasionally I might pull particular quotes and add them to a spreadsheet with annotations.

The next stage was generating initial codes. At this stage I began writing about my interests, and questions I had for my data based on the big ideas that I was seeing. I then began going through interview transcripts and pulling quotes that I felt captured these ideas or were related to them. At this stage I prepared a spreadsheet with quotes, my thoughts about the quotes, and a descriptive code that captured the quote's place in my thinking. For example some quotes in the early stages of the Roles project from chapter 4 had the code "coworking and learning together" to capture EDBERs' interest in having peers to work and learn with. As I generated these codes I discussed what I was seeing with my research colleagues and coauthors to validate codes and ideas. IRR would be performed on sets of quotes to determine whether or not my coauthor and I agreed about what the quote represented. This stage is also often heavily informed by, and/or heavily informs choices of theory. If I have a theory in mind already at this stage then it is informing the kinds of things I am noticing and recording about my data (that is my codes are theory driven). If I don't have a solid choice of theory at this stage, then my codes are driving me to think about what kinds of theory I need to describe and validate what I am seeing.

Stage three of thematic analysis is searching for themes. Eventually I had a spreadsheet full of quotes and codes. The exact point wasn't determined in advance, I waited for a sort of saturation, or point where I saw many of the same codes coming up again and again, but wasn't finding new codes. At this stage I began grouping codes into groups that shared a common theme. These themes and are where thematic analysis gets its name, and the ultimately it is these themes, more so than the codes or quotes, that are my final product. The process of grouping codes into themes involved consulting my previous notes and thinking that I had recorded throughout the coding process, consulting comments from my research

colleagues, and bringing together the writing and work of the coding process to decide on major categories.

The fourth stage is reviewing potential themes. Once I had done the work of listing a number of potential themes, I had to revisit my work and see if those themes really captured my codes. In the process of creating themes from codes it's easy to get lost in the weeds and create superfluous themes, or themes that actually aren't directly supported by my codes, or to miss creating a theme that is actually there. At this stage I had to sit with my themes and ensure that each theme captured a variety of codes, and that all my codes were captured by my themes somewhere. If there were codes that weren't captured by any of my themes then I had to decide whether I needed a new theme, or whether maybe the code simply didn't represent a trend in the data (maybe it only appeared once, for example). At this stage I spent a great deal of time with research colleagues discussing my themes, performing IRR to determine whether or not we agreed on which codes belong to which themes, and determining whether my themes appropriately captured the range of ideas in the data that were relevant to my research questions.

Stage 5 is the time to review the names and definitions of my themes. This might seem odd, since I certainly needed definitions and names in the preceding steps, but those names and definitions were rough drafts. In step five I had to hammer out the details of names and descriptions, making sure that other people can make sense of them, and making sure that they clearly communicate what I was thinking. It would be bad to mean one thing and have my readers imagine another. Finally it's critical that the names and definitions I've used support my audience's understanding of the narrative I am trying to tell with my data. In order to make this happen I begin to present my work to my research group, or through posters and talks at conferences. These preliminary presentations allow me to receive community feedback, criticism, and validation for my work. Additionally as I am doing presentations and receiving feedback on my work, this is an excellent chance to review past writing and consider my choices of theory. Do I need to make changes? Is my theory sufficient? Community input allows for me to make changes to theory to better capture my research questions and data.

The final stage is producing the report. Throughout my data analysis I am writing notes to myself and my colleagues, taking notes and ideas in spreadsheets, producing presentations and posters. A wealth of writing is already at my disposal, and revisiting and iterating on prior stages has left me with a well developed narrative. In this sense, stage 6 is really just the process of putting words into my papers or dissertation.

As you are reading my dissertation thematic analysis is the data analysis method consistently used throughout. Though theories, research questions, and particular focus vary from chapter to chapter, whenever you read about my data analysis you will be reading about themes that have arisen through thematic analysis. In subsequent chapters my primary goal will be to introduce you to these themes, and provide a discussion of them grounded in education literature and theory, which explains their significance and what they mean for professional development of EDBERs.

Chapter 4

Roles community members can take up to support EDBERs

4.1 Introduction

In this chapter I begin my investigation into the needs of EDBERs¹. The first step in this research was trying to understand how education researchers could support EDBERs. I was particularly interested in the roles that people could fill, keeping in mind that the PEER program discussed in chapter 3 is a fantastic opportunity to help EDBERs build their network and become integrated in an education research community of practice (which I shall discuss in more depth in section 4.2).

When engaging with any practice, having other people to engage with is important. Broadly we seek people like mentors, peers, and students to fulfill our needs as we seek to learn new skills, develop our professional practices, and grow our work. This need for mentorship and peers is broadly discussed in a variety of literature^{18;19;21;22;26;29;30;49;50}. Researchers entering into a new discipline are no different from other people in this regard. They seek guidance from knowledgeable and experienced people, as well as peer support. This is critical for developing ideas, planning projects, obtaining grants, obtaining data, and accountability

¹Portions of this chapter appear in Hass et al 2021⁴⁹

among other benefits.

In their executive summary of the benefits of mentorship programs, Alana Cunningham notes that research has shown that having strong programs of mentorship in a workplace can⁵¹

1. improve workplace culture
2. support protecting and including less experienced workers
3. improve recruitment, retention, and continuing development for employees
4. improve retention for people from underrepresented and historically oppressed groups.

Further research shows that mentorship has strong benefits for both mentors and mentees, improving job satisfaction, providing opportunities for learning, and sustaining and building professional networks for instance as early as 1989 Beck wrote on the benefits and career impacts of mentoring⁵².

The importance and impacts of peer relationships are similarly discussed in a wide variety of literature. They are of particular interest in educational settings. Patchan and Schunn for instance discuss the benefits of peer feedback in the context of writing in higher education⁵³. They note that by evaluating each other's work peers develop stronger skills in detecting, diagnosing, and resolving problems in their own work. Having peers in a similar situation to your own also has positive impacts on persistence, and can provide empowerment and support in dealing with day to day problems. Marino et al highlight these benefits in the context of patient persistence in the use of medications⁵⁴, while education researchers having often pursued this angle in recruitment and retention of underrepresented groups^{55;56}.

Further work shows the importance of peers as leaders and role models to promote persistence and sense of belonging, as demonstrated in Shook and Keup's 2012 literature review⁵⁷. Some early work on peer relationships in the workplace, conducted by Kram and Isabella, explains that peers are not replaceable by mentors, and the peer relationships provide unique benefits unavailable through mentoring relationships⁵⁸. The literature we've just discussed tells us that peers provide invaluable support in reviewing each other's work, helping each

other build fundamental skills, supporting each other's persistence, providing a sense of empowerment, and helping each other navigate challenging situations.

As we continue in this chapter I seek to address the question “*What roles can education researchers take up to support EDBERs engaging with education research communities of practice?*” I will discuss how themes around peers and mentorship emerged during my thematic analysis of early interview data. These themes have persisted throughout this project, and will reappear throughout subsequent chapters. The work of this chapter will be to develop three roles based on the themes emerging in the data. I will ground these roles in a theory of motivated behaviour to better explain the impact that these roles have, and how they can fit into a professional development program such as PEER.

4.2 PEER as a community of practice

In section 3.2 I say that PEER is attempts to build a local community of practice for participants. A community of practice is a group of people with shared interests who engage in activities together to learn about and further those interests³⁵. Communities of practice have evolved some in their usage since their initial conception, and consist of three major components 1) a domain of interest that people focus on together, 2) a community or the group of people which are collectively engaged with the domain, 3) and a practice through which the community engages with the domain³⁶.

At PEER we bring together a group of people who share an interest in formal methods of investigating educational practices. Though their precise interests may vary the facilitators, coordinators, and participants all are interested in the practice of education research. As we can see, PEER consists of a local community of coordinators, facilitators, and participants, who share a interest in education, and are engaged or are becoming engaged in the practice of research. Thus we can say that PEER constitutes a community of practice.

Participants attend PEER because they wish to know how to engage with the wider community of education researchers. They are interested in learning the required skills, methods of communication, and building a network (a local community) of education researchers with

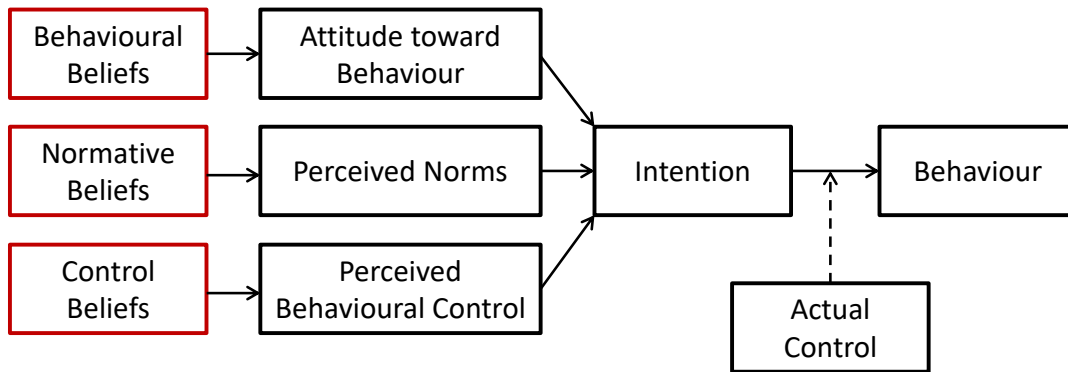


Figure 4.1: *A diagram of the reasoned action approach. We see how beliefs give rise to attitudes and perceptions, which in turn give rise to intentions. Finally external influences moderate whether intentions become behaviors.*

whom to share their work. Although they may not couch in technical terms, what they are often seeking is to develop a community of practice as a bridge to the wider education research community. In this chapter I will discuss how these themes emerge in our data, and how we can leverage PEER’s community of practice to support EDBERs.

4.3 Belief and motivation: the Reasoned Action Approach

To analyse what EDBERs need from our PEER community of practice I needed a theory to support my understanding of what motivates EDBERs as they transition into DBER. Why do some faculty choose to transition into DBER? What challenges do they face? What kinds of support do they need? I chose the reasoned action approach⁵⁹ (RAA, see figure 4.1) as my theoretical framework to aid me in understanding the motivations behind people’s actions and choices.

According to the RAA, beliefs drive behavioral decisions. The RAA specifies three kinds of beliefs: behavioral beliefs, normative beliefs, and control beliefs. Behavioral beliefs are related to the consequences of engaging in a given behavior (e.g. publishing a paper may support my tenure package). A behavioural belief is a belief I hold about how the engaging

in a particular activity will affect me. Will I learn something new engaging in an activity? Or perhaps I could make progress towards a promotion. Normative beliefs relate to the norms surrounding the behavior (e.g. my department expects me to have 7 publications to obtain tenure). I hold beliefs about what is expected of a person in my position, what is normal within a given community or group, what is acceptable and normal within society, in other words I have beliefs about norms. These normative beliefs have a strong impact on what I believe I should do, or am required to do. Control beliefs are about one's control over the behavior (e.g. I can apply for a waiver that will pay for my page charges). Do I have the capacity to actually do this thing? Will trying a new activity incur financial hardship, or perhaps I simply don't have the time? My beliefs about whether or not I am actually capable of engaging in an activity may cause me to simply give up trying entirely.

A person's beliefs give rise to their overall attitude toward the behavior, perceived norms around the behavior, and perceived control over the behavior. For example, because I believe publishing will support my tenure application, I may develop a positive attitude towards it (behavioural belief). I may perceive my department as expecting me to be actively publishing papers with undergraduate students, pushing me to set up a research program that is accessible to undergrads (normative belief). Also, perhaps I work at a small institution, and don't have large amounts of research funding or connections to international collaborations, so conducting research within my classroom is more realistic than conducting research on the standard model (control belief). These beliefs might lead me to participate in physics education research, which would allow me to publish, while still engaging undergrads, and not requiring enormous funding. People's attitudes and perceptions give rise to intentions, which finally give rise to a decision about behavior (moderated by their actual level of control over the particular behavior).

While the RAA helps me frame decisions in terms of beliefs which serve as a bridge between participants motivations and actions, it does not suggest mechanisms to support or change EDBERs beliefs. Being thoughtful about how I support or seek to change particular beliefs held by EDBERs is critical to guiding them on their path into DBER. Conjecture mapping^{60;61} is a powerful tool that allows me to ground my theoretical and design ideas

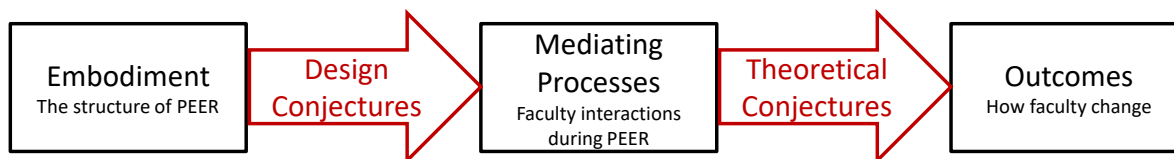


Figure 4.2: *Conjecture mapping allows me to link the theory and data concerns that drive research with the practical design concerns which drive professional development programs. My work in this paper has been grounded in the design of the PEER program. My design and theoretical conjectures in this paper explain how the three roles I posit connect the embodiment, mediating processes, and outcomes of PEER.*

about professional development in components of a specific program. I have used conjecture mapping to show how the results of my analysis are implemented in the PEER program. The basic elements of a conjecture map are *theoretical conjectures*, *design conjectures*, the *embodiment* of the program, *mediating processes*, and *outcomes*. The first two are my conjectures about how the other three are linked, while the last three represent the practical design elements of the program, and their consequences for participants. Their interactions are depicted in figure 4.2. I use conjecture mapping to ground my results in the context of the PEER program.

The PEER program discussed in chapter 3 brings together EDBERs for intensive writing and thinking about research questions and research design. Through conjecture mapping I can see how each of the three roles that come out of our analysis is implemented at PEER. I can then connect the roles to their potential impacts on participants beliefs to better understand how they are supporting our participants persistence in education research.

Table 4.1: *Three roles for supporting faculty EDBERs while they are transitioning into DBER. We have explicitly tied each role to the RAA framework⁵⁹, and have outlined how the roles are connected to theoretical and design conjectures of our conjecture map for the Professional-development for Emerging Education Researchers program.*

	Design Conjecture	Theoretical Conjectures		
		Control Beliefs	Normative Beliefs	Behavioral Beliefs
Peers	PEER's active idea sharing and interactive research building brings together EDBERs to form peer groups.	Peer relationships reinforce the belief that they can find and work with collaborators.	Peers legitimize being new and entering DBER in a non-traditional way.	
Subject Matter Expert	Providing responsive instruction around field specific knowledge and practices allows EDBERs to take up these ideas.	Taking up ideas supports EDBERs confidence in incorporating new DBER knowledge into their research.	Selecting among ideas and narrowing the focus of research questions normalizes speciliazation within DBER.	Developing greater comfort with DBER knowledge increases EDBER confidence in positive interactions at conferences.
Project Manager	Scaffolding research design and project planning gives EDBERs space to safely begin managing a project.	Working within the scaffold provided and receiving feedback on plans boosts EDBERs confidence in project planning and execution.		

4.4 3 roles for supporting EDBERs

During my analysis of data I discovered recurring themes around mentorship and peer support. Our participants were consistently interested in connecting to a broader education research community. Many of our participants perceived themselves as being relatively isolated. They may have connections only at their institution, and only distantly, or they might have connections only to a couple of other people in their department when it comes to research on education. Many of our participants expressed that they had no one to work with on education research, nor did they know many other people who were involved in education research. Comments from our participants became three themes: a desire for peers, a desire for subject matter experts, and a desire for project guidance. These became the three roles I will discuss next. These three roles, and their connections to the PEER program are summarized in table 4.1.

4.4.1 Peers

The first of the roles evident in my data is the peer. Peers are people with similar expertise and seniority within education research, in short other EDBERs. In my data major benefits that peers provide include:

- opportunities to work and learn together
- valuable, low-stakes feedback
- accountability.

They may participate as collaborators on projects, members of accountability groups, members of social networks, or just as friends that you meet at conferences. As one participant states, “when we talk about community, [...] it’s just providing the network of people that are regionally close by that have similar goals and have dedicated time with me.” EDBERs often keenly feel their isolation, and lack of connection to other EDBERs.

In response to this need for people to work with my first design conjecture states: PEER’s active idea sharing and interactive research building brings together EDBERs to form peer groups. Among PEER’s four principles is collaboration (see table 3.1 in chapter 3). The PEER program’s focus on collaboration building directly supports EDBERs in developing a network of peers.

Our participants also express their concern about reaching out to members of education research communities due to perceived stigma. One worries, “[...] if there is a stigma for bringing in a whole bunch of other people [in DBER]?”. Others similarly worry that as people without an education background they may be perceived as illegitimate or opportunistic. The concerns presented by EDBERs within my data set can be summarized as follows:

- people may look down on me for not having an education background
- I might be perceived as “opportunistic” for seeking to do education research because I’m in a teaching focused position with research expectations.

Being able to connect with other EDBERs allows them to see that they share many similar goals, and that it is neither uncommon, nor unacceptable for people without education backgrounds to become interested in, and participate in education research.

I have two theoretical conjectures about how PEER can help with this. First: Meeting other people at PEER reinforces the control belief (see the RAA, figure 4.1, section 4.3) that EDBERs can find and work with welcoming collaborators. PEER's ability to expose EDBERs to others in their situation gives participants the chance to network with people who share both their fears and their position. Second: Having peers from similar backgrounds supports a normative belief that transitioning from non-education STEM backgrounds into EDBER is acceptable and common. PEER is an excellent opportunity to make it clear that STEM education in particular includes many individuals who have taken up education research later in their career as part of their mission or personal research interests.

4.4.2 Subject Matter Experts

The second role is the subject matter expert. These are experienced education researchers with extensive knowledge within the field. They have publications, seniority, and are active researchers within their area. One interview participant notes: "Like, I felt like these people had trained for five to six years, you know, decades, and so that they would just have so much more knowledge." Our emerging education researchers often feel that they don't know enough to participate in education research. Participants in my interviews were looking for people to help with the following

- locating information
- learning new techniques and methods
- scoping the literature around research projects
- validating ideas.

Subject matter experts are the people who help mentor our emerging education researchers in a new field of research.

My second design conjecture about PEER is that subject matter experts at PEER providing responsive instruction around field specific knowledge allows EDBERs to take up DBER ideas. PEER is coordinated by three highly experienced, and well connected discipline based education researchers. They are able to bring together qualified facilitators from different disciplines and research specialties to provide support for EDBERs. These experts are then able to model research practices and ideas for participants.

Subject matter experts can also foster positive experiences for EDBERs. My interviewees express uncertainty and even fear towards the wider education research community due to real and perceived negative interactions with experienced education researchers. In one case, “When I talked to people [at the RUME Conference] they said, ‘Oh you sound like someone who’s interested in education research, but you don’t use any of the correct terms or phrases’, so I felt very much like ‘ok I’m not really doing it’.” A lack of technical knowledge can lead emerging education researchers to feel like they are not welcome or don’t fit in. Two major concerns from EDBERs in my interviews are:

- harshly critical reviews without support for improvement hinder participation in publication
- lack of technical knowledge makes EDBERs stand out, and makes it difficult to participate in community discourse.

My third theoretical conjecture says that having someone to provide guidance on community norms (around question asking, and being new for instance) and technical knowledge can help emerging education researchers to engage constructively with journals and conferences, building positive behavioural beliefs about community interactions. PEER provides access to experts who can help you parse what reviewers are asking for, define technical terms, and point you in the right direction to pursue self learning on particular topics. Facilitators knowledge of subject matter and community norms can enrich EDBERs understanding of the education research discourse.

My interviewees often express uncertainty about what they do and don’t know in the field of education research. Tabitha points out “that if you come into a field as a graduate

student, right, you have mentor who says, these are the important people to pay attention to, and these are the good journals to read, and this is how we do stuff in this field of exploration. And when you stumble into it as a, I'm trained as a biologist not an education researcher, like nobody's there telling you, you know, or pointing you in the right directions." Often interviewees are concerned that they cannot correctly employ education research ideas and practices in their work.

This gives me my fourth theoretical conjecture: subject matter experts at PEER can assist EDBERs in taking up and using education research ideas and practices in their work, supporting a control belief that EDBERs are capable of engaging productively with the education research field. When you are employing new ideas, having an experienced expert to validate your ideas, and help you decide where to look for new ideas can greatly boost confidence (and publication success). This can help EDBERs in feeling that their work has a chance of being accepted, and is well grounded in existing knowledge.

Sometimes my interviewees express uncertainty about the value of their work to the education research community. According to a participant: "To have time to do [DBER], you probably need grant funding, and if you're going to get grant funding, it has to be important, right?" They continue by saying that as an "incrementalist", they feel that their work "doesn't require grant funding because it's not really important enough to generate grant funding." EDBERs in my study often feel that there is some great, united field of education research out there. That education researchers must be knowledgeable generalists, who do big work. In truth most education researchers are specialists who promote incremental change.

My fifth theoretical conjecture states that having subject matter experts to normalise specialisation, and assist them in identifying appropriate venues and communities for their work, is very valuable to emerging education researchers. At PEER one of our modules is "Finding a journal home" (as seen in appendix C). This is a module specifically dedicated to helping EDBERs understand the scope of the field, it's different specialized sub-groups, and the places that your work might fit in.

4.4.3 Project Managers

The third role I have identified is the project manager. Project managers are experienced education researchers who coordinate research projects with emerging education researchers as collaborators. This can take many forms, EDBERs may be involved as students, post-docs, collaborators, or co-PIs. The important function of the project manager is to help the EDBER to set goals, handle administrative concerns and paperwork, and coordinate activities and timelines. EDBERs often fear that a project may fail due to poor time or resource management, or paperwork and administrative errors, leading to a loss of invested time and resources. The following quote reflects a desire for project management help: “So it would probably take like somebody to say like, ‘hey, I’d like you to be part of my project. I need you to do this and this, and I’m going to take care of this and this, right?’ Somebody else[. . .] and they’ve kind of thought through some of the structure and so you can kind of get into something like on somebody’s coattails, right?”

Having the administrative support of a project manager boosts emerging education researchers confidence in project success. It also gives them time to focus on developing subject specific skills in education research, as opposed to having to focus on paperwork. This kind of support can be extremely valuable for supporting emerging education researchers, especially faculty who are typically strapped for both time and resources. More importantly, having project managers to model how to administer an education research project supports EDBERs in working independently in the future.

PEER is constrained by time, as the program can’t continue indefinitely. As such my third design conjecture says that PEER’s scaffolding of research design and project planning gives EDBERs space to safely begin managing a project. PEER’s coordinators and facilitators will not be able to stay with each participant for the full duration of their individual research projects. Thus, for PEER it is most practical to provide coaching and guidance on project deadlines and goals. This also leads to my final theoretical conjecture: being mentored in project management helps EDBERs build a control belief that they can plan and administer a research project successfully.

4.5 Onwards to belonging

In this chapter I have developed the first of several key ideas in this dissertation: that EDBERs require community support in their effort to be effective education researchers, and that this support can take on the form of direct involvement with education research community members. Peers support each other by working together, exploring community norms together, evaluating and building ideas together, and empowering each other in their work. Subject matter experts support EDBERs by introducing them to new knowledge, guiding their exploration of a new field, and introducing them the norms and expectations of the field. Project managers support EDBERs by helping them to effectively manage the limited time and resources they have to maximize research output and success.

I recognize that both subject matter experts and project managers are mentorship roles, and I want to emphasize that they are not the same role. While it is certainly possible for one person to fill both roles (a PhD advisor does this for instance), it is not required. I would like to encourage education researchers to step into these roles and support EDBERs where they can, and recognize that it may be easiest for them to take up some but not all of these roles.

Having established these roles, we will move on to chapter 5 where we will discuss the importance of these roles in supporting EDBERs sense of belonging. As I will discuss in chapter 5 fostering a sense of belonging to a community is vital for the persistence of our EDBERs. Further, a wider diversity of people involved in education research is important for the health productivity of the field.

Chapter 5

Community support can foster a sense of belonging in EDBERs

5.1 Introduction

So far this dissertation has focused on describing the PEER program, and how it supports EDBERs by providing people in several different specific roles. In chapter [2](#) I argue that it is important for PD programs to pay attention to more than just local skill building, they must consider a person's career development holistically. In this chapter I am going to discuss one of the aspects that must be considered for our EDBERs: their integration into education research communities of practice.

In chapter [4](#) I argued that PEER built a local CoP to support participants. Participants often continue to interact with each other post-PEER, and sometimes participants even form lasting working groups or collaborations. Unfortunately PEER is not dedicated to building continuing collaborations among participants, and formal evaluation of whether or not it fosters long term connections between participants is beyond the scope of my research. In this chapter I wish to emphasize that the building of long term connections is very important (and this is perhaps something to consider as part of the future development of the PEER program).

Here I address the question “*What does it mean for EDBERs to feel a sense of belonging within an education research community of practice?*” I will begin by discussing the education research field, its connections to CoP, and how EDBERs fit in. I will then introduce the notion of belongingness, or sense of belonging, and its importance as part of human motivation and interaction. Finally I will return to my interview data and use cases of participants to illustrate how the roles defined in chapter 4 can support our EDBERs in developing a sense of belonging.

5.2 Theoretical perspective

5.2.1 Education research communities

In chapter 4 I argue that the PEER program develops a local community of practice among its participants. Here in chapter 5 I will expand this discussion of community participation beyond the PEER program. To refresh your memory a community of practice is a group of people with shared interests who engage in activities together to learn about and further those interests³⁵. Communities of practice have three major components 1) a domain of interest that people focus on together, 2) a community or the group of people which are collectively engaged with the domain, 3) and a practice through which the community engages with the domain³⁶.

The field of education research includes many features of a community of practice. For instance education researchers are jointly interested in how people teach, learn, and share information, and how education shapes and is shaped by people, our domain. We form a community of people who collaborate, present, and publish together. And of course, we are jointly engaged in the practice of research.

While education research probably isn’t a single community of practice (it’s simply too broad and diffuse), it is clearly a collection of overlapping communities of practice. These communities may involve conferences, online communities, research groups, research collaborations, departments, and such groups. These communities overlap with communities of

practice from outside education research. This is especially true in DBER where many of our researchers are based in disciplinary departments as opposed to schools of education.

Our EDBERs then are people who are navigating not only the disciplinary communities of practice they are already a part of, but are trying to find education communities of practice to belong to. They are legitimate peripheral participants in the language of CoP³⁵, people who are participating in legitimate practice as part of joining a new community of practice. As we clearly saw in chapter 4 our EDBERs are looking for human support on their journey into education research, which seems sensible in this interpretation.

When joining a new community newcomers may be uncertain of the quality of their connection to the community. In their 2007 paper Walton and Cohen present the idea of belonging uncertainty as a part of their discussion of how socially stigmatised groups may feel that they do not “fit in” in new settings and communities⁶². In chapter 4 you may have seen hints of this uncertainty, in this chapter it will be the explicit focus. In order to support EDBERs developing their skills as education researchers, and balancing their commitments to the various overlapping communities they are a part of, we need to support their participation in education research communities of practice, and make space for them to belong. In the following sections of this chapter I will discuss what I mean by belonging, and how it affects EDBERs as they attempt to navigate this new-to-them research field.

5.2.2 Healthy communities: belonging

Leary and Cox present the idea of belongingness motivation, arguing that belonging is a fundamental motivation for human behaviour. In fact they go further and argue that it is the first and most fundamental form of human motivation (not the only one, nor that it can explain everything, but the most important)⁶³. Human desire to form lasting relationships and closeness with other humans drives much of what humans do. Leary and Cox point out that this can be used to explain the existence of many groups and communities which exist among humans, as well as the constant attempts of humans to join and fit into communities which are important to them.

Belongingness as an idea has a long history, and a number of complementary definitions in psychological literature. Anant discusses belongingness as experiencing personal involvement in such a way that one feels they are a part of a given system⁶⁴. Hagerty et al additionally identify the importance of valued involvement (a person needs to be valued and accepted) and fit (colloquially the idea of fitting in)⁶⁵. Maslow provides extensive discussion of belongingness, including many of the aforementioned ideas describing belongingness as a need to be valued, accepted, and recognized by others⁶⁶. Finally we might look to the work of Somers⁶⁷, following in the footsteps of Baumeister and Leary⁶⁸, who defines belongingness as “the need to be and perception of being involved with others at differing interpersonal levels across varied environments which contributes to one’s sense of connectedness, and esteem, while providing reciprocal caring, acceptance, and valuing to others” (Somers, 1999, p. 16).

Belongingness highlights the importance of making space for newcomers within our community, while also recognizing that the community has existing norms, goals, and standards. People who have fostered a sense of belonging in the community have a reason to uphold and develop the norms and standards of the community, to care for its health. However as people who belong to the community they also have the voice to bring forward their own goals and ideas, and shape the broader agenda of the community.

Research backs the idea that a sense of belonging is very important to persistence, building on the idea of belongingness motivation. Booker presents her work on how sense of belong is important for the persistence of African American women in college degrees⁵⁵, and Lewis et al examine the persistence of women in physics⁶⁹. Both of these examples take up the idea of belonging to understand why minority groups in particular contexts may not persist in their studies. In both studies students who report a sense that they are not welcome, that they don’t fit in, that others do not take up or respect their ideas, are less likely to persist. Their feeling that they do not belong in a given context (college classrooms, or college physics classrooms) drives them to leave and seek a place where they do feel that they belong. By contrast, students that report a higher sense of belonging are more likely to persist. Both studies highlight multiple factors for students’ belonging, including perceived

competence, being respected by peers and instructors, seeing their own ideas taken up and pursued, being properly issued credit for their ideas, and many others, all of which can be seen in a substantial body of supporting literature⁷⁰⁻⁷³

5.2.3 Threatening and promoting belonging

Much literature in psychology discusses the impact of belonging on mental health, Stillman & Baumeister provide an excellent discussion of this in which they note that people who experience acute moments of rejection, or chronic lack of belonging identify more strongly with statements about the futility and meaninglessness of life⁷⁴. In their 2022 paper Jaremka et al discuss threats to belonging and health in the context of the COVID 19 pandemic. They note 4 major kinds of belonging threats that are well discussed in literature: loneliness, no/low social support, romantic relationship distress, and stigmatisation. These threats can signal to a person that “they are socially disconnected, unloved, uncared for, or devalued”⁷⁵. Though romantic relationship distress is beyond the scope of our research, the other three threat categories manifest in various ways in discussions with EDBERs.

People will tend to seek out places to belong^{63;68;74} and so in order to better support newcomers to our field and ensure their persistence it makes sense to support them in developing a sense of belonging. Research on promoting sense of belonging is abundant, for instance Graham-Smith et al⁷⁶ who talk about how feeling cared for is important for the persistence of students with disabilities. Beck and Malley note in a study on belongingness in schools that we should build a community that “emphasises the democratic ideal in which caring, cooperating, and serving form the cornerstones of the learning process”⁷⁷. Peacock and Cowan writing on online learning environments point out that literature focuses on “the importance that learners place on their relationships with a caring tutor who knows them and is enthusiastic, friendly, encouraging, helpful, and, most importantly, can be trusted”⁷⁸.

Much literature concludes the importance of developing relationships with other people. These relationships need to provide us with caring help, love, valuing, and in general need to make us feel that we are wanted and accepted as members of a group. In order for people to

feel that they belong within a community, positive, supportive relationships with members of the community are critical. In our discussions with EDBERs we see signs that they are experiencing common threats to their belonging. In accordance with the literature, they want closer relationships with members of the education research community, which could help them overcome those threats.

For example, the education research community has a huge body of established knowledge. EDBERs are, generally, not well acquainted with this knowledge, and our conversations with EDBERs show they often feel that they don't know enough to engage with education research. Moreover, they express that they cannot be considered education researchers because of their lack of qualifications/knowledge. They fear stigmatisation due to their novice status, which threatens their sense of belonging. Having support in engaging with the knowledge in the community and gaining some confidence with established education research knowledge would be very helpful to EDBERs sense of belonging.

There is an additional concern around the scope and breadth of knowledge. Some EDBERs are actually reasonably knowledgeable about a particular thing, but they lack breadth in their knowledge and they feel that this disqualifies them from true community membership. A lack of social support means that they have no role models, no way of knowing what level of specialisation is normal and acceptable. Helping EDBERs establish an idea that specialisation is normal, that the education community is split into many groups, and none of them know everything, could help them foster a sense of belonging to a subset of the education community.

If it were merely a problem of self-efficacy, then these concerns could be addressed simply through workshops and learning resources. However, EDBERs express a particular need for people supporting them. The problems surrounding lack of knowledge aren't only about lacking knowledge, but also about understanding the place that knowledge and expertise holds within the community. Having connection to a subject matter expert is important as the subject matter experts demonstrate the position and role of expertise and knowledge within the community. Seeing how subject matters belong to the community helps our EDBERs establish their own sense of belonging within the community.

Another common concern among EDBERs is whether or not they are welcome. There are a lot of surface reasons for this. Some EDBERs may come from research heavy backgrounds in other fields. They may have seen the competitiveness and pride that various disciplinary and sub-disciplinary groups have. As a result they feel concerned that they might not be welcomed because they don't have expert backgrounds or status within the field. Other EDBERs are from teaching focused backgrounds. They may have PhDs and credentials in other fields, and even small research projects. Many of them express interest in education research because they are highly pedagogically motivated, and it aligns well with their primary mission. They sometimes express a concern that the field may look down on them as doing this because it is "easy" or "convenient". They display both a fear of stigmatisation and loneliness, often performing research alone within their department or institution.

For EDBERs, it could be helpful to their sense of belonging if they come to understand that their transition into education research is very normal. They aren't strange, lots of people choose to transition into education research later in their career. These people do so for a variety of reasons including academic interest, pedagogical interest, personal/life-style reasons, alignment with other parts of their career and work, etc. By having a group of peers undergoing a similar transition, it can help our EDBERs feel that they can belong to the education community even with diverse backgrounds and not-necessarily-academic motivations.

5.3 Participants for illustration

In the next sections of this chapter I will be discussing the themes around belonging that emerged from my interview data. In order to properly illustrate each theme I will be using quotes from participants along with discussions of their circumstances. These brief case studies, involving 6 EDBERs, illustrate different aspects of what it means for EDBERs to feel like they do (or do not) belong to a given community. The themes themselves are drawn from the larger PEER data set discussed in section 3.4. In particular, these themes are drawn from interviews using the EDBERs Original Protocol, Revised General Protocol, and Pre

and Post PEER Interview Protocols. These four protocols focused generally on the needs and interests of EDBERs.

I'll start with Alex, a tenure track faculty member in their first year at an institution very focused on teacher training. Alex is in the mathematics department, and was hired specifically to conduct education research. At the time of interviewing Alex was reflecting back for us on their experiences as an EDBER, and how it had shaped their career so far. Alex had a moderate level of experience in education research, with a couple of publications in small journals and a record of conference attendance and participation.

Alex has a strong interest in diversity and inclusion research. In particular, Alex is focused on white, male, European dominated conceptions of mathematics and the harm they can cause to students, particularly of minority groups. Their primary interest is in developing mathematical curricula that encourage bringing non-white cultural perspectives into mathematics, and encouraging the development of perspectives from underrepresented and historically oppressed groups in the classroom. Since they are at an institution which is strongly focused on teacher training, Alex is also very interested in training their students to question the notion of mathematics as a subject of fundamental and objective truths.

Brooke is a pre-tenure faculty member at primarily undergraduate institution. She is expected to be applying for grants, and to have a few publications at the time of her tenure review, however the heaviest part of her duties centers on teaching. Brooke is very new at the time of interviewing, with no formal background in education research. She is talking to us about her interests and plans for the future.

The main things Brooke is interested in are outreach and curriculum design. Brooke is particularly interested in building a writing component into her math courses to try and explore students conceptual understandings and ability to communicate and interpret mathematics. During her discussions with us another important feature of Brooke is that she has a local CoP involving some biology researchers interested in education, but otherwise struggles to find an education research community to be a part of.

I'll speak of Cole on several occasions. Cole is a mid-career, tenure track, mathematics faculty member and department chair. During his interview he is reflecting for us on his

involvement with education research. One of the particularly interesting features of Cole is that he still sees himself as a new and emerging education researcher, even though he has been involved with education research on and off for 10 years. While he has been involved for a long time, he has only been involved intermittently, has no formal background in the field, and struggles to grasp the full scope of math education research.

Cole's main interest is in differential equations, as his background was in dynamical systems. He has studied alternate curricula that focus on conceptual and graphical solutions to differential equations, fostering students' skills for modeling differential equations. This is different from standard curricula which focus on having students memorize solutions to common, simple differential equations. Cole has had the opportunity to collaborate with established education researchers, and views his role as primarily bringing disciplinary and pedagogical knowledge to the team.

James is mid-career, contract faculty at a teaching focused institution. He is in the math department and is also department head. James has been involved in education research for some time, but only intermittently. In his interview he is primarily reflecting on his career journey for us.

The main interest James discusses with us is teacher outreach. James is strongly pedagogically motivated, and has spent a lot of time running math circles, a style of PD that he uses to reach out to K-12 math teachers for skill building. He's particularly proud of the opportunities that this has afforded him to go and conduct outreach in K-12 programs. The biggest struggle which he faces and often talks about is limited resources.

Melinda is tenured faculty at a historically black university in their biology and biomedical sciences department. She is a biologist, with a specialty in genetics. She did not conduct graduate studies in DBER, but she did do her post-doc in STEM education research, and she has published some labs that she developed.

Melinda is in a teaching focused role at her university, and so she would like to conduct education research to integrate her teaching and research missions. Unfortunately, her university expects her to be involved in what she terms "bench research", that is to say her genetics research in order to conduct biology research projects with undergraduate students.

As a result, Melinda has developed an interest in blending lab practices and research into her courses. She is conducting research on doing this so that she can more closely align her teaching and research missions.

Rebecca is a tenured faculty, and her job is teaching focused. At the time of the interview her institution was rethinking their mission, and she couldn't clearly tell us what the institution was expected to be. She has been teaching and conducting research around curricula and classroom interventions for a long time, and has some publications. She feels that she is rather disconnected from the broader education research community and struggles to establish connections.

Her main interest is curriculum development. Rebecca loves innovating in courses, and talks about several projects. She and some colleagues implemented new labs in course about linear algebra, she's been working with department colleagues to change to more active learning styles in their general education math service courses, and she is particularly excited about a course she created called story-telling with data. Rebecca is an experienced innovator, but she feels that she often expresses doubt about how her work will be received by the education community, and how to interact with other education researchers favourably.

5.4 What does it mean for newcomers to belong?

Section 5.2.2 explains why a sense of belonging is important to people within a community. In order to support emerging education researchers in becoming permanent members of the education research field it is important for us to help them foster a sense of belonging. As part of my analysis of interviews with emerging education researchers I identified 7 ways in which emerging education researchers determine who belongs to the education research community. These 7 aspects of belonging emerged from the data as themes around belongingness.

In this section I will discuss each of the 7 themes, drawing on the experiences of participants discussed in section 5.3 to illustrate how these themes manifest in our interviews with EDBERs. Discussing the particular circumstances of several of our participants serves to illustrate what each theme means, how it arises in the experiences of EDBERs, and also

shows how we as members of education research CoP can support EDBERs in developing a stronger sense of belonging. The 7 themes are

- acknowledgement of work
- contributing to others' work
- having shared knowledge
- being able and welcome to ask for help
- having access to privileged spaces
- a sense of competence
- belief in one's own qualifications

5.4.1 Acknowledgement of work

Among the most prominent and obvious of the results is that emerging education researchers feel people belong to a community when their work is acknowledged by that community. Alex gives us one of our clearest examples of this, when discussing some work they collaborated on analysing a group of letters published in their disciplinary research field. Alex was part of a group that analysed a series of public letters surrounding equitable hiring practices within their field. They published a paper analysing the signatories of various letters that were part of a debate about having demographic specific hiring requirements (for instance requiring a hire to be a woman).

Alex says “[A] group of us did some analysis of the signatories of these various public letters and so it’s like a description of the community and it’s a description of the, you know, like the signatories of these three different letters, you know, statistics and some identity stuff. I’m not sure if my colleagues will include that as math ed. I mean, it’s definitely thinking about the community of mathematicians, but I’m not 100% sure if they think of that as within the purview.”

The analysis used these letters to examine community opinions about diversity, and the state of diversity concerns in this field. While diversity is a common concern in many fields, Alex notes that some of their colleagues might not consider this education research. On the other hand many education researchers may find it relevant due to the impact of diverse educators on students. In this instance Alex received impressions from some colleagues that this work they were doing wouldn't qualify them as part of an education research CoP. On the other hand, Alex was supported in this work by collaborators who were in education research, providing validation for their work and place in the community.

One of the big challenges facing EDBERs is that they are often located within disciplinary departments (for instance Alex is a math education researcher located within a math department). Often times department colleagues who are not involved with education research have very different ideas about what education research is than education researchers do. Thus, work that may be celebrated within education research communities of practice may not be well received within disciplinary departments. Since many EDBERs lack an education research CoP within their own department, this can mean low departmental support for and acknowledgement of their work.

In this, Alex is an exception, because their department has an active math education research group (which they are a part of). Alex notes "I mean, the other direction is the one that I would be concerned of, they're in a math department that won't count anything education as scholarship, and that's not the case here. If anything, it's slightly the other direction because I'm hired in an education position, but I'm in a math department, so there's definitely a lot of like the mathematicians may not necessarily know what education research is. So they trust the ed subgroup to say like this is, in fact, good scholarship, so if my subgroup says that, then the rest of the department's like okay, sure." A key feature of that Alex points out is that even within a department with an active DBER subgroup, most of the department doesn't know what counts as good DBER scholarship. Thus, having connections to an education research CoP, ideally within their own department, is extremely important for EDBERs if they are going to receive acknowledgement for their work.

In summary having your work acknowledged as being education research is important.

This may seem trivial, or obvious, but it turns out EDBERs often work within CoP that don't acknowledge the work they do as education research, or don't acknowledge education research as valuable. Here quotes from Alex show how having a position that acknowledges their work, and people who acknowledge their work help to cement their position as belonging to an education research CoP.

5.4.2 Making a contribution

Coupled with the idea of having one's own work be acknowledged is contributing to other people's work. Part of being in a community is contributing to the community, and being able to contribute to and support the work of colleagues is a fundamental part of being in a research community. Our emerging education researchers often express the importance of being able to contribute to the work of others, or express the isolation of being unable to contribute to other projects. Here we'll look at Cole, who talks about the positive impact of being able to contribute to a project conducted by a group of senior education researchers.

Cole says "And then I had a really good experience with Chris and Karen and Nick, we have a [inaudible] paper together where Chris kind of brought the education side to the writing and I brought the teaching technique, how it goes, kinds of things the mathematician thinks about side to that paper." Cole highlights the importance of how his expertise was acknowledged. He isn't an expert education researcher, but was still able to contribute to this education research project and feel that his personal expertise was invaluable. Cole goes on to comment specifically "And so I wanted to be more involved in that and they liked it and, you know, they were excited to have someone who was a champion for the mathematics involved, right, and could say, "oh yeah, yeah, we could push this this way, this way," and so they brought me back on to conduct those online working groups." The research project he participated in here had a phase where they attempted to disseminate the developed curriculum to educators. During this phase they brought Cole back as an online group facilitator because his expertise in the mathematics and enthusiasm for it made him excellent at communicating with other mathematics professors.

Cole is a faculty member at a small teaching focused institution, and doesn't have much education research experience. However, Cole is an experienced teacher and mathematician, who's focus in research was differential equations. The research project discussed in this quote was focusing on reforming teaching in a differential equations course. Here, Cole felt strongly encouraged being part of a collaboration that acknowledged his strengths as teacher, and allowed him space to make relevant contributions. In this way he felt welcomed in the education research community, without feeling that he had to be primarily a researcher.

I go out of my way to highlight Cole's experience here because it is of particular relevance to EDBERs. Many EDBERs, like Cole, are faculty who have a deep interest in teaching and/or the pedagogical mission of their program. They are not people with a background in education research, and some of them may never desire to be fully independent or exclusively education researchers. Cole's case is an important example of how education research CoP can include these education motivated faculty, and encourage their valuable contributions to furthering understanding of teaching and learning.

Regardless of where EDBERs are at in their career and their future career expectations, being willing to meet EDBERs where they are at and acknowledge the expertise they have is important. By tapping EDBERs particular expertise to integrate them into education research CoP, we build a place for them to belong without needing to feel like they are highly qualified education research experts. This in turn supports their persistence, and gives them time to build those qualifications and expertise.

5.4.3 Shared Knowledge

Communities of practice, uses the term *shared repertoire* to refer to knowledge shared by a community, in current incarnations of CoP this would be part of the domain. In order to be a CoP the community involved must have shared knowledge, norms, and terms, information that defines what they know and study. Our emerging education researchers may not use precisely these words, but they regularly describe the importance of having shared knowledge, terms, and expectations. This comes up often in a negative sense, when you don't possess

this shared repertoire you may feel excluded. Rebecca illustrates this for us while recounting her experiences at a conference, as someone who didn't share the jargon of other conference goers she stood out.

Rebecca says "When I talked to people [at the RUME Conference] they said, 'Oh you sound like someone who's interested in education research, but you don't use any of the correct terms or phrases', so I felt very much like 'ok I'm not really doing it'." Rebecca was at a conference on undergraduate mathematics education research. Most conference attendees are part of a CoP built around this conference, with familiar people that they see each year, particular research subject matter that they seek to share and learn more about, and particular norms and activities that they participate in. Rebecca, interacting with these people, felt she was instantly identifiable as an outsider because she didn't share the terms and phrases of people there. This left Rebecca feeling that she wasn't a member of this CoP.

When you don't share in the expected ways of speaking and behaving you wind up feeling excluded, or in this case being explicitly told that you don't really belong. EDBERs are tacitly or explicitly aware of this fact, and find themselves looking for opportunities to develop this repertoire, preferably with other people who share that goal. James tells us more about this when we ask him about things that he would need to become more involved in education research.

James says "you'd probably need some kind of a just a group of people that are meeting once a week for like a seminar where you're reading a paper each week or something, and then discussing it, and you're thinking like, okay, what was, you know, what did we learn from reading this paper?" James highlights a practice that is common in graduate programs, and among many research groups. Holding regular meetings as a CoP where you engage with your domain of interest and develop your knowledge and skills together, building a shared understanding of material. For many EDBERs who are faculty in departments where there isn't an existing education research CoP, it is hard to find opportunities to be involved in these sorts of knowledge building activities. This problem is further exacerbated by the fact that there are any faculty at teaching focused institutions who are lack dedicated time and resources for research, but are interested in pursuing education research. Thus not only do

they not have a local CoP to join, they don't have the time or resources to explore CoPs in other places (such as conferences where they might meet other people to work with).

In order to support an EDBERs sense of belonging to an education research CoP it's absolutely critical to provide accessible opportunities for domain development. This requires making opportunities for EDBERs to meet each other and receive support in building groups together. This includes helping EDBERs access conferences and established research groups, and also thinking hard about how we may include EDBERs from small or non-research focused institutions in online DBER spaces.

5.4.4 Asking for help

James' interest in a working group to discuss ideas with also hints at another piece of the belonging puzzle. People who belong to a community feel that they can ask for help. When I say "can ask for help" I don't just mean "are able to". They need to feel that:

1. help is available in a format that meets their needs,
2. they are welcome access it (i.e. they aren't being burdensome, asking for help is normal and appropriate for someone in their position),
3. they have support in finding additional resources.

This is immensely important for anyone, but especially for people who are attempting to grow and learn as EDBERs.

Alex says of one of their early mentors "I said to her like, this is something that's really interesting to me, this is a project I'm interested in exploring and she came back with a, you know, list of 40 papers she thought I should read, and said like, you know, please let me know, chat, kinds of things. So early on, and I think that was before I submitted my first RUME proposal for the conference, that was somebody who was like yes, you should do this [inaudible], and also here's sort of how you start to educate yourself about it, and please be in touch."

Notice that this mentor heard Alex express their interest in education research, affirmed the validity of their interest, and offered them advice and an open invitation to ask questions and discuss ideas. Alex discussed this in our interview as one of their more important formative encounters in education research. Acknowledging the validity of Alex’s interest connects with section 5.4.1. This mentor offered help in the form of personal advice and a series of papers, a format that met Alex’s needs at the time. They then went on to invite Alex to reach out to them and discuss things with them further, making Alex feel welcome to ask for help. Finally they made themselves available to help Alex find resources in other formats (they didn’t just say they would send Alex papers anytime, for example).

When participating in a community people need to feel cared for and valued (see section 5.2.2) in order to feel a sense of belonging. Here senior member of the community values Alex’s ideas, and provides care for Alex by offering help in the moment and in the future. Interactions like this one can be critical formative encounters when developing a sense of belonging.

5.4.5 Access to privileged spaces

An important part of any community are the spaces it comprises. Conferences, meeting rooms, classrooms, listservs, social media groups, all of these and more form spaces in which the community meets, shares ideas, and performs regular activities. These spaces aren’t open to anyone, they are privileged spaces which are open to accepted members of the community. Some spaces may be more open than others, for instance a general listserv might be open to anyone who knows to sign up for it, while other spaces, like a meeting room, might only be open to a select few relevant individuals. EDBERs often struggle with accessing privileged spaces.

Brooke for instance says in general “Because there’s a definite fear of like, He’s well, I don’t know if I really know what the people in STEM education think and I also, like is there is a stigma for bringing in a whole bunch of other people? ”. Brooke neatly captures a fear of stigmatization, which in section 5.2.3 I point out is a serious threat to belonging.

This fear is especially strong for EDBERs who become involved with education research as faculty who don't have a background in education. These are often faculty with teaching focused positions, or who are strongly pedagogically motivated.

In section 5.4.3 Rebecca talks about her experiences at a conference. In that instance Rebecca entered a privileged space, but felt that she shouldn't be there because she didn't know the "correct terms or phrases". More generally our EDBERs find privileged spaces hard to access because they may not be aware of them (for example with listservs or online groups), may not have the resources to participate (with conferences in particular), or may not have the connections (to join in on research collaborations with experienced education researchers).

In order for our EDBERs to truly belong to an education research CoP they need to be able to access the spaces of that CoP. Inviting EDBERs to enter privileged spaces (such as research group meetings or seminars), helping to provide resources and access for faculty from underprivileged or small institutions (to get them to conferences), and being supportive of EDBERs when they enter privileged spaces are all critical to helping EDBERs feel that they belong to education research CoP.

5.4.6 Competence

Perhaps unsurprisingly one of the very important things to support EDBERs sense of belonging is a belief in their own competence. EDBERs must feel that they are capable of participating in community activities in a productive and acceptable manner. If you aren't considered competent (or at least considered to be legitimately gaining competence) within the community's domain you aren't really a full member of a CoP. Within CoP the process of newcomers learning about the community's domain and practices and gaining competence is called legitimate peripheral participation. In this sense, our EDBERs need to feel like legitimate peripheral participants to feel that they belong to a CoP.

Melinda for instance discusses her uncertainty as the new chair of her research collaboration's writing committee "And so this is my first time being chair of a writing committee

and I did meet with Ellie earlier, and I haven't gotten back with her, but she got me started in directing the committee and I felt much more confident after talking to her that I could do this." Here Melinda discusses feeling nervous about her new role, and how having support from a subject matter expert (Ellie) affirmed she was participating in legitimate practice, rather than just winging it.

Feeling competent, and believing you can participate in community practices successfully is a direct issue of self-efficacy⁷⁹. Having your activities recognized as legitimate peripheral participation, and developing a sense of competence helps to define and legitimize your role within the community. Thus supporting emerging education researchers in developing a sense of competence is also an important part of developing their sense of belonging.

5.4.7 Qualifications

Finally our EDBERs are often concerned about whether they are qualified to be education researchers. Recall that many of our EDBERs are STEM faculty with disciplinary backgrounds, not education backgrounds (for instance they may have been laser physicists in graduate school). As a result they don't have a PhD in education research. Many of them may not have a post-doc in education research either. As such they have never received formal mentorship or training in an education research setting. Without such formal qualifications and/or credentials, it's reasonable for them to doubt their qualifications to be a part of an education research CoP. Never the less, we must help them overcome this barrier if they are to succeed as education researchers (and I would point out that many senior and founding members of DBER fields did not have backgrounds in education research either for instance in physics education research⁸⁰).

Alex recalls telling a friend that they were "thinking of maybe I'll get a master's in math that year and that's what I do and that'll be like fill in some of the gaps, and get me the credential" but their friend told them "no, you do not need any more degrees. Don't do that. You just need to go visit some people and do some projects with them." Although Alex expresses uncertainty about their qualifications for education research (they're looking

to get their credentials) their mentor in education research rebuffs this idea, and suggests practical experience instead. Among our EDBERs, they occasionally express feelings of underqualification because they do not have degrees in education research (they lack qualifying credentials). In a number of cases this also results in them saying they do not feel like they are education researchers.

Part of a being a legitimate member of a CoP is having the agreed upon qualifications to be there. It's actually not that strange for researchers in various fields to go on to do work that is very different from their graduate or post-doctoral work. This is why researchers may go and join a collaboration at another institution when they go on sabbatical for example. By becoming legitimate peripheral participants within a CoP they build the skills they need to feel qualified for the work that they do. It is important for education researchers to support EDBERs in recognizing the qualifications they have, and participating in reasonable activities to compensate for the qualifications they are lacking.

5.5 What can the community do?

During our analysis of data we discovered recurring themes around mentorship and peer support. Our participants were consistently interested in connecting to other education research CoP. Many of our participants perceived themselves as being relatively isolated. They may have connections only at their institution, and only distantly, or they might have connections only to a couple of other people in their department when it comes to research on education. Many of our participants expressed that they had no one to work with on education research, nor did they know many other people who were involved in education research. These participants find that there isn't enough overlap between the CoP they are a part of, and education research CoP, leaving them isolated.

These concerns of isolation and disconnection are often reflected in literature on gatekeeping, where gatekeepers isolate or exclude outsiders from community groups. Barzilai-Nahon presents an extensive review of gatekeeping across many fields⁸¹. Gatekeeping appears throughout DBER literature as people consider students and their attempts to participate in

various settings, it also appears in professional literature and many other fields⁸²⁻⁸⁴. Gatekeeping runs counter to promoting belongingness, as the point of gatekeeping is explicitly to control the gated, to keep prevent the passage or entrance of someone. In section 5.2.3 my review of the literature notes that major threats to belonging include

- loneliness
- no/low social support
- stigmatization

two of which are natural results of keeping someone out. Many academics in education research fields do not display malicious intent, rather as academics we have standards of peer-review, disciplinary jargon, implicit community norms, many gathering places or communication methods that simply aren't accessible to people who don't have insider support. In this way we gate outsiders from our research field. In some cases, like peer review, this is an intentional and important part of maintaining the field's integrity. In other cases, like disciplinary jargon, this gatekeeping is an unintentional side effect of trying to be efficient.

Recently Montgomery, in a response to the extensive problem of gatekeeping in academic leadership, presented the idea of groundskeeping as an alternative⁸⁵. Montgomery explains that groundskeeping recognizes that people have individual aspirations, needs, and goals. It encourages organisations and communities to actively make space for individuals' unique aspirations and needs. Leaders in the community must act as groundskeepers, ensuring that they cultivate a responsive and flexible environment in which individuals and their ideas can flourish.

These ideas from groundskeeping hinge on things like caring for individuals and their ideas, ensuring that they feel included, safe, and welcome to contribute their thoughts, and supported in their goals. Groundskeeping is naturally aligned with literature in section 5.2.3 about promoting belonging. It focuses on caring for individuals, combating isolation with inclusive practices, and even addresses stigmatization by encouraging explicit welcoming and celebration of people's unique goals and ideas.

Peers	Peers are people with similar levels of experience in education research. They are fellow EDBERs who have similar needs and concerns.
Subject Matter Experts	Subject matter experts are people who have extensive knowledge in the field of education research. They act as mentors who provide subject expertise and support for EDBERs.
Project Managers	These are mentors who are experienced in planning and administering research projects. They support EDBERs in planning around paperwork, resource management, project goal setting, and overall timing of project and project flow.

Table 5.1: *In chapter 4 I discussed three roles that emerged from thematic analysis of my interview data while investigating the needs of EDBERs. People from education research CoP can support EDBERs by taking up these roles in various capacities.*

Based on their feelings of isolation, it makes sense to support EDBERs by enriching and enhancing the network of people they can interact with. In doing this we open up new communities of practice for them, and thus new opportunities for development and growth. Through our thematic analysis we discovered three roles that members of education research CoP could fill in order to address the needs and concerns of EDBERs. These roles were sometimes directly requested, but more frequently were identified as a response to needs and concerns of EDBERs. This is in line with prior work on teaching development for faculty^{19;21;22;29}, and also in line with work on research development for undergraduate and graduate students^{30;56;86}. Table 5.1 provides a summary of the roles (see chapter 4 for more information on these roles). In the next section I will bring together the different aspects of belonging from section 5.4 and the roles from chapter 4.

5.5.1 Peers

Let's begin with peers. Peers are incredibly flexible, and can support emerging education researchers across all 7 belonging factors. Peers are people that you may work with, discuss your work with, present to at conferences and in private settings. Peers are people who acknowledge our work and think about it with us. When they are collaborators they are

people who's work we are contributing to. We may also contribute to our peers' work and receive acknowledgement from them during casual discussions about each others' work.

Peers are often our most frequent discussion partners, and therefore are people with whom we build a shared repertoire. Whether this is through discussion at conferences, joint work, reading and writing groups, or other shared activities. Spending time with our peers allows us to develop and share knowledge with each other, and build shared understandings of what we do. Peers are also a first stop when we need help. Before heading to an advisor, senior researcher, or our boss for information or advice, it's quite normal to stop by your peer's office for a casual conversation.

Peers are also a critical part of accessing privileged spaces. Whether it's the aforementioned group activities, meeting up with people at conferences, attending group meetings, lab meetings, or casual peer gatherings, all of these represent spaces that only community insiders can fully access and participate in. Our peers represent many of the people in these privileged spaces, as well as people who may invite us into privileged spaces we were previously unaware of.

Finally, witnessing and participating in work with our peers can help bolster our sense of competence. Whether it is completing projects together, supporting (and receiving support from) our peers, or just seeing other people in similar situations to ours. Having peers around helps us to establish norms about what it means to be competent, and see how we fit into those norms. Establishing relationships with a variety of peers also allows us to meet people from diverse backgrounds, and get a sense of how different people become qualified as education researchers. This in turn can help us understand our own qualifications as education researchers.

5.5.2 Subject Matter Experts

Subject matter expert is the role that we probably think of most often when we think about advisors and mentors in academia. People who are knowledgeable experts in their field. As advisors and mentors their acknowledgement of our work is a significant boost to our sense

that we belong as members of a community. At the same time, if they do not acknowledge our work this can greatly alienate us from the community. They can help us determine where our work will be best received and acknowledged, further helping us develop a sense of where we can belong. Working with someone more senior on a project to learn the ropes is a common thing to do. In this sense, we may find ourselves contributing to the work of subject matter experts.

Subject matter experts are the authorities on the parts of the shared repertoire in their field of expertise. This means that they are great people to learn from, and offer us access to the knowledge of their field. They can also bar us from accessing a field, as they are often influential. When we have subject matter experts who are open and welcoming, it provides space for us to ask questions, seek help, and feel that we are supported.

As knowledgeable experts, subject matter experts are usually senior in their field. Senior people tend to have a high level of control over privileged spaces. Creating them, managing them, and controlling access to them. This makes subject matter experts powerful supporters when seeking access to privileged spaces. Subject matter experts can also pass direct judgement on our level of competence. And they can support our sense of competence by sharing knowledge with us, giving us feedback and assistance, and encouraging us in our work. Finally subject matter experts are, by virtue of the role, generally considered qualified practitioners in education research. As a result, they provide an excellent example of what it means to be qualified, and also are in a position to acknowledge whether or not emerging education researchers are qualified to be education researchers. This means that having a subject matter expert's approval can be a powerful boost to one's confidence in their qualifications.

5.5.3 Project Managers

Finally the project manager is an oddball among the roles. Emerging education researchers often find that administrative concerns are a barrier to progress. Project managers are a form of mentor who help us manage those administrative concerns, and set us up for success.

They also set an example and model for us how to properly administer education research projects. As people in charge of organising, goal setting, and task management, project managers are well situated to celebrate our progress and acknowledge our work. We also get the opportunity to contribute to their projects, which gives us a place to belong within the education research community. As our directors on a project, project managers can greatly boost our sense of belonging by providing us someone to ask for help when we aren't sure how to move a project forward.

Project managers are in control of the project, and therefore the many spaces associated with it. Whether those are meetings, lab space, data collection spaces, or other spaces, the project manager has the power to invite us into these spaces and grant us access to their local education research project community. Helping us set manageable goals, and celebrating our accomplishments can help us develop a sense of competence. Also, successful projects may result in publications, conference contributions, and other contributions to the research field, boosting our confidence in our own qualifications as education researchers.

5.6 Conclusion

Education research as a field attracts a wide variety of people. While many people enter through more traditional channels as students or post-docs, others join as faculty. EDBERs, particularly those who become involved with education research as faculty face unique challenges. I set out to better understand how education research CoP might support EDBERs.

I identified 7 factors which affect EDBERs sense of belonging: acknowledgement of work, contribution to others' work, having a shared repertoire, being able to ask for help, access to privileged spaces, believing in their own competence, and believing in the own qualifications. I then argued that education researchers could take up 3 different possible roles to support EDBERs sense of belonging: peers, subject matter experts, and project managers.

Each of those three roles supports aspects of belonging by caring for, valuing, and building relationships with EDBERs. This will support our EDBERs, and increase their persistence and engagement within education research. I would invite education researchers to consider

taking up one or more of these roles for EDBERs within their sphere of influence in order to support these new people. In particular, I would like to encourage education researchers to reach out to smaller institutions in their region and/or faculty in teaching focused positions within their institution, as many emerging education research faculty find themselves isolated at small, teaching focused institutions.

Chapter 6

Gatekeeping of emerging discipline based education researchers

6.1 Introduction

I have worked my way through literature, the PEER program, how the PEER program can provide access to a CoP and people in particular roles that can support EDBERs, and have expanded to how people in those roles can have impacts beyond the PEER program on EDBERs sense of belonging. Gradually the work in this dissertation has expanded from being grounded solely in the PEER program to making comments about the needs of EDBERs when interacting with education research CoP more broadly. In this chapter I will continue to explore the impacts of education research CoP on EDBERs¹. In particular I will address the question “*How do EDBERs perceive experiences of gatekeeping in DBER?*”.

Discipline-based education research as a field has become more formally established in recent years, gaining support and formal recognition from STEM disciplinary societies. As the field of DBER has grown, so has the network of involved academics, societies, journals, etc. The growth and development of this DBER network presents unique challenges as research on tenure-stream DBER faculty shows that many do not follow the typical pathway

¹Portions of this chapter are published in Hass et al 2023⁸⁷

into education research (as discussed in chapter 2). Instead, many DBER faculty move into education-focused positions without significant prior background (see section 2.3 e.g., science faculty with education specialties¹). Emerging DBER faculty often feel unprepared for research in education or find themselves lost and anxious as they try to engage with education research. Unfortunately, unlike teaching, relatively little work has been done to understand and support EDBERs in joining research CoP.

DBER as a research field comprises networks of individuals and institutions working together to conduct, present, and publish research. In this chapter I will discuss how EDBERs react to some of the practices in this field, and how they experience gatekeeping within DBER as part of their journey into education research. Gatekeeping is the process of controlling someone's access to information, resources, or space, and often receives a negative connotation. However, gatekeeping is an important part of most communities and networks as it is necessary to control the flow of information and participation of individuals within any group. In this chapter I will discuss some of the impacts of typical gatekeeping on EDBERs, and how we might manage the impacts of gatekeeping to better promote EDBERs involvement while maintaining the health of our research communities.

I will begin by introducing a theory of gatekeeping, so that we might better discuss the details of gatekeeping as experienced by EDBERs. After that, I will discuss the themes around fear and gatekeeping which have arisen within my data which include: underqualification, alienation, and connections. I will end the chapter with a discussion of groundskeeping and how it can reduce the impacts of gatekeeping on EDBERs.

6.2 The theory of network gatekeeping

Work within DBER has not focused on the issue of gatekeeping. In order to facilitate my work in this chapter I need a theory of gatekeeping, and it should be compatible with CoP. A community of practice is a group of people working together, and in a social network theory sense it could be seen as a network of people. An appropriate theory of gatekeeping then should point to important features of a network of people that control the flow of information

and participation of people within the network.

In searching neighbouring disciplines for a theory it became clear that although gatekeeping is widely discussed in numerous fields, these discussions are not always consistent and often are not theoretically grounded. Barzilai-Nahon reviews and analyses a wide variety of theories and frameworks for gatekeeping in their 2009 paper in which they specifically note the lack of consistent, broadly applicable theories of gatekeeping⁸¹. We use Barzilai-Nahon's (2008) Theory of Network Gatekeeping (TNG), which they produced as a synthesis of the fragmented literature, as a theoretical lens to analyze and discuss gatekeeping within DBER. The theory is designed as an interdisciplinary theory of gatekeeping intended to unite the disparate research across disciplines, and provides a well-defined and precise framework for assessing gatekeeping in a wide variety of contexts⁸⁸.

The TNG begins building a description and theory of gatekeeping from the ground up. The first concept that should be defined is the *gate*, a point through which information or a person must pass in order to enter a network (CoP) or a specific part of that network (such as a journal or privileged space). The gate is important conceptually as it acknowledges that networks have points through which they control the flow of information and/or people. On the other hand the gate is often not an easily identifiable literal point or object, so we won't discuss it much going forward.

Gatekeeping is the process of controlling passage through the gate. This tends to involve processes such as selection, filtering, manipulation, prevention, etc. As information or people attempt to pass through a gate they may find themselves blocked wholesale, but passage could also be selective, require changes, or otherwise involve controlling passage without straight up denial. For instance in the case of information it may pass through the gate but be manipulated, added to, subtracted from, etc. On the other hand people may experience gatekeeping not as straight up denial of passage, but as forced change, meeting certain criteria, or needing certain connections.

The *gated* are those whose network access is being restricted. Either the people who are being gatekept when trying to access a CoP, or the people whose information is being gatekept when they try to publish for example. Being gated doesn't necessarily mean that

you have been forced into that position. It's possible for instance, that you could publish your paper in a lower impact journal, but wish to publish in a higher impact journal, and are thus facing gatekeeping. Throughout this chapter, EDBERs will typically be the gated.

The TNG discusses *gatekeeping mechanisms*, which are the mechanisms by which passage through a gate is controlled. These mechanisms can vary enormously depending on the kind of network you are looking at. Within the context of DBER common gatekeeping mechanisms include things like peer review, hiring committees, tenure and promotion, and graduate qualifying exams. Grants and funding access also represent an important mechanism by which gatekeeping is accomplished. More nebulous things may include advertising of and accessibility of conferences, online networks, and PD workshops.

Gatekeepers are those who are responsible for deciding who or what can pass through the gate. Gatekeepers can include individuals or organisations, and they control passage through a gate via various gatekeeping mechanisms, exercising their discretion based on the standing of the gated.

Having established definitions for each of the important features of gatekeeping, the TNG then builds a second component to support explanations of gatekeeping: *gatekeeping salience*. TNG is designed to capture the dynamical nature of gatekeeping. The roles of gated and gatekeeper, movement through the network, gatekeeping mechanisms, all of these things and their relationships with each other can change and evolve. Further, not all gated are gated in the same ways or to the same degree. Gatekeeping salience tells us how significant a particular gated is to gatekeepers.

There are four attributes of the gated to explain the ways gatekeepers prioritize allowing entry of the gated: power in relation to the gatekeeper, information production ability, relationship with the gatekeeper, and alternatives in the context of gatekeeping⁸⁸. These attributes can occur in any combination, come in many degrees, and any given gated could possess some, none, or all of them. Barzilai-Nahon provides an extensive discussion involving every possible combination of these attributes, and the kind of gated they represent. I will not be going into quite that level of detail here, it will be sufficient to discuss how some of these attributes manifest among EDBERs.

Power in relation to the gatekeeper might be the most self explanatory attribute. Whenever two people interact relative power in a given context plays a part in the interaction. For example at a conference having the name of a well known senior researcher in the field on your presentation may make audience members less likely to question or challenge your work. If you are a graduate or undergraduate student, then as a junior member of the research field you may face less rigorous criticism from the audience, or be allowed to present less mature work. On the other hand you have less ability to defend yourself should a senior researcher come after you. Our EDBERs being new comers within education research CoP are likely to have low power compared to gatekeepers who are likely to be more senior members.

Information production ability represents the gated's ability to contribute new ideas to the network. Within a research setting contributing new ideas is what members of the field do, and most of our EDBERs are quite capable of producing new ideas. Some are more capable of producing ideas that are reflective of current ideas and literature within a given education research CoP than others. Information production among EDBERs may take the form of research within their classroom context, presentations on action research projects or outreach projects, publications, and other forms of information typically produced and shared by researchers.

Relationship with the gatekeeper has a major impact on how visible the gated is to the gatekeeper, and how much influence they might exert. If I am friends with the editor of a journal I may have better access to the help in preparing a publication, and submitting it for review. If I have a PhD advisor in PER I may have better connections to conferences and research collaborations. Having a relationship with a gatekeeper can fundamentally change how the gated are received and controlled. The kind of relationship you have also affects what kind of gatekeeping mechanisms the gatekeeper has at their disposal and is likely to use.

Alternatives in the context of gatekeeping can give the gated more influence. Having alternatives may not mean freedom from gatekeeping, it may simply mean that there are multiple different gates and gatekeepers to deal with. However this choice could mean that the gated has increased salience if they choose one gate over another (for instance publishing

in a journal where they know the editor versus publishing in a high impact journal they have no connection to). The presense of choices means any given gatekeeper loses some of their control because the gated could choose to go somewhere else. On the other hand, sometimes the gated choose to limit their alternatives (if say they are only interested in publishing in high impact journals).

In the context of our work, EDBERs are the gated, while the education research CoP serve as the networks EDBERs are attempting to access, and members of these communities or institutions linked to them serve as gatekeepers. The alternatives available to emerging DBER faculty, and the relationships they may have with the DBER community, can vary strongly based on personal experience; this will become an important part of our discussion. Finally, while emerging DBER faculty are all capable of engaging in the discipline based education research process (information production ability in TNG), the ability to produce information does not necessarily mean that information can be shared since controlling information flow is the role of the gatekeeper. As a final note we note that the TNG makes no requirement that the gatekeeping be real or direct. A person's perceptions, general tacit feedback from a group, or lack of connections, while imagined or indirect, can still contribute to being gated.

6.3 EDBERs perceive gatekeeping within DBER

Here I present three themes, each of which is grounded in the four attributes of the gated as defined in the TNG⁸⁸ (see section 6.2): underqualification, participants feel underqualified for DBER; alienation, educators feel out of place or excluded by established researchers in DBER; and connections, the importance of closer relationships with existing community members for becoming a part of the community. These themes emerged from thematic analysis of my interview data. They are grounded in the TNG, but they are observations not theoretical predictions. While presenting those themes I will use examples drawn from my data to highlight and explain the themes. I will talk about the people who appear in those examples now.

Alex is tenure track faculty member in their first year at an institution very focused on teacher training. Alex is in the mathematics department, and was hired specifically to conduct education research. At the time of interviewing Alex was reflecting back for us on their experiences as an EDBER, and how it had shaped their career so far. Alex has had supportive connections in their career, and speaks about these often. Further, even when Alex encounters negative or discouraging situations, their network of supporters helps lend them confidence and resilience.

Alex has strong opinions and intuitions in research, but has less of the formal literature background possessed by other members of their education research CoP. Sometimes Alex finds that other members of the education community downplay their experience or opinions because they aren't reflected in the current literature.

Andrea is tenured faculty and has moderate to high expectations for both teaching and research from her institution. Andrea spent a lot of time reflecting for us on the development of her career and how she became involved in education research. She does not emphasize strong connections to other education researchers or CoP, and often expresses feelings of isolation and frustration with people she has tried to collaborate with.

Her interests are strongly focused on outreach. Andrea has been involved heavily in mathematics outreach programs since graduate school, including managing over 1 million dollars worth of grant money for outreach programs as part of jobs before she took on a faculty position. As faculty she is very interested in how students are impacted by participation in outreach and enrichment programs.

Cole is a mid-career, tenure track, mathematics faculty member and department chair. During his interview he is reflecting for us on his involvement with education research. One of the particularly interesting features of Cole is that he still sees himself as a new and emerging education researcher, even though he has been involved with education research on and off for 10 years. While he has been involved for a long time, he has only been involved intermittently, has no formal background in the field, and struggles to grasp the full scope of math education research.

Cole's lack of formal training is a sticking point for him. He often says that he often

talks about his expertise in teaching, while downplaying his experience as a researcher in education. He feels that his lack of formal training has left him without the literature, theoretical, and methodological expertise that an expert should have.

Madison is in her first year as a tenured faculty member. She is at a primarily hispanic serving institution, and has fairly balanced expectations for research and teaching. Her home discipline, which she loves, is material physics. She has a supportive community around her, and is excited about education research because she enjoys teaching.

Madison talks frequently about her connections to other people, and how these connections have helped her to develop her current interests. She has colleagues who are involved with or interested in education research, and she leans on those connections to learn more and get involved. Madison is an outgoing individual, and an interesting case because although she doesn't have a natural education research CoP within her department, she leverages connections and opportunities for networking to build one.

Rebecca is a tenured faculty, and her job is teaching focused. At the time of the interview her institution was rethinking their mission, and she couldn't clearly tell us what the institution was expected to be. She has been teaching and conducting research around curricula and classroom interventions for a long time, and has some publications. She feels that she is rather disconnected from the broader education research community and struggles to establish connections.

Rebecca has been involved in some conferences, and expresses in particular her feelings of alienation in those settings. At her own institution she doesn't have an education research CoP within her department, and has only a limited community to participate in on campus. When she talks about her conference attendance she emphasizes the language differences between her and the other people there, as well as how her research interests don't align with those of the conference CoP.

Samuel is currently a graduate student in physics education research. He was previously in applied physics, and he was until recently the only graduate student in his group. He's been doing this for about 3 years.

Samuel has several robust education research CoP on his campus that he is able to

be a part of, but none in his own department. He often feels that he is lacking as an education researcher because he isn't connected to an established physics education research (PER) group. He also struggles to become more connected with the PER field outside of his institution. In an effort to combat this he is becoming more active within the major professional organisations associated with PER, including the national PER graduate student organisation.

6.3.1 Underqualification

As DBER has become more prominent in several fields within STEM, statements have arisen establishing DBER and defining what it is. According to a 2012 report from the National Research Council, DBER “investigates learning and teaching in a discipline using a range of methods with deep grounding in the discipline’s priorities, worldview, knowledge, and practices. It is informed by and complementary to more general research on human learning and cognition” (p.9). Henderson et al.⁴ describe DBER as “[seeking] to develop evidence-based knowledge and practices that improve teaching and learning in the science, technology, engineering, and mathematics (STEM) disciplines” (p.1). The American Physical Society’s (APS) statement on Physics Education Research (PER) (2019) describes DBER as being “both objective and experimental, it has established publication and dissemination mechanisms, and Ph.D. students trained in this field are recruited to establish new programs”. All of these statements highlight the importance of formal qualifications for DBER.

These statements highlight what governing bodies and researchers within DBER fields consider to be important qualifications. Notably these statements highlight the importance of being knowledgeable about field practices, norms, and knowledge. They highlight the importance of research quality, as controlled by peer review. They also highlight the importance of connecting both theory and experiment in education research. Notably DBER is said to prioritise understanding learning and teaching within specific disciplines, by conducting research in a way that is deeply grounded within disciplinary culture. I take time to highlight these criteria because EDBERs are often able to meet the criteria for good research listed

here without having to have a degree in DBER. However they also often feel that their lack of a degree makes them underqualified. The APS statement from the previous chapter in particular highlights advanced degree programs within DBER fields as an important signal of their legitimacy.

Participants largely frame their under qualification as a lack of technical know-how or a lack of credentials. Given the what statements about the DBER field value as important, this makes sense. Among our participants there are those who voice concern over not having a Ph.D. or post-doctoral research experience in the subject. For instance, Cole (chair of a mathematics department) said: “here’s [the interviewer] working on his PhD to be able to do this kind of research” and continues “I also think that research should be done by professional researchers, right?” Cole is very capable of participating in DBER scholarship and generating new information (in sections 5.3 & 5.4 we discussed Cole’s collaboration on education research projects and publications) (TNG, information production ability), however his perception that he lacks qualification acts as a barrier to his entry into the DBER discourse (TNG, gatekeeping). It is also important to note that a lack of credentials (be that a lack of Ph.D., postdoc, publications, job title, etc.) represents a significant lack of power relative to established members of the DBER community (TNG, power in relation to the gatekeeper).

Participants also discuss their perceived lack of qualification not in terms of credentials, but in terms of missing expertise. Andrea discusses very clearly instances where collaborators have told her that she is lacking expertise and therefore can’t be a part of their project: “a colleague that just would get really frustrated that I hadn’t been trained and I wasn’t listening, and I wasn’t doing this, and they couldn’t bring me on the journey with them because they wanted to spend a lot of time telling me I was wrong, and we couldn’t work together.” This colleague perceived Andrea as lacking expertise, and spent a lot of time talking down to Andrea or correcting her, without really helping her develop necessary skills (TNG, relationship with the gatekeeper). In this instance Andrea’s colleague basically labeled Andrea as unqualified for the work (TNG, power in relation to the gatekeeper). This is contrast to Cole’s experience in chapter 5 where Cole discusses how his collaborators

celebrated and welcomed his pedagogical expertise, while compensating for his lack of DBER expertise. In Andrea’s conversation with us, this incident was one of the major incidents that she used to explain why she didn’t see herself as an education researcher. She goes on to extensively discuss how she lacks subject knowledge, and therefore isn’t fully qualified for the role.

Our EDBERs often voice their experiences that they lack qualifications. Sometimes this is because they perceive themselves as lacking some form of credential (like a degree or publications), and other times this is because they perceive themselves as lacking critical skills or knowledge (or are told they lack this by others). This perception that they are underqualified limits the ability of EDBERs to participate in the field.

6.3.2 Alienation

Among emerging DBERers we interviewed, those who were primarily educators discussed feeling alienated within DBER. Often educators feel out of place or excluded by established researchers in DBER (TNG, relationship with the gatekeeper). This often manifests through the extensive use of jargon and the undervaluing of educators’ experiences and observations in a research context. How members of education research communities value the intuition and experiences of educators as part of education research has a significant impact on their participation within DBER.

For instance, Alex (assistant professor of mathematics) described conversations with researchers at the Research in Undergraduate Mathematics Education (RUME) conference: “I have a lot of intuition that I feel comfortable talking about, and sometimes the RUME scholars are like, ‘but this is the only thing that’s been studied and because people have thought about this way in the past, this is sort of how the conversation has to go”. Here Alex attempts to put forward ideas that aren’t based in the literature or extensive research, but are rather based in their own experience as an educator. Rather than acknowledging these as valid ideas that could be reframed as research questions and studied, experienced members of the education research CoP instead restrict Alex’s ideas because they don’t fol-

low from the current and historical scholarly conversation (TNG, power in relation to the gatekeeper).

Rebecca (associate professor of mathematics) recalls attending a different DBER conference: “When I talked to people, they said, ‘oh, you sound like someone who’s very interested in education research, but you don’t use any of the correct terms or phrases.’” Her lack of jargon and terms marked her as an outsider, and left her feeling alienated (TNG, relationship with the gatekeeper). Although both Alex and Rebecca, who are experienced STEM educators, have many ideas (TNG, information production ability), their relationship with researchers in DBER is an outsider-insider relationship (TNG, relationship with the gatekeeper), which constrains their ability to share those ideas (TNG, gatekeeping).

Sometimes community control of ideas is even more explicit, and emerging researchers may simply be shut out of the conversation entirely (TNG, power in relation to the gatekeeper). For instance, Rebecca, when talking about her research at RUME recalls being told by a researcher: “oh assessment, that was popular in the ‘70’s. No one’s doing that now.” For many EDBERs, their relationship with the DBER community is one of outsiders and insiders, and so they receive perfunctory feedback on their ideas, or even outright dismissals, making it difficult for them to continue to engage with the community and disseminate their research ideas (TNG, gatekeeping).

6.3.3 Connections

While we documented existing barriers to entry in the DBER field, many participants also discussed positive encounters within the community. When discussing what support they need to successfully become involved with DBER, all of our interviewees agreed that closer relationships with existing community members are key. Developing relationships with established community members gives EDBERs channels for constructive feedback on their work, as well as mentorship and PEER support (as discussed in chapter 4).

Samuel (graduate student in Physics Education Research) said: “I’ve been in physics education research for probably about three years and we have a DBER group on campus

that I'm in with other people, and I've found these to be enjoyable, effective places where I can learn about education research." In his discussion of this group he goes on to explain that this local education research CoP (TNG, relationship with the gatekeeper) comes together to do skill building and discuss techniques within DBER. They provide space to generate and share ideas (TNG, information production ability). He does note, however, that they aren't specifically a PER group, and so he doesn't get some of the disciplinary support that he would like.

Having connections may also grant EDBERs allies with more power within the DBER community. Madison (associate professor of physics) talked about a researcher who is part of a well-established and recognized physics education research group "I've been working with [Hillary] out of [Pseudonym U]. I worked with her group for like three years on advanced lab" when discussing her DBER CoP and people who support her in her DBER efforts (TNG, relationship with the gatekeeper). Having relationships with people in the DBER field boosts the ability of emerging DBERs to enter the DBER community, both by helping them develop recognized and valued skills, and by boosting their confidence and access to community members.

The experiences of Madison and Samuel are consistently echoed throughout our data set. EDBERs with strong connections gain many benefits from sharing a positive relationship with a gatekeeper of an education research CoP (consistent with the TNG understanding of the impacts of relationships with the gatekeeper). On the other hand, those who lack any connections struggle more, more often express feelings of alienation and frustration, and have more trouble obtaining qualifications that they perceive themselves as lacking.

6.4 Opening our arms through groundskeeping

Throughout this chapter I have emphasized how the field of DBER functions as a network with gatekeepers who control the flow of information and participants throughout. I have noted that EDBERs in my study frequently discuss alienation and underqualification barriers which inhibit their participation within the DBER field. I have framed this as a form of

gatekeeping, real or perceived, which controls who can and cannot fully participate within DBER. Now that I have discussed how themes around gatekeeping emerge within my data and impact EDBERs in my study, I shall discuss one option for responding to it.

Before that though, I should highlight that gatekeeping is a necessary and important feature of DBER. Within a research field information flow and participation do need to be regulated, and gatekeepers serve a vital role in this process. Peer-review of publications is an excellent example of a gatekeeping mechanism which is not only desirable, but vital to the integrity of a research field. As I invite the reader to think about how we mitigate the impact of gatekeeping on EDBERs, I would remind them that gatekeeping is not so much an evil to be defeated as a behaviour to be managed.

To mitigate the negative impacts of gatekeeping on EDBERs I will turn to the idea of groundskeeping presented by Montgomery in their 2020 paper⁸⁵. Montgomery is writing about the harmful effects of gatekeeping in the context of academic leadership, presenting an alternative, or perhaps complementary mindset in the form of groundskeeping. Where gatekeeping is very much designed to regulate ideas and often serves to maintain status quo through exclusion of that which is undesirable, groundskeeping seeks to foster an environment in which individuals ideas and aspirations can take root and contribute to community growth and development.

Gatekeeping is formulated here within the context of networks as the act of controlling flow through critical access points called gates. It is through this control that CoP limit who can change their practices, contribute to the development of their domain, and participate in their discourse. However it should be clear that merely limiting people's participation cannot allow a CoP to grow.

While gatekeeping is about controlling flow through a network, groundskeeping could perhaps best be conceptualized as the conscientious cultivation of that network's growth and evolution. Groundskeeping means cultivating an environment in which all members of a CoP can contribute to the growth and development of that CoP's domain and practice through the pursuit of their interests and goals. In order for this to happen, it is important for us to recognize the ideas and expertise of each community member, and support them

in developing those ideas and expertise in a productive manner.

A fine example is when an EDBER who is primarily an educator without much education research experience wishes to participate in a project on developing new curricula (for example) in undergraduate quantum mechanics courses. Frequently quantum mechanics is highly mathematical, limiting the students who can participate in it substantially, and also limiting when it can be taught within a physics program. Developing a course on quantum mechanics that is conceptually driven, with a minimum of mathematics could expand the pool of students who can engage to include non-majors, and could facilitate the introduction of quantum concepts to introductory physics majors courses. This is a big project, and a physicist with no background in education research may find it intimidating to have to design the course using evidence based practice, evaluate the pedagogy and effectiveness of interventions, and justify to their department colleagues the effort has been successful.

In such a situation an experienced education researcher can assist in providing an overview of existing literature and research in PER on conceptual quantum mechanics, provide guidance on evidence based curriculum design, and help with project design and evaluation. Cole discusses a situation like this in his interviews (we heard about him in [chapter 5](#) and earlier in this chapter) when he discusses his collaboration with a research group developing new differential equations pedagogy. Lest you think that the education researchers are doing all the work for no benefit, recall that Cole was highly valued by his research group for his mathematical and teaching expertise. In our current example this physics faculty member is bringing their passion, disciplinary knowledge in quantum mechanics, and knowledge of the students and environment in which they teach to the project.

By developing an environment in which education research CoP value the interests and skills of EDBERs, and support them in developing new skills as they pursue those interests, EDBERs are supported in developing necessary qualifications to be part of the group. Further, by valuing the interests and ideas of EDBERs rather than calling them out for not sharing the community's ideas the impact of alienation can be significantly reduced, making the community a more welcoming place.

All of this is groundskeeping at work. Carefully cultivating an environment in which new

and different ideas are encouraged, and guided in their growth. In doing this communities can support new and emerging education researchers, can improve the quality of education research conducted by peripheral members, and increase the quantity and diversity of ideas and perspectives available in the literature.

6.5 Conclusion

In this chapter I have discussed evidence of gatekeeping in DBER, both within public statements about the field and within the lived experiences of emerging DBERers documented as part of this study. Gatekeeping can have a serious negative impact on people who are trying to move into the field, and can limit or prevent their participation. EDBERers are capable of producing information relevant to the field, and are interested in participating in DBER discourse. However they lack power within the field to make their ideas heard, and they also lack relationships with established members of the DBER community which could help them rearticulate or imagine their ideas in a way that the community finds acceptable. Ultimately the loss of EDBERs ideas through gatekeeping represents a loss of information available within the field.

In order to minimize the negative impact of gatekeeping within DBER, I encourage community members to make space for emerging DBERers by being mindful and providing constructive feedback. It is important to recognize the experience and expertise that EDBERs do have, even while acknowledging places where their knowledge may be insufficient. This invites emerging DBERers to begin participating meaningfully in community discourse, rather than being shut out of it. I also encourage opening up collaborations with emerging DBERers to help them build relationships with established DBER community members. Finally, valuing the ideas and experiences that emerging DBERers bring to the discussion as educators can reduce the impact of power differentials on emerging DBERers.

The ideas in this chapter represent the culmination of all of our efforts which began back in chapter 4 to understand the needs of EDBERs and how communities can impact their development. I started from how the PEER program in specific can support EDBERs

through developing a local community of practice and providing fundamental research skill building. In chapter 5 I discussed how education research CoP come together to form overlapping research fields in which EDBERs participate, and how they can support EDBERs involvement. Finally in this chapter I have discussed gatekeeping as a barrier to EDBERs involvement and the importance of mitigating its negative impacts in order to create a more inclusive DBER research field.

In the next chapter, chapter 7, I will move away from discussing community impacts on EDBERs, and focus on discussing knowledge as a barrier to their participation. In particular I will discuss how theory in education research is troublesome for EDBERs. With this, I will highlight how paying careful attention to concerns of EDBERs has lead to advancements in the PEER programs curriculum, and lead to a deeper understand of how they are learning to engage with a new field.

Chapter 7

Making sense of theory in a new field

7.1 Introduction

So far throughout chapters 4, 5, and 6 I have focused on EDBERs interactions with education researchers and the education research CoP that they are attempting to join. I have tied these ideas back to the PEER program to see how the PEER program uses these interactions to help EDBERs develop their research practices. In chapter 5 and 6 I explained how interactions with education research CoP outside of the PEER program impact EDBERs as they are developing. I have not however spent much time on the fundamental skills that EDBERs are developing as they merge their disciplinary and education research practices.

In this chapter I will focus on the fundamental skill of theory and its usage in research¹. EDBERs express the need for guidance in a number of fundamental research skills, but theory in particular caught my interest due to the kind of questions they had about it. When asking for help with methods, literature reviews, or data collection and analysis EDBERs expressed interest in learning the particulars of “how to do” these things. They might want help locating appropriate literature, scoping research projects, choosing appropriate methods, learning how to use a method correctly, how to collect data, etc. These are very procedural questions that you might expect from a researcher who is new to a field.

¹Portions of the chapter appear in Hass et al 2022⁸⁹ and Hass et al 2023³²

On the other hand theory interested me because the quality of some questions that EDBERs had about theory were different. While EDBERs certainly expressed confusion about what theories were available and how to use them (procedural questions), they also asked fundamental questions that I wouldn't have expected from trained researchers (recall that many of our EDBERs are trained researchers, even if they are trained in a different kind of research). Our EDBERs asked questions like "What is theory?" and "Why do I need a theory?". These questions about the definition and purpose of theory in research surprised me.

In this chapter I will first discuss theory in education research, and how I understand what theory is and what it is used for, alongside literature from a broader academic discussion of theory. I will then delve into the first round of this project, where I identified questions about theory emerging in my data. I'll address the question "*How do EDBERs struggle with understanding and implementing theory in education research?*" Finally I will discuss the second part of this project, "*How are EDBERs making sense of theory in their disciplines and education research?*"

7.2 Sensemaking: building understanding

To understand how EDBERs are developing ideas about theory I turned to the theory of sensemaking. Sensemaking as a theoretical idea in the literature has been around for a long time. It's been used in many contexts across multiple disciplines, and in a number of different ways, a nice synthesis is provided by Odden & Russ⁹⁰ and a detailed explanation can be found in Odden's dissertation on the subject⁹¹. Sensemaking as an idea has been discussed as a dialogic process⁹², a process of modeling⁹³, and a process of knowledge transfer⁹⁴. It has been used within the context of physics education research to explain students' problem solving processes^{90;95}. Sensemaking's use in many context has resulted in a fragmented and inconsistent definition of sensemaking in the literature.

In their 2019 paper, Odden and Russ provide a synthesis of sensemaking literature, and argue that in spite of the many definitions of sensemaking, all of the literature agrees upon

certain key features of sensemaking. They use this overlap between different conceptualizations of sensemaking to provide a definition of sensemaking. Sensemaking is characterized as “a dynamic process of building an explanation to address an inconsistency or gap in knowledge”⁹⁰ and Odden and Russ argue the key features of this process are:

- it promotes deep understanding of material, allowing students to build connections between new and existing knowledge, and engaging students more completely in a task,
- it facilitates transfer of knowledge between domains,
- it is an essential part of the process by which researchers generate new knowledge.

In the coming sections I will use sensemaking as a theoretical lens to frame EDBERs questions about and struggles with theory (section 7.5), and to interpret case studies of 3 of my interviewees reasoning about theory in the context of their own discipline and education research (section 7.6). Sensemaking is an appropriate lens because these EDBERs are students of the PEER program, and understanding how they are engaging with material that they are learning about is the explicit purpose of this study. It also fits well as I am studying how EDBERs transfer and merge knowledge from their disciplinary STEM research into education research, and because they are researchers and sensemaking is an essential part of the research process.

7.3 The PEER theory project

This part of my dissertation came about in two stages. In the first stage data was gathered as part of better understanding the needs of EDBERs. In interviewing EDBERs who were coming to participate in the PEER-Chicago 2021 workshop (more information in section 3.4) I noticed that they were particularly struggling with theory as part of education research. This struggle was often visible more because of their avoidance of the topic than because of direct comments from them. In order to better understand what our EDBERs were thinking

about theory, I drew upon not only interviews with them before and after PEER-Chicago 2021, but also artifacts that they produced during the field school through an online tool called Padlet⁹⁶.

Padlet is an online tool that allows multiple people to engage with a single board to post and interact with each other's content in real time. The PEER-Chicago 2021 workshop used Padlet to create a board on which participants could anonymously post questions they had for facilitators and topics they wished to learn more about. One of the Padlet boards used particularly asked participants to post questions they had about the research process (of which theory is a part). As I am discussing how EDBERs are thinking about and struggling with theory in the next section, I will draw upon the Padlet data alongside my interview data to highlight participants' questions and ideas about theory.

In the second stage I had examined how EDBERs were struggling with theory, and we had implemented the Theory module (see section 3.3.1) at PEER based upon those results. However I still had not been able to understand how EDBERs were reasoning about theory, *why* were they struggling with theory so much? To address this question I conducted a second set of interviews before and after PEER-Chicago 2022 at which participants engaged with the theory module. These interviews focused on understanding participants thinking about theory before and after learning about it at PEER.

7.4 Framing “What is Theory?”

Before I discuss data and results, I should discuss what theory is, and I shall ground that discussion in the context of the social sciences as that is the particular context we are working in now (having said that, definitions of theory across academic disciplines have much in common). 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 phenomena⁹⁷.” This definition captures a number of key features that you might hear from a discussion with any researcher about theory:

- Theory provides a language and structure for understanding and examining a phenomenon.
- Theory is systematic.
- Theory's purpose is to explain phenomena that we are studying.

Although there isn't a single agreed upon definition of theory, I will use this definition as a good working definition so as to facilitate a conversation of how EDBERs engage with theory as a part of research practice.

Theory is something that researchers select, and the selection of theory is a significant part of academic work within the social sciences. As argued by Stinson, our choices of theory and how we use it are strongly influenced by our philosophical perspectives and worldviews as researchers⁹⁸. When working on research the choices a researcher makes about what theories to use reflect their interests and fundamental ideas about what is happening in their project and what is important to be known. Within physics for instance researchers routinely make choices about what simplifying approximations are appropriate when making theoretical predictions. Within education research a researcher may make choices about whether to focus on an individual's cognitive process, or the interactions within a group. This process of choosing theory appropriately is something that our EDBERs often struggle with.

Many authors 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^{99–102}. Often one of the biggest challenges facing an academic who is looking at new (to them) theory is understanding how it fits within an academic conversation, and whether it is appropriate to use within the context of their own work. In support of this process of choosing among theories other authors have made an effort to create accessible summaries of available common theories for EDBERs¹⁰³. In an effort to help EDBERs make informed choices about theory, Schoenfeld offers a practical set of standards with which to judge theories and results, grounded in the notion that research and theory in education has much in common with the physical and life sciences¹⁰⁴. Even as these authors work to provide detailed introductions to the theory of education research,

they all recognize 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 EDBERs.

As discussed in chapter 3 I 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 (see figure 3.1). 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 Simon⁹⁹. We also agree with Stinson that personal worldviews and philosophical alignment play an important role in the selection and interpretation of theory and data⁹⁸. 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.

7.5 Struggling with DBER Theory

When EDBERs are asked in my interviews about education research, and what they think it entails and what they may wish to learn more about, they often discuss literature reviews, methods, analysis, and data collection. They also discuss project and time management, and challenges dealing with skeptical audiences or departments. They rarely discuss theory, and when asked about theory they tend to drift to other topics rather than engaging deeply with it. This made me wonder how exactly they were understanding theory and its purpose in education research. Using the data drawn from PEER to investigate this I was able to identify different ways in which participants are confused about theory. I also noted that learning about theory appears to be transformative for PEER participants.

In the section that follows I will discuss ways in which EDBERs in my data were struggling with theory. I will then go on to discuss the positive impact that learning about theory had on some of our EDBERs. All of this information became an important part of building

a theory module for the PEER program (see section 3.3.1 for more information about the structure of the PEER program).

7.5.1 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, the interviewers didn't initiate discussion of theory. Several participants did discuss theory naturally during their pre-interviews. It's worth noting that all participants who did mention theory had prior experiences in projects conducted by education researchers. Ryan and Lily in particular had clear 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. Even post analysis, his comment remains one of the best illustrators of the sentiment that theory is overwhelming. In particular, he highlights the challenge of 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. In the language of our theory of sensemaking, we see Ryan identifying a gap in his knowledge here. This is a very practical concern that many of our participants share. It’s not always clear where or how you should search for theory. Social sciences in particular have a very wide variety of theories with many purposes. As a new researcher in the field of education research, it can be hard to get a sense for the scope of theories used within the your field, and which ones are useful for the work that you do.

Ryan continues by 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 highlights the value of linking Ryan to the community’s conversation on theory. A critical part of using theory is ensuring that the theory you are using

is well established and accepted by other researchers in the field. Ryan here expresses and need for information situating available theories within his academic context. Many EDBERs express a similar sentiment: having a few curated sources to look at would be highly valuable. Curated sources like this already exist, several examples of which can be found in section 7.4. Some of these sources would be provided at the PEER-Chicago field school that Ryan would attend after this pre-interview.

Providing references may not be sufficient for EDBERs to engage productively with theory however. Lily comments on theory: "...[A]t the beginning, the whole idea of a theoretical framework was totally mind boggling to me." acknowledging a gap in her understanding. She goes on to say "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 highlights the importance of having someone to hold a conversation with and bounce ideas off of when trying to understand theory, which shows an attempt by Lily to address this gap. Although she had access to papers about particular theories, understanding the usage of those theories and their roles in her work required discussion with other people. 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 education research. Lily focuses on the words "theoretical framework", however researchers within education often refer to theoretical frameworks, theories, theoretical perspectives, worldviews, and theoretical lenses without clarifying what these different words mean or how they relate to one another. People within the field are used to navigating these ambiguities, but EDBERs generally are not.

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 education research can be very confusing to EDBERs. Secondly, even for those who have developed an understanding of what theory is in education research, it can be very difficult to source theory and learn about new theories without guidance. These represent important practical concerns which must be addressed

when attempting to support EDBERs.

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 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 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. The problem of how theory is sourced is incredibly important as a practical issue, and in part is related to community norms around who is allowed to generate theory, and what it means to generate theory.

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 education research. 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? Another 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?

Through my analysis here I have developed two major different categories of confusion that EDBERs express about theory:

- Practical confusion: questions about the “how to” of theory sourcing and usage.
- Principled confusion: questions about the definition and role of theory in education research.

In helping participants engage with theory and develop their skills as researchers, it is important for PD programs like PEER to address both kinds of concerns. Addressing each kind of concern effectively, however, can require different approaches.

Early on in this section I highlighted Lily and Ryan recognizing gaps in their knowledge, and perhaps even seeking to address those gaps. Similar gaps can be seen in other quotes throughout the section. Notably however, the data presented in this section doesn’t shed much light on EDBERs reasoning about those gaps, and attempts to synthesize answers to their questions about what theory is and how it is used. In section 7.6 I will discuss the stories of Geraldine and Robert from PEER 2022 interviews about theory. In their stories I will explain more about different ways in which EDBERs are making sense of theory, and addressing the gaps highlighted in this section.

7.5.2 PEER can transform participants’ thoughts about theory

After the PEER-Chicago 2021 workshop I 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 2021 had impacted their understanding of education research. As I am was interested in how EDBERs engage with theory in education research, I included an examination of what these participants said here in order to highlight the impact of fundamental skills development during PEER. As will become more clear later in this chapter, the comments from participants in this section also lend insight into why learning about theory in education research is important and impactful for EDBERs.

I shall begin with Peter who noted: “The idea of using part of this theoretical framework and combining it with that one, I’d never considered it before”. Peter is a physicist who is new to education research. Peter discusses in his interview how he is used to thinking of different theories as covering different, and often mutually exclusive or entirely separate domains of knowledge. Learning about theory at PEER transformed how Peter thought about implementing theories in his own education 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.” Clearly Peter isn’t yet entirely comfortable with the idea that multiple theories could apply to his work, and that choosing among them is often a matter of researcher perspective. Even so, 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. He has had his eyes opened to the possibility of choosing between different theories to highlight different aspects of his work, and bringing multiple theories together to offer more complete descriptions of phenomena. Peter is recognizing a gap in his understanding here, seeing multiple theories applying to what he does doesn’t make sense to him. And he is also moving towards addressing that gap, considering this idea of combining multiple theoretical frameworks together. This suggests that something at PEER helped Peter to notice this gap in his thinking and start reconstructing his understanding of theory to address it.

Another participant, Olivia discussed how learning about theory has transformed her view of education research. Olivia is a mathematician with over 20 years of experience as

mathematics faculty, but education research is a new enterprise for her. She was a part of our pre-interview data set as well, and described her very practical interests in issues like student retention and demonstrated learning gains. She wasn't interested in abstract or highly theoretical work. In her post-interview Olivia notes specifically "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 acknowledges that she wasn't very open to the importance of theory, and deeply theoretical research within education research. She has become more open to it after learning more about the role of theory within education research. This is an important development because, even for researchers who are focused on very practical and applied work, sound theoretical underpinnings can result in improved outcomes for students and a stronger voice within education research CoP.

Finally Penelope is a junior mathematics faculty member, and is new to education research in particular. She has voiced strong concerns in her pre-interview about her place within education research. Like many of our EDBERs Penelope worries about being accepted by education research CoP and finding a place for her work within DBER as a field (see chapter 6 for more information). In her post-interview, having learned a bit more about theory Penelope comments: "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. Penelope has developed an understanding of how her more practical and empirically driven interests fit within a broader context in education research. She understands that there are people

in the field who are deeply theoretically motivated, and that she is not one of those people. She also now has enough context to feel comfortable with that realization.

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 education research, 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. Learning about theory, developing a deeper understanding of this part of research and what it is for, can help transform our participants understanding of how research is framed, their position within their field of research, and how distinct focuses of different researchers come together to produce a rich academic conversation. Learning about theory is pushing these participants to rebuild their understanding of theory and research in new and interesting ways, and this observation led us to create the PEER theory module, and led me to conduct interviews specifically about this reasoning and rebuilding that participants are engaged in.

7.6 EDBERs sensemaking about theory

To further understand how participants are conceptualizing theory, I conducted interviews with participants before and after their participation in PEER-Chicago 2022. At PEER-Chicago 2022 participants went through the theory workshop previously described in section [3.3.1](#). During my interviews with these EDBERs I focused on asking them about how they use theory in disciplinary research, what it does for them, and what they thought theory was. Then I asked them to compare this to education research. As participants went through this process they were often forced to think explicitly about things that they usually only considered implicitly or in passing. They were forced to build meaning and think about theory. In the rest of this chapter I will be discussing what occurred in these interviews to tell a story about how EDBERs are conceptualizing theory. In order to tell that story I will draw upon the theory of sensemaking to examine how EDBERs are conceptualizing theory before and after learning about it at PEER.

In this section I am going to present findings from the second round of data collection for this project. The first part of this chapter (section 7.5) presents my initial findings regarding how EDBERs struggle with theory in education research. These findings prompted some changes to my research questions, and I wished to investigate how EDBERs were conceptualizing what theory was. I initially believed that they perceived major differences between theory in their home disciplines and theory in education research, and that this was the primary source of the confusion presented earlier in this chapter. To investigate this I conducted two new rounds of interviews explicitly about theory, one set before the PEER-Chicago 2022 field school, and one after, to determine how EDBERs were reasoning about and understanding theory, and how learning about theory was impacting this understanding (see chapter 3 for a discussion of the various interview protocols used for my data collection).

The interviews about theory were quite illuminating, and they proved my initial assumption very wrong. In this section of my dissertation I will present case studies from three of my participants to show how EDBERs are understanding theory. I will be discussing Geraldine, who is a materials physicist, as she provides a clear example of the reasoning I see among many of my participants, and is particularly clear when discussing and reflecting on her understanding and use of theory. For contrast with Geraldine, I will discuss Robert, a theoretical physicist whose understanding and use of theory is (perhaps unsurprisingly) very different from those of people who are more experimental scientists. Finally, I will discuss the special case of Jacob Junior (JJ), who is not in fact an EDBER, but is rather a career education researcher with a great deal of experience, and who provides a nice example of the contrast between experienced and emerging education researchers' thinking about theory.

The interviews about theory began by asking participants about their position, discipline, and work expectations. Afterwards participants were asked how they engage with theory in their home discipline's research, what role theory plays in their home discipline, and what theory is in their home discipline. Following that they are asked the same general questions about theory in education research. Finally the interview finishes with questions asking them to compare their understandings of theory in their home discipline and education research. The *What is Theory* interview protocol can be found in appendix A. The case

studies that follow will follow the same general setup as the interviews in order to better show participants's sensemaking processes.

7.6.1 Geraldine

Geraldine is a tenured associate professor of physics at a state university. Her university is largely a commuter campus, and she describes her responsibilities as having fairly balanced research and teaching components. She identifies herself as a surface science nano-physicist. Geraldine is very reflective in her interview, and gives a beautifully clear example of the sensemaking that our participants are engaging in as they discuss theory with us. Throughout the course of this interview, Geraldine engages in sensemaking to develop an explanation of how theory is connected to her practice as a physicist. Also, contrary to my initial expectations, Geraldine demonstrates a remarkably consistent understanding of what theory is and how researchers engage with it in both physics and education research.

Theory in physics

When asked how she engages with theory in her research Geraldine pauses for a moment, and then begins by describing her work with surfaces. She comments “a lot of my theory was developed when I was a graduate student in understanding what are the fundamental forces, what are the fundamental interactions going on there. And now a lot of what I’m working with is a little bit less with theory, but more saying okay, I think that this would cause those kind of interactions to be more prevalent, and so what I will see on the surface is this.” She goes on to explain that surfaces aren’t really flat when you zoom in on them, they’re a complex mix of atoms and broken bonds. As she continues discussing her research into surfaces she goes on to say “a lot of my [theory] is just underpinning and background of understanding what impacts molecular and atomic absorption, but what I’m doing on a day-to-day basis is more I’m trying to use rows to make molecules line up. And so I’m not really dealing with the theory on a day-to-day basis.”

Unpacking this we can see that Geraldine isn’t framing theory as something she does.

As she is discussing theory here, she focuses on fundamental theories of physics that she learned about in graduate school. When discussing her current research she argues that she doesn't really work with theory, rather she works with ideas and assumptions about how atoms and bonds will behave on freshly cut surfaces. She acknowledges that she has a lot of "underpinning and background" that goes into her overall understanding of the situation, but doesn't consider this to be theory that she uses day-to-day.

Probing deeper into her use of theory, Geraldine admits that theory comes up in publications and presentations "because we have to use it support what's going on, to support what we see", as she continues along this line however she drifts away to discussing her collaborations and returns to discussing theory as a background idea, not something that she engages deeply with as part of her research. She specifies that she doesn't see herself as a theoretical physicist, or involved in the work of producing theory "I don't think of myself as a theoretical physicist, in the way that I'm not developing necessarily new theories, but I am adding new information and helping flesh out things that we already know" and goes on to say that she's thinking about the question "How can I add new pieces to this puzzle and develop this a little bit further?"

Through her discussion of theory we can see Geraldine attempting to connect her ideas of theory as big overarching frameworks for the work that she does, and this idea that what she works with every day are little pieces of information and assumptions. As she works through these pieces and has to explicitly confront her own explanation, Geraldine comments that her idea of theory is tied up in "this idea of theoretical physicists and these are the people that sit in their offices and think the really deep thoughts" and that she isn't that person. She says that she's now being forced to confront her biases about what theory is in physics. Here I argue that Geraldine has noticed a gap in her knowledge and reasoning, this idea that theory exists only the background doesn't align with the reality that she is generating information that will eventually contribute to theory. As she is putting these pieces together she goes on to build a working explanation of what theory is that connects these pieces "I think of theory as kind of the framework that supports everything, and you're always trying to develop it or trying to contrast it and then explain why the theory wasn't correct and how

we can tweak it and make it better. Usually most of us aren't creating theories out of new cloth. We're developing them and furthering them and helping tweak them and helping... Yeah." Here Geraldine describes theory as a framework that supports everything, that is subject to continued testing and scrutiny, and is developed slowly through small advances and new discoveries. This new explanation comes as a result of Geraldine's sensemaking about her own work and how theory is related to it.

Finally Geraldine is asked to explain how she conceptualizes of theory in physics. In attempting to answer this question Geraldine struggles for a bit "Do I have to? In that sense, I like understanding how the world... I like just seeing what..." Geraldine stops twice to rethink, and reframe how she is answering the question. At both pauses she looks away from the camera and frowns in thought before continuing. She continues after the second pause with "I like understanding why things come together, what happens, and so in that sense, I mean, my day-to-day research, I don't think of it as being fundamentally theoretical." Geraldine has temporarily abandoned the question of what theory is, and has moved into reflecting on her research practice. She continues this discussion by saying that she isn't quite an applications person, and she also isn't a theoretical person. She goes on to say that "So if I do this little bit, then the next person can do that little bit, then the next person can do that little bit" explaining how she sees science as a collective sort of puzzle building effort, where each person contributes some pieces to extend the theories. Once again Geraldine is connecting pieces of her understanding of her own research practice, to what theory is, tacitly building an image of theory as a great patchwork of ideas.

When I asked Geraldine about her understanding of theory in physics, I didn't get the clear and concise responses I expected. Frankly I expected this part of the interview protocol to involve fairly short, concise, and confident responses around how theory in her own discipline is used, how she engages with it, and what it is. Instead Geraldine encountered a gap in her own knowledge, and had to spend time bringing out many different ideas and parts of her knowledge to first assemble all of her thoughts about theory, before attempting to connect all of those pieces and synthesize an explanation of theory to answer my questions. As Geraldine worked through a process of sensemaking about theory in physics, it

became clear that she didn't have a well articulated cognitive structure for explaining the connections between her practice and theory in physics. This cast the struggles of EDBERs with education research theory in a new light: perhaps EDBERs didn't struggle with theory in education research just because it was different from their home disciplines. Perhaps they are struggling with theory in education research in part because they lack a pre-existing, well articulated cognitive structure connecting their practice to theory.

Theory in education research

When first asked whether she has encountered theory in education research, Geraldine responds by discussing what theory has to say about how we should teach better, or what curricular and pedagogical tools to use. She doesn't immediately consider the problem of how theory could shape her research in education. This is a very common response among disciplinary faculty who are becoming involved with education research. As part of this discussion she tells us the story of how she became involved in the PEER program.

Following Geraldine warming up to the idea of theory in education research, I ask her if she has considered how theory might be used to support her education research projects. Much like in physics, she doesn't answer right away, but instead first begins laying out some of the work she is doing in education research. She discusses how she has a project implementing reading and responses as part of course curricula. She's been trying to implement the use of Perusal into her course for this, and she's been collecting some data to see if there are different impacts on students based on demographic. She ends up laying out the entire project, discussing methods of data collection that she is using, and touches upon the idea of theory when she says "And I'm looking at a lot of things through this DEI lens, so did it help everybody, or did it just help the [white, male students]?" Although this question doesn't directly reference any theory, buried beneath it are modern ideas about how classroom practices often disproportionately favour white, male-presenting students. The connection to contemporary theories of diversity, equity, inclusion, and belonging hover just beneath the surface of her discussion.

Pushing her to elaborate on what role theory plays in her work, Geraldine responds

“Theory is that if students come prepared to class, they have the foundation to dive deeper into the coursework, and then in the end, they will ultimately learn.” This isn’t a named theory, however Geraldine references Mazur, a researcher who has done similar work. She talks about how the theory says that is students do their readings before coming to class, then they get more out of class. Here Geraldine is connecting theory to her research practice, in that it is informing the questions she is asking, or hypotheses that she is testing.

Note that Geraldine’s attitude toward theory in education research is somewhat different than her attitude towards it in physics. She doesn’t compare theorists to experimentalists, nor does she claim that theory isn’t something that she does. Here she is also connecting the word theory to literature, the validated claims of previous researchers, and smaller local theories about student comprehension and its relation to reading assignments. This is different from physics where she saw theory mostly as the big, overarching frameworks, and the smaller claims, principles, and local theories that she used in day to day work weren’t classified as theory in her discussion.

Summary

Having discussed theory in both physics and education research with Geraldine, I asked her to explicitly compare theory in physics and education research. Geraldine tells us “The physics theories are the ones that are already nailed down.” She then contrasts this with education research “Because there’s a lot of studies that say if you come to class prepared you will do better. But how can we encourage that preparation, and is that preparation going to be reading, or is that preparation going to be something else, or does that preparation look the same for all students? And I think those are still questions fundamental to the theory maybe.” Finally she sums up “I think of physics theory as being a lot more established, and education theory as more being developed.”

In spite of what she tells us here in her comparison, she discusses a lot in common between physics and education research theory. Throughout her discussion of physics theory she talks about this tension between well established major theories, and the smaller pieces of knowledge that she uses and develops in her work. The hypotheses and principles that

guide her experimental choices, and the small pieces of knowledge that she contributes to the literature feel reminiscent of her description of the pieces of knowledge that are missing from theory on pre-class reading preparation. Note that when she is discussing education research with us she frames her contributions to education research in terms of the smaller pieces of the conversation she is contributing. Although she discusses them differently consciously, in both education and physics research Geraldine recognizes the importance of major theory in guiding her overall research questions and situating her work within the broader field. Further she acknowledges that what she does is produce smaller pieces of uncertain and knew knowledge that exist at the edge of existing theory, and build on other research to supplement and grow that theory.

7.6.2 Robert

Robert is a sessional instructor at a large research university, who just graduated with his PhD in physics a little over a year ago. His responsibilities are entirely teaching related, and he is responsible for teaching a couple of sections of undergraduate physics courses. He works closely with the course coordinator, who is very open to feedback but ultimately has control of the course content and final exam. Robert is a theoretical physicist by trade, which makes him a very interesting case in my study on theory. Robert demonstrates a very different understanding of theory than his experimental counterparts within my study population. Robert demonstrates a pure view of theory in physics, and its purpose, but also an extremely consistent and insightful description of his expectations for theory in education research.

Theory in physics

Opening with the question of how he has engaged with theory in his research, Robert responds that he new early on that he was “a terrible experimentalist” and describes his dissertation work as being “all around theory”. He goes on to describe this work as “So equations, a little bit of data, analysis, basically thinking about how based upon my as-

sumptions what can I describe about the universe, and can we actually test this”, giving us a surprisingly nice working definition of theory before we even begin the discussion. Although he certainly doesn’t frame it as a definition of theory, and it’s not a complete definition, Robert’s casual and easy description of what theory in research looks like is quite different from Geraldine’s effortful construction of a definition of theory.

I ask Robert to elaborate on his work, and so he continues by explaining that he studied black holes. In particular he was curious about measuring gravitational waves “When two black holes orbit one another they emit waves. We call these things gravitational waves.” As he is discussing gravitational waves he explains that different black holes produce different frequencies of detectable waves, and that our current detectors are highly frequency limited, making many black holes invisible to them. As such he was investigating using the possibility of vibrations in ultra-cold gases to measure gravitational waves “It turns out, in principle, these waves come to earth, they cause a gas of atoms to slightly vibrate. If we can detect something about the vibrations, then we’re able to work backwards and say something about the gravitational waves so then something about the black holes that emitted these waves. So that was the theory part of my research.” Here he is explicitly calling his work theoretical research. He wraps this up by commenting “I also looked at how do we... Is it possible to implement this in the lab?” and briefly explains that it would be very difficult and expensive to do, showing that he’s actually very knowledgeable about experimental design, even if it isn’t his area of specialty.

It’s worth noting that most of what he has discussed is actually potential experimental conditions and general relativistic concepts. In this sense his discussion is very similar to how Geraldine described her research, in terms of experimental conditions and chemical bonding concepts. Never the less, while Geraldine claims that her research doesn’t directly involve much theory, Robert frames his research as being theoretical. I don’t wish to argue that either of them is wrong in their framing, rather I find it interesting that they both provide such strongly holistic descriptions of their work, even though they don’t necessarily say their work is very holistic (i.e. Robert calls his work theoretical, and Geraldine calls her work experimental, in spite of their tacit recognition of deep ties to the other half of physics).

Pushing Robert on what role theory plays in his research he explains that theory informs what questions he can ask, and how he asks them. He goes on to say “So what theory allows us to do is to develop a way of understanding the universe and hand it off to experimentalists to basically say is this way correct or not? If you find something, great, that tells us we’re on the right track. If you don’t find, that’s also interesting because it means [...] we need to go back to the drawing board, and hopefully the next iteration allows us to be able to more accurately describe or predict whatever phenomena is or isn’t being seen in the lab.” He describes theory as an iterative process that is informed by and built upon experimental results. This is similar to Geraldine’s discussion of producing pieces of knowledge that expand existing theory. For Robert theory both informs the questions he can ask, it is also the subject of his research, and it’s development is one of the goals of his research. These goals rather closely align with the roles of theory that Geraldine discusses.

Finally I ask Robert to tell me what theory is in physics. Robert is fairly quick on this, he says that he would describe theory in a couple of ways, first “ When we say something like the theory of general relativity, it’s the best way that we have of describing the universe, describing gravitational interactions. General relativity is why GPS works. If we didn’t include general relativity, we wouldn’t have GPS. So that’s what I would describe as theory if I use theory as a capital T.” Here Robert acknowledges that there is a form of theory which is highly formalized and established. On the other hand he continues “If I describe theory more in a colloquial sense, using theory with a small t, I would describe it as starting from an underlying set of concepts, underlying set of assumptions, as few assumptions and concepts as needed, in order to describe a certain set of phenomena.” Here Robert describes something more in line with Geraldine’s small pieces of knowledge, hypotheses, and principles that she uses in her work.

Robert’s discussion of theory in physics is very interesting because it has so much in common with Geraldine’s description, while at the same time not really displaying the same features of sensemaking. While Geraldine definitely spends much of her time connecting concepts and ideas to build an explanation of theory’s connection to her practice, Robert’s responses are quick and practiced. It’s clear from discussion with Robert that he thinks

explicitly about theory, both big and small, global and local, and it's roles in his project quite frequently. This is very different from Geraldine who thinks mostly about smaller local theory (what Robert calls 'little t' theory) explicitly in her work (and she doesn't call it theory), and doesn't usually spend much time explicitly considering larger, more global theories ('capital T' theory) in her daily practice. Of course, Robert is a theorist and Geraldine is an experimentalist, so the differences in how they use theory aren't that surprising. The interesting difference is Robert's understanding of theory as operating with different levels of formality at different scales, versus Geraldine's characterization small bits of information as not really theory.

Theory in education research

Robert took a few courses during his PhD about teaching university undergraduates. Here he encountered some theory around how students learn, and how we teach better. He also describes conducting a literature review around teaching practices "So I guess during the research paper, it was more along the lines of experimental verification of different teaching techniques. But behind each of the teaching techniques, there was a bunch of educational theory underlying it. And then educational theory was being used to essentially do statistical analysis and say why these teaching techniques might be better than [standard lecture]." Robert notes that there was substantial theory within the paper guiding the analysis and explanation of why and how the pedagogy presented helps students learn. Elaborating on what the theory in education research projects that he read about was for Robert says "So the theory, I guess, was working more in the background of why students were performing better [...]" For Robert, theory in education research seems to playing a background or supporting role, which isn't as direct or clear cut as theory's role in physics.

Asking Robert to explain the role of theory in education research he says "So yeah, my understanding with educational theory would be... Yeah. Something that would explain why students might behave one way versus another way, why one course of action might be better than another course of action. So that's what I would describe... That would be how I'd understand the role of theory in educational research." He pauses twice here as he reflects

on what he is saying. Although he is less comfortable with theory in education research, his explanation is actually quite consistent with his idea of theory in physics. Theory is still an explanation of a given observed phenomenon, and it has a certain amount of predictive power, the ability to tell us what kinds of actions will have what kinds of outcomes.

The parallel's between Robert's understanding of theory in physics and in education research become clearer as he discusses how he has struggled with theory in education research. He explains how theory in education research contains a lot of moving parts, and he's not always certain how to account for differences in experiments. Robert notes "you have all of these other effects that go into informing the theory, but I don't really have clear understanding of how one can correctly account for the effects." and continues "And there's just a bunch of other variables that are completely out of your control that in a physics theory I can say, here are your assumptions, under these assumptions we can always test these assumptions, and I can say, okay, is this theory actually robust under different situations. But with education, the situation's always changing that, sure, you show that a partially flipped classroom may work well in this setting, so it's something that's worth looking into, but I have no guarantee that your theory that you've described in this context will transfer over to my specific context." Robert as a theoretical physicist is used to being able to define and control for the many assumptions and variable involved in physics theory. In education research we are dealing with humans, and highly variable contexts, there are simply too many variables to be able to control them all, and generalize theory to all contexts. Robert isn't sure how to handle this. That said, Robert has drawn yet another parallel between physics and education theory: the presence of variables and assumptions to be recorded, and controlled if possible.

Summary

In wrapping up the conversation, Robert describes theory in education research and physics as significantly different because of the researcher's role in the project. Robert explains that "The theory describing an electron doesn't really care about whether we can write down an equation or not. An electron does what an electron does. In education theory,

well, you don't have electrons, you have people with actual feelings, and what you do as an instructor directly influences the entire experimental setup, the entire, well, context behind your theory." He elaborates on this saying that in education research your actions as the instructor fundamentally alter your observations of what is happening in your class. If you fail to report on something that you do, either because you thought it wasn't important, or more likely because you simply overlooked it, this could actually be a critical omission. So theory in education research and physics are different in Robert's view because the researcher's behaviour and understanding actively changes how the system under scrutiny works.

Robert also sees some important distinctions in the importance of theory in physics and education research. Robert says "I would say, so for physics if you don't have any theory whatsoever, you are not doing physics." On the other hand, Robert goes on to say "I'd say, education research, the theory would be there allowing you to come up with a testable hypothesis, but you don't necessarily need to know the intricacies of why active learning is better than passive learning in a whole bunch of situations." Robert doesn't say that education research can be done without a theory, but he does think that in education research you could get away with just a surface level understanding of a theory to help guide your hypothesis. On the other hand he goes on to explain that in physics you really need to know your theory in depth to conduct your research.

Robert presents a very detailed view of theory, and clearly has the benefit of having spent a lot of time thinking about what theory is and how it is used. This sets him apart from Geraldine, who has more trouble at first engaging with theory. Where Geraldine had to connect her various understandings of theory to generate an explanation of how she conceptualizes theory, Robert had already done most of that work and didn't spend time on sensemaking. However, in other ways both Robert and Geraldine were very similar, demonstrating many similar ideas about the role of theory in research, the pieces of knowledge that are linked to theory and their projects, and what theory ultimately is.

7.6.3 Jacob Junior

JJ is an assistant professor of educational leadership at teaching focused institution. His institution teaches primarily undergraduate students, though they also offer some masters programs and doctoral programs. JJ has roughly even expectations from his institution for teaching, research, and service, although he admits that in general most of his time is spent teaching (perhaps 50%) with about a third on research, and the remainder spent on service. JJ is primarily responsible for overseeing graduate and doctoral students.

JJ is of interest here because he has a formal background in education (adult learning and leadership), and his career has continued to focus on education and leadership. He is not new to education research, rather he is very experienced. As such, he presents a sophisticated view of theory in education research which provides a useful contrast with Robert and Geraldine. JJ's understanding of theory also gives us some insight into the kinds of thinking we might hope our EDBERs will move towards as they learn about theory.

In the early parts of our interview, JJ discusses his work very briefly. JJ frames his work in educational leadership as being about understanding "how could people be change agents within their institutions wherever they may be." JJ studies how we educate leaders and how we shape educational institutions of all types through their leadership. JJ is particularly interested in a framework called learning cities "learning cities in [the original authors's] concept is more around economic development, which it includes this, but I look at it more as a more comprehensive way that includes economic development, education, lifelong learning, but also things like the arts, recreation, public health, and so on." JJ is very interested in taking a holistic and systemic view of education. How do we understand education as part of a larger system, and do we understand the different kinds of systematized learning that occur within that system (for instance not just schools, but also on-the-job training, community education, informal education initiatives).

Having grounded us in the kinds of work that he does, I ask JJ what role theory plays in his research. Interestingly, JJ responds to this very differently from Geraldine and Robert. While Geraldine and Robert engage with how they do (and do not) use theory in their

projects, JJ says “Oh man. Theory, well, let’s back up for a minute. So I think of theory in the context of a philosophy.” JJ begins by talking about how he defines theory. While Geraldine, and Robert both wanted to start by talking about how theory is used, JJ actually preferred to start from the definition. He goes on to explain his notion of theory to us “So if we go into a funnel for a minute, I would say philosophy is first, then we get into theory, and then we might later on get into like, let’s say, model, and then we get into certain kind of principles, and then practices, right?” JJ here is presenting a sophisticated idea of theory as part of a larger conceptual picture that grounds his research.

JJ goes on to say “So philosophy is the real structure there, and the theory then is a way to make more sense of that philosophy.” as our discussion continues he characterizes philosophy as a worldview, and theory as a way of contextualizing and actualizing the principles of his worldview. “the philosophy is very broad, then the theory tries to put a, makes more sense of how this philosophy can be applied” and goes on to say that theory “helps us with certain language, it helps us with certain terms, it helps us with certain examples. And then once we get some sense of that then we may be able to create from that theory models”. JJ is has described a sophisticated hierarchy of ideas with his philosophy or worldview at the top informing his practices and interests, and theory allowing him to actualize that philosophy within his research, finally leading to the possibility of creating concrete models of what is occurring within the world.

Regardless of the correctness of JJ’s model, we can see that JJ already has a sophisticated understanding of what theory is in the context of education research. Further, JJ didn’t have to spend time sensemaking about what it is or how it connects to his practices. He traces the idea of theory from the top down and does so in a confident and practiced fashion.

7.6.4 Sensemaking summary

I have now introduced you to three different people: Geraldine, Robert, and Jacob Junior. These three were interview participants who each engaged with questions about how they use theory in research in markedly different ways. Geraldine, who is an EDBER and also

has a very experimental background found it very difficult to connect her understanding of theory with her research practice. Robert, an EDBER with a theoretical background, found that connecting theory to his research practice was an easy task, but found that understanding theory in education research was more difficult. Finally, JJ does have to consider his response, but only because he is trying to word it appropriately, he already has a very sophisticated understanding of what theory does and it's role in his research practice.

During her interview we can see Geraldine sensemaking about theory and it's role in research, not just in education research, but in her home field of physics. She notices early on that there is a gap or inconsistency in her thinking about theory. She acknowledges the big theories of physics, but has trouble connecting those to her daily research practice. Through the course of the interview Geraldine goes through a process of marshalling ideas, bringing them together, forming a coherent picture of how they connect and interact, and finally presenting an explanation of how theory fits into her practice. I don't give her much additional information during the interview, so she still lacks pieces of the picture that we see in JJ's explanation (for example Geraldine doesn't consider the idea of philosophy or worldview explicitly). That said, by the end of the interview Geraldine has clearly encountered an inconsistency in her thinking, engaged in a process of idea generation and connection, and built an explanation to try and address that inconsistency, that is to say she has engaged in sensemaking. Further her explanation of theory that she has developed has ideas of connecting broad ideas and ways doing things to intermediate explanations to the nitty gritty details of her work. This has much in common with JJ's explanation of actualizing worldview in research.

During Robert's interview we notice Robert doing markedly less sensemaking. He does marshal ideas, and connect his ideas to theory, but he doesn't need to do this in order to build an explanation of how theory connects to his work. Rather Robert already has very clear notions of what theory is, how it connects to his work, and the boundaries of theory. As we move into education research however, things become more muddy. Here he begins to pause and hesitate as I ask him to explain what theory is doing in education research. He spends more time marshalling ideas before bringing them together to explain

theory's role in education research. Ultimately though his understanding of theory here is consistent with his physics understanding. Mostly, he expresses unfamiliarity with theory in education research, being less uncertain about what it is used for, and more uncertain about the details of particular theories. Robert is especially concerned about education research theory's ability (or lack thereof) to completely account and control for variables in a study.

JJ provides our most sophisticated and clear explanation of theory and what it is and is used for in education research. Given that he is a career education researcher, his confidence with theory in education research is unsurprising. Important features of JJ's understanding of theory include his idea that there is a high level philosophy which informs your decisions about theory, and that theory is a way to mediate between that and situations in the world. Theory gives us the means to contextualize and actualize pieces of our philosophy within research. Geraldine and Robert both actually hit upon similar ideas of theory as connecting high level ideas to observable and measurable interactions. A common thread for all three people is that theory is primarily a tool to mediate between ideas and implementation, and to connect our ideas to those of other people.

Perhaps most interestingly Geraldine's sensemaking about theory led her to construct an understanding of theory that contains most of the significant features of JJ's expert understanding. She did this without me teaching her any additional content, and without needing to see and learn about particular education research theories. This suggests that the most critical work of a module to teach EDBERs about theory isn't to teach them particular theories, but to give them opportunities to sensemake about what theory is, and what it does in the context of their own research.

7.7 Conclusion

EDBERs transitioning into education research often bring substantial knowledge and research experience from their original sub-disciplines. As they enter education research they are in the process of transferring that knowledge to education research, and attempting to address remaining gaps in their knowledge. There are many aspects of education research

that they wish to learn about including literature, field scope, methods, theories, paper publishing, ethics and paperwork, and more. Among these many topics EDBERs understanding of theory stood out to me as particularly interesting because they asked not only anticipated practical questions (like what theories exist and how do I use them), but also unanticipated fundamental questions about the definition and role of theory in research.

In order to understand their concerns so that we could better address this at PEER I analysed interview data from PEER-Chicago 2021 to get a sense for the questions that EDBERs had about theory. From this analysis I developed two major categories of struggles with theory: practical concerns and principled concerns. These categories then became the foundation of a new module about theory at PEER. However a question remained unanswered about *why* EDBERs were struggling with such fundamental aspects of theory in research.

To address that question I conducted a second round of interviews before and after PEER-Chicago 2022, where we implemented the newest iteration of the Theory module. These interviews focused on understanding participants reasoning about theory before and after engaging with theory at PEER. During these interviews it became clear that participants display very different conscious levels of understanding about the role and definition of theory in their research, both within their home discipline and within education research. As participants notice these gaps in their understanding they engage in a process of sensemaking to build an explanation of theory as part of their research. Among the case studies here, we can see that by engaging in this sensemaking process one of our participants, Geraldine, was able to build an understanding of theory that was closer to JJ's expert understanding.

In order to most effectively support EDBERs and developing professionals in general, it is critical to first assess their understanding (as I did in the first part of this chapter). This makes it possible to construct interventions targeted at their needs. In the second part of this chapter I examined EDBERs sensemaking, a mechanism by which they overcome gaps in their knowledge. Geraldines remarkable success in building an explanation of theory, even before formal training at PEER, suggests that pushing EDBERs to engage in this process of sensemaking is highly effective in helping them develop knowledge in a new (to them)

research field.

Chapter 8

Conclusion

Discipline based education research is becoming more common at institutions throughout the United States. DBER fields are founded in the notion that education research should attend to the cultural and disciplinary ideas inherent to different disciplines. Due to the strong disciplinary focus, many of the researchers who become involved in DBER have disciplinary backgrounds, and not education backgrounds. This means that PD opportunities are needed for researchers who are new and emerging within DBER. In this dissertation I have examined some of the needs of these EDBERs, the ways in which they engage with DBER CoP, and some of the ways in which members of DBER CoP may support them.

My work throughout this dissertation has been grounded in the professional development for emerging education researchers (PEER) program. PEER is a program that provides fundamental research skill building opportunities for EDBERs, focusing on a responsive and community based approach to skill development. At PEER EDBERs are afforded opportunities to develop their own research projects with support from experienced facilitators. PEER offers learning opportunities in a variety of topic areas, and grounds that learning in participants' own research projects and interests. During the last few years I have published several papers with my coauthors from PEER that have formed the basis for this dissertation

- *Community Roles for Supporting Emerging Education Researchers*, 2021⁴⁹
- *Emerging Mathematics Education Researchers' Conception of Theory in Education Re-*

search, 2022⁸⁹

- *Gatekeeping of Emerging Discipline-Based Education Researchers*, 2023⁸⁷
- *Emerging Education Research Practitioners and Theory*, 2023³².

This dissertation has examined the needs of EDBERs, through the lens and context of the PEER program. I have examined the ways that community members support EDBERs in their journeys, the ways that EDBERs struggle to access our research communities and what we might do to mitigate that struggle, and particular subject matter within education research that EDBERs struggle with. As the dissertation draws to a close, I will take time to reflect on the different parts of this research, and discuss what is missing, what I would like to learn next, and work that could yet be done.

8.1 Community roles which support EDBERs

In chapter 4 I took up the Communities of Practice perspective to examine how EDBERs become involved in education research, and build their education research skills. Thematic analysis of interviews with EDBERs led to three roles that members of a community may fill to support the needs of EDBERs. I grounded this discussion in the PEER program, examining how those three different roles manifest in PEER's CoP. There were peers, subject matter experts, and project managers. Two of those roles represented different types of mentors.

In reflecting on the careers of a typical researcher it makes sense that these three roles are not the only roles that are important to a researcher's career development. Although it didn't appear in our data, most people at various stages of their careers have mentees, and this has been identified as important in the literature. (see chapter 2 for more information on factors influencing career development). Reflecting on my own career I can say that mentees have been an important part of my development, and so too have my collaborators (some of whom were peers, some of whom were mentors, some of whom were mentees). One might

even imagine that there are other roles as yet unspecified that are a significant part of career development.

Although my work stopped at identifying three roles, there wasn't a principled reason to stop there, that was merely the limit of what was available in my data. Future work in this vein should probe to see how these roles might expand. What other roles might already be implicitly or explicitly defined in the literature? How do these roles impact EDBERs and their career development? How can PD programs be designed with these various community roles in mind to better build CoP for EDBERs to participate and learn in?

On the PD side, lessons to be taken away from this are the significance of a community minded approach to PD. Understanding the roles that people play within a given CoP allows us to better understand how to structure programs to get the greatest benefit for participants. Conjecture mapping as a method of building theoretical and empirical research results into a program allows us to bridge the gap between research and practice.

8.2 Belonging to a community

Understanding the roles that community members can fill to support EDBERs perhaps begs the question of why we should take a community oriented approach to PD at all. In chapter 5 I examine the importance of belonging to a person's persistence within a given community or group. People seek a sense of a belonging in all aspects of their lives, it is a basic human motivation that pervades much of human decision making. As people become involved in education research, supporting them in developing a sense of belonging in turn helps them to persist. It also gives us the opportunity to make EDBERs part of established education research CoP and positively influence the quality of work that they do. By expanding our CoP we expand the range of perspectives available to our field.

The basic notions of belonging here were all visible in my data, but my data collection wasn't originally focused on belonging as an idea. Rather, the notion of belonging emerged as an important theme within the data. Future work could target the idea of belonging and how EDBERs develop a sense of belonging to develop a more complete picture of belonging

among EDBERs.

Further work also remains to be done in connecting notions of belonging to PD practice. It was beyond the scope of my work to establish how these aspects of belonging are supported within a particular PD program. Although I did discuss how peers, subject matter experts, and project managers can support these aspects of belonging and those three roles were grounded in the PEER program in chapter 4, conjecture mapping could be used to examine how developing a sense of belonging is embedded within a PD program. Since PEER attempts to establish a CoP as an explicit goal, this research would be particularly valuable to PEER as it could result in stronger connections between EDBERs who attend PEER.

8.3 Gatekeeping within DBER

Chapter 6 was one of the most interesting projects for me personally. Understanding how information and participation within a community is controlled, and how we balance openness and quality control within our communities is a very interesting topic to me. The issue of gatekeeping in DBER is an interesting case of the tension between being welcoming to new people, and maintaining the boundaries of a community. In chapter 6 I argue that more can and should be done to mitigate the negative impacts of gatekeeping on EDBERs.

It is important to note that I don't mean to say that gatekeeping is inherently bad, though it has received a negative connotation in the literature and everyday use. Gatekeeping includes such activities as peer review, qualifying exams, thesis defenses, job interviews, and editing. None of these things are inherently bad, quite the contrary these are all practices that are meant to ensure quality, safety, and success. Jargon is another topic that came up as being related to gatekeeping, and once again this not necessarily a bad thing. Jargon is an important part of how we streamline and standardize information transfer. In short, gatekeeping is a normal and important part of how any community operates.

Having said that, increasing diversity, equity, inclusion, and belonging (DEIB) is important to many contemporary communities. For education research, and DBER in particular, having a wider variety of voices involved has benefits for the community including broader

perspectives, and a higher capacity for research output. Thus, while maintaining the integrity of our research CoP is important, we must strive to do so in a way that encourages growth.

The practical upshot of this is that DBER CoP need to balance gatekeeping with welcoming and nurturing new members. While recognizing the positive impacts of gatekeeping, we must still be cognizant of and attempt to minimize the negative impacts. For this I propose that groundskeeping is a complementary idea in line with contemporary research on DEIB and aligned with the goal of promoting community growth while maintaining community integrity.

Further work on this should include a more robust analysis of specific gatekeeping mechanisms and how they impact EDBERs. It will also be important to better understand how groundskeeping interacts with gatekeeping mechanisms and standard field practices. As a final thought, it would be interesting to consider how PD programs can foster groundskeeping habits and practices in attendees, and make attendees explicitly aware of the impacts and mechanisms of gatekeeping within their own communities.

8.4 Understanding theory in a new field

In chapter 7 I focus on how EDBERs are struggling with and reasoning about theory in education research. Using theory in research is one of many fundamental research skills that one needs to fully participate in a research field. I could have focused on other skills such as methods, analysis, literature reviews, collaboration building, etc. There are two reasons I chose to focus on theory: 1) because theory came up as a theme in my data, 2) because I thought the ways that EDBERs were struggling with theory were particularly interesting.

I started my discussion of EDBERs struggle with theory by discussing briefly what theory was, but people from education research fields surely noticed that there was much I left unsaid about theory. For instance theory, theoretical frameworks, frameworks, conceptual frameworks, worldviews, philosophy, theoretical perspectives, and theoretical lenses are all closely related concepts. I didn't bother to disambiguate these concepts, nor did I attempt

to define each one. EDBERs express confusion about these things en masse, and as such I treated them all under the broad umbrella of theory. It is beyond the scope of this work to disambiguate or define these topics, and in fact there is no general agreement in the literature on how these things should be defined or disambiguated.

My work continues by identifying ways in which EDBERs struggle with theory in research, moves into explaining how we have implemented a theory module in PEER to address those concerns, and finally discusses a deep dive into EDBERs sensemaking about theory. The work on sensemaking in particular was done after the initial development of the theory module, and future work should be done to examine how the theory module does or does not support EDBERs sensemaking about theory (and if not, how can it be reimaged to do so).

Further, although I have left issues of theory and its neighbouring concepts ambiguous, there is room in the literature for work disambiguating the various concepts surrounding theory and how they are used. It may be helpful to try and understand how EDBERs are trying to make sense of these concepts after they have engaged with the theory module. If such understanding can be developed, then it may be possible to include a discussion of these terms and how they may be disambiguated in future iterations of the theory module.

8.5 Goodbye

And now, dear reader, I have reached the end of this particular book. Thank you for joining me on this not-so-brief tour of my dissertation journey. I hope that this work has proven, if not illuminating, then at least interesting food for thought. Issues of how we engage with new communities as we grow and develop in our career have fascinated countless people and organizations, and for good reason. I hope you have seen some of those issues here, and will continue to think about community building as part of your daily life and practice.

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Appendix A

Interview Protocols

In this appendix are all of my interview protocols. They are listed in the following order:

- EDBERs Original Protocol
- Revised General Protocol
- Pre-PEER Interview Protocol
- Post-PEER Interview Protocol
- What is Theory Interview Protocol.

Set-up and Introduction

[Gallery view. Open up the Chat window, make it visible, and select Private Chat.]

"Hi, I'm **NAME**. Thanks for taking the time to talk to us today! **NOTE TAKER NAME** is primarily going to be taking notes, and may chime in at the end with some questions if we have time.

Just to refresh your memory, the goal of this project is to understand how we can better support new and emerging STEM education researchers. We are interested in talking to you because you have had experience with STEM education research. We would like to understand your successes, challenges, motivations, and needs in doing STEM education research.

Before we begin:

- [If consent form has been received] Thank you for sending us your interview consent form. Do you have any questions about the consent form or this project?
- [If consent form has not been received] Have you seen the consent form attached in a recent email? [Help interviewee find and review consent form, sign consent form, and email you consent form.] Do you have any questions about the consent form or this project?

With your permission we would like to record this interview to help us conduct more accurate data analysis. Can we record this interview?

- [Make sure in Gallery view; Check that recording has started.]
- Just to have your permission on the recording, do you agree to having us record this interview?

In order to protect your identity, we will use a pseudonym to refer to you during the study. Do you have a name that you would like us to use or would you prefer that we pick one? What pronouns would you like us to use for you?

As a reminder, participation in this interview is voluntary. You may decide not to participate at any time during the interview.

Great, thank you again!"

Interview Questions

Understanding participants thoughts on DBER

1. To help us get a better understanding of your position, could you share your obligations for research/scholarship, teaching, and service?
 - a. What counts as research/scholarship for the purpose of tenure and promotion?
 - b. How do your institution and department value STEM education research/scholarship?
 - c. How does this compare with your personal definition of success for STEM education research/scholarship?
2. What excites you about STEM education research?
 - a. You mentioned [XXX] in your pre-interview survey, tell us more about that!
3. How would you define STEM education research?
 - a. Do you believe you have conducted STEM education research? Why or why not?
 - b. [Optional follow-up] Do you think the STEM education research community would call what you're doing STEM education research? Why or why not?

Experiences in DBER

4. Could you tell us about some of your experiences with STEM education research?
 - a. [If they don't have any experience] What project would you like to do?
 - i. When you imagine doing that research, what does it entail?
 - b. Which classes have you tried this in?
 - c. Would scholarly communication from this work (like a publication) support your tenure package?

- d. In the pre-interview survey you mentioned [XXX], tell us about that experience!
 - e. Your CV says you were involved in [XXX], could you tell us about that?
 - f. Are there any other STEM education research activities you have led or participated in that you haven't shared yet (grants, data collection, analysis, program evaluation, etc.)?
 - i. Could you talk a bit about your role in [this activity]?
- 5. Which of those experiences felt the most successful to you? Why?
 - a. Were there any scholarship and/or teaching benefits that came out of it?
 - b. What was personally exciting about these projects?
- 6. When you started, how did you think others would react to your involvement with STEM education research?
 - a. Did these factors impact your work?
 - b. Did the actual reactions differ?
 - c. Did you have other personal, practical, or logistical considerations when you were initially considering engaging in STEM education research?
 - i. How did those considerations pan out in the end?
- 7. What has supported your success in STEM education research?
 - a. [If mentorship comes up] What does mentorship look like for you?
 - b. [If funding comes up] If you had funding, what would it be spent on?
 - c. In the pre-interview survey you indicated you are comfortable doing [XXX], how did you develop those skills? [Question 10]
 - d. You also indicated that you are unfamiliar/unpracticed with [XXX]. Do you feel this skill is important for your success in STEM education research? Why or why not?
- 8. From the experiences you shared at the beginning of the interview, which of them felt the most challenging to you? Why?
 - a. When you were first engaging with STEM education research, what challenges did you imagine having?
 - i. How does this compare to the challenges you encountered?
 - b. What was personally frustrating about these experiences?
- 9. How have you engaged with the STEM education research community?
 - a. Have you attended conferences?

- b. Presented your work?
- c. How successful have your attempts to engage with this community been?

10. What support would you have liked to help you overcome those challenging experiences?

Wrap up

- 1. [At 50 min:] I'm mindful of your time; do you need to go right at XX time?
- 2. Before we close, is there anything you'd like to add from the survey or during this interview, or anything we should have asked you about, but didn't?
- 3. Are there any questions that you have for us?

"Thank you so much for your time! This was very useful and we really appreciate it."

Set-up and Introduction

[Gallery view. Open up the Chat window, make it visible, and select Private Chat.]

"Hi, I'm NAME. Thanks for taking the time to talk to us today! NOTE TAKER NAME is primarily going to be taking notes, and may chime in at the end with some questions if we have time.

Just to refresh your memory, the goal of this project is to understand how we can better support new and emerging STEM education researchers. We are interested in talking to you because you have had experience with STEM education research. We would like to understand your successes, challenges, motivations, and needs in doing STEM education research.

Before we begin:

- *[If consent form has been received]* Thank you for sending us your interview consent form. Do you have any questions about the consent form or this project?
- *[If consent form has not been received]* Have you seen the consent form attached in a recent email? *[Help interviewee find and review consent form, sign consent form, and email you consent form.]* Do you have any questions about the consent form or this project?

With your permission we would like to record this interview to help us conduct more accurate data analysis. Can we record this interview?

- *[Make sure in Gallery view; Check that recording has started.]*
- Just to have your permission on the recording, do you agree to having us record this interview?

In order to protect your identity, we will use a pseudonym to refer to you during the study. Do you have a name that you would like us to use or would you prefer that we pick one? What pronouns would you like us to use for you?

As a reminder, participation in this interview is voluntary. You may decide not to participate at any time during the interview.

Great, thank you again!”

Interview Questions

Understanding participants thoughts on DBER

1. To help us get a better understanding of your position, could you share your obligations for research/scholarship, teaching, and service?
 - a. What counts as research/scholarship for the purpose of tenure and promotion?
 - b. How do your institution and department value STEM education research/scholarship?
 - c. How does this compare with your personal definition of success for STEM education research/scholarship?
2. What excites you about STEM education research?
 - a. You mentioned [XXX] in your pre-interview survey, tell us more about that!
3. How would you define STEM education research?
 - a. Do you believe you have conducted STEM education research? Why or why not?
 - b. *[Optional follow-up]* Do you think the STEM education research community would call what you’re doing STEM education research? Why or why not?

Experiences in DBER

4. Could you tell us about some of your experiences with STEM education research?
 - a. [If they don’t have any experience] What project would you like to do?
 - i. When you imagine doing that research, what does it entail?
 - b. Which classes have you tried this in?
 - c. Would scholarly communication from this work (like a publication) support your tenure package?
 - d. In the pre-interview survey you mentioned [XXX], tell us about that experience!
 - e. Your CV says you were involved in [XXX], could you tell us about that?
 - f. Are there any other STEM education research activities you have led or participated in that you haven’t shared yet (grants, data collection, analysis, program evaluation, etc.)?
 - i. Could you talk a bit about your role in [this activity]
5. And then what happened?

- a. Was that a good experience for you?
- b. What kinds of feedback did you get?
- c. What have been your prior experiences with other DBER people?
- d. Did you feel welcome? Did you feel like you could ask them basic questions?
- e. Do you still work on that project?

Perception of DBER

1. What is your current DBER community?
 - a. What kind of support do you have for your DBER work (community, supportive colleagues/administrators, financial etc..)?
 - b. Do you have any mentors?
 - c. What kind of support do you wish to have for your DBER work?
 - d. Are you planning to go to specific conferences in the near future (example: RUME)?
2. Have you
 - a. participated in a DBER conference or workshop?
 - b. worked on a DBER project with more experienced DBER people?
 - c. submitted a paper or poster in DBER?
3. What are some challenges you are encountering with the field?

Identity

1. How do you describe your current professional identity?
 - a. Do you describe yourself as a DBER researcher? Why or why not?
2. How do you relate different aspects of your professional identity to your DBER work?
 - a. How do you feel DBER relates to your teaching?
 - b. How does being an instructor help you be a better DBER person? How does DBER help you be a better instructor? Is this important to you?

Wrap up

1. *[At 50 min:]* I'm mindful of your time; do you need to go right at [XX time]?

2. Before we close, is there anything you'd like to add from the survey or during this interview, or anything we should have asked you about, but didn't?
3. Are there any questions that you have for us?

“Thank you so much for your time! This was very useful and we really appreciate it.”

Pre-PEER interview protocol

Set-up and Introduction

[Gallery view. Open up the Chat window, make it visible, and select Private Chat.]

"Hi, I'm NAME. Thanks for taking the time to talk to us today! NOTE TAKER NAME is primarily going to be taking notes, and may chime in at the end with some questions if we have time.

Just to refresh your memory, the goal of this project is to understand how we can better support new and emerging discipline-based education researchers as they engage in the PEER (Professional-development for Emerging Education Researchers) workshops. We would like to better understand your motivations, needs and expectations in participating in the PEER program.

Before we begin, do you have any questions about the consent form?

With your permission we would like to record this interview to help us conduct more accurate data analysis. Can we record this interview?

- *[Make sure in Gallery view; Check that recording has started.]*
- Just to have your permission on the recording, do you agree to having us record this interview?

In order to protect your identity, we will use a pseudonym to refer to you during the study. Do you have a name that you would like us to use or would you prefer that we pick one? What pronouns would you like us to use for you?

As a reminder, participation in this interview is voluntary. You may decide not to participate at any time during the interview.

Great, thank you again!"

Interview Questions

Interest in PEER

1. What brings you to the PEER program?

- a. Why did you apply to the PEER program? What drew you to participate in the upcoming PEER workshops?
- b. To help us get a better understanding of your background, could you tell us a little about your current position.
 - i. Are you in physics or mathematics or ...?
 - ii. What's the balance of teaching and research in your position?
 - iii. How big is your department? Is it math/physics/education/something else?
 - iv. Could you share your current obligations for research/scholarship, teaching, and service?
- c. What counts as research/scholarship for the purpose of your career advancement?
 - i. tenure and promotion?
 - ii. thesis/dissertation completion?
- d. How does your current institution and department value discipline-based education research (DBER)?

Interest in DBER

2. We would like to discuss or elaborate on your interests in DBER.
 - a. What is your background in DBER?
 - b. Why are you interested in DBER? What is exciting about DBER?
 - c. How does DBER fit in your future professional goals?
 - d. When you imagine doing that research, how do you imagine it?

Experience in DBER

3. Could you tell us about some of your experiences in DBER?
 - a. You indicated that you had
 - i. some experience with DBER via [XXX]. Could you talk about your role in [XXX]? Tell us about that experience. What did you imagine would be the benefits going into this?
or
 - ii. minimal experience with DBER.
You noticed a problem. How did you notice it? What prompted you to try to fix it?
How do you envision conducting a research project around [activity]? What do you imagine would be the benefits going into this project?
 - b. Have you:
 - i. attended any conferences or workshops?

- ii. presented your work?
 - iii. written any papers?
- c. Are there any other DBER activities you have led or participated in that you haven't shared yet (grants, data collection, analysis, program evaluation, etc.)?
 - i. Could you talk a bit about your role in [this activity]?
- d. What do you hope to accomplish with DBER?

Expectations from participation in PEER

- 4. What are your expectations? What do you hope to gain from your participation in the PEER program?
 - a. in a practical sense (create collaboration, find an advisor(s), develop a specific skill..)?
 - i. What does mentorship/collaboration look like for you?
 - b. on a personal development level (outlook/perception of DBER ...)?
 - c. other factors/considerations?
- 5. What do you want PEER to look like for you?
 - a. What do you envision your experience at PEER to be like?
 - b. What kinds of things do you think you need to bring with you to be successful at PEER?
 - c. What do you hope you will take away at the end?

Perception of DBER

- 6. What is your current perception of the DBER field?
- 7. What is your current DBER community? What kind of support do you have for your DBER work (community, supportive colleagues/administrators, financial etc..)?
 - a. Who in your community do you talk to about your current or future research?
 - b. In what ways does your current community support your research goals?
 - c. Are there any other supports (e.g to materials, training etc) that would have been beneficial when
 - i. you wanted to get started in DBER projects?
 - ii. you faced challenges in DBER projects you've been part of?
 - d. Have you had interactions with the DBER community (conferences...)? What has this experience been like?

8. How do you describe your current professional identity?
 - a. Do you describe yourself as a DBER researcher? Why or why not?
9. How do you relate different aspects of your professional identity to your DBER work?
 - a. How do you feel DBER relates to your teaching?
10. What else would like us to know about you at this stage?

Wrap up

1. *[At 50 min:]* I'm mindful of your time; do you need to go right at [XX time]?
2. Before we close, is there anything you'd like to add or anything we should have asked you about, but didn't?
3. Are there any questions that you have for us?

"Thank you so much for your time! This was very useful and we really appreciate it."

Post-PEER interview protocol

Set-up and Introduction

[Gallery view. Open up the Chat window, make it visible, and select Private Chat.]

"Hi, I'm NAME. Thanks for taking the time to talk to us today! NOTE TAKER NAME is primarily going to be taking notes, and may chime in at the end with some questions if we have time.

Just to refresh your memory, the goal of this project is to understand how we can better support new and emerging discipline-based education researchers as they engage in the PEER (Professional-development for Emerging Education Researchers) workshops. We would like to better understand where you are after participating in the PEER program.

Before we begin:

Do you have any questions about the consent form or this project?

With your permission we would like to record this interview to help us conduct more accurate data analysis. Can we record this interview?

- *[Make sure in Gallery view; Check that recording has started.]*
- Just to have your permission on the recording, do you agree to having us record this interview?

In order to protect your identity, we will use a pseudonym to refer to you during the study. Do you have a name that you would like us to use or would you prefer that we pick one? What pronouns would you like us to use for you?

As a reminder, participation in this interview is voluntary. You may decide not to participate at any time during the interview.

Great, thank you again!"

Background

1. For new interviewees:

- a. Tell us a little about your current position.
 - i. Are you in physics or mathematics or ...?
 - ii. What's the balance of teaching and research in your position?
 - iii. How big is your department? Is it math/physics/education/something else?
- b. Before PEER, what was your background in DBER?
- c. How does your department treat DBER work for the purposes of tenure & promotion (faculty only)?
- d. How much time could you have devoted to research last week?
- e. Does your institution explicitly value external collaborations?
2. For re-interviewees, has anything changed since we talked last time?
 - a. How much time could you have devoted to research last week?
 - b. Does your institution explicitly value external collaborations?

Perception of PEER

1. How was PEER for you?
 - a. Did it live up to your expectations? Why or why not?
 - b. Was your PEER experience what you envisioned it to be like? How so?
 - c. What are some things you did not get at PEER but hoped you had?
2. What do you think you have gained (skills, people...) from your participation in the PEER program?
 - a. Were there particular workshops that were most impactful for you? Which ones? Why?
 - b. How do you know if you have gained (or not) these things?
 - c. Were there topics you would've liked to see in more depth? Less depth?
3. People and collaboration
 - a. Did you meet new potential collaborators? How will you collaborate with them?
 - b. Mentors?
 - c. Mutual support peers?
 - d. How do you plan to work with them in the future? Accountability groups, the slack, joint projects...
 - e. Are there other roles that you would like other people to fill?
 - f. How would you like to help with or contribute to your peers' projects?
4. Did you make significant progress in your thinking about your project?
 - a. About DBER in general?
5. What do you think PEER is now?

- a. What are some of your takeaways from your experience?

Experience in DBER

1. During PEER
 - a. What is your research project about?
 - b. How did your research project evolve during PEER? In what ways?
2. Present
 - a. Where are you currently at with your DBER research?
 - b. How do you feel about your work?
3. Future
 - a. What comes next for your research project?
 - b. What skills do you hope to develop in the future?
 - c. What are some of your goals for your research?
 - d. Do you feel like you have the skills to achieve your goals?
 - e. When you get stuck, where will you look for help?
 - f. How will you know you have gained these skills/accomplished goals?
 - g. Do you have plans to publish or present? Are DBER publications part of your tenure plans?

Perception of DBER

1. What is your current DBER community?
 - a. What kind of support do you have for your DBER work (community, supportive colleagues/administrators, financial etc..)?
 - b. What kind of support do you wish to have for your DBER work?
 - c. How has your DBER community expanded while you were at PEER?
 - i. Have you gained new collaborators?
 - ii. Do you feel that you have gained mentors who you can reach out to and/or work with in the future?
 - d. Are you planning to go to specific conferences in the near future (example: RUME)?
2. Before PEER, had you
 - a. participated in a DBER conference or workshop?
 - b. worked on a DBER project with more experienced DBER people?
 - c. submitted a paper or poster in DBER?
3. And then what happened?
 - a. Was that a good experience for you?
 - b. What kinds of feedback did you get?

- c. What have been your prior experiences with other DBER people?
 - d. Did you feel welcome? Did you feel like you could ask them basic questions?
 - e. Do you still work on that project?
4. How has your perception of the DBER field changed?
 5. How has your understanding of DBER evolved with your participation in PEER?
 6. What are some challenges you are encountering with the field?

Identity

1. How do you describe your current professional identity?
 - a. Do you describe yourself as a DBER researcher? Why or why not?
2. How do you relate different aspects of your professional identity to your DBER work?
 - a. How do you feel DBER relates to your teaching?
 - b. Have your ideas about how DBER and your teaching interact changed during PEER?
 - c. How does being an instructor help you be a better DBER person? How does DBER help you be a better instructor? Is this important to you?

Wrap up

1. *[At 50 min:]* I'm mindful of your time; do you need to go right at [XX time]?
2. Before we close, is there anything you'd like to add or anything we should have asked you about, but didn't?
3. Are there any questions that you have for us?

"Thank you so much for your time! This was very useful and we really appreciate it."

Set-up and Introduction

[Gallery view. Open up the Chat window, make it visible, and select Private Chat.]

"Hi, I'm **NAME**. Thanks for taking the time to talk to us today! **NOTE TAKER NAME** is primarily going to be taking notes, and may chime in at the end with some questions if we have time.

Just to refresh your memory, the goal of this project is to understand how we can better support new and emerging STEM education researchers. We are interested in talking to you because you have had experience with STEM education research. We would like to understand your successes, challenges, motivations, and needs in doing STEM education research.

Before we begin:

- *[If consent form has been received]* Thank you for sending us your interview consent form. Do you have any questions about the consent form or this project?
- *[If consent form has not been received]* Have you seen the consent form attached in a recent email? *[Help interviewee find and review consent form, sign consent form, and email you consent form.]* Do you have any questions about the consent form or this project?

With your permission we would like to record this interview to help us conduct more accurate data analysis. Can we record this interview?

- *[Make sure in Gallery view; Check that recording has started.]*
- Just to have your permission on the recording, do you agree to having us record this interview?

In order to protect your identity, we will use a pseudonym to refer to you during the study. Do you have a name that you would like us to use or would you prefer that we pick one? What pronouns would you like us to use for you?

As a reminder, participation in this interview is voluntary. You may decide not to participate at any time during the interview.

Great, thank you again!”

Pre-Interview Questions

Background

1. What is your current position?
2. What is your home discipline?
3. What are the expectations for you in your job, and as a member of that discipline?

Conceptualizing Theory

1. How do you engage with theory in [home discipline] research projects?
 - a. Example of research you have done?
2. What role does theory play in a research project in [home discipline]?
 - a. Ask them to talk about the thing we discussed above.
3. How do you conceptualize theory in [home discipline]?
4. Have you encountered theory in education research?
 - a. [Yes] What is your impression of theory in education research?
 - b. [Yes] How do you find yourself struggling with theory?
 - c. [No] Were you aware that theory can be a part of education research?
 - d. [No] What role would you expect theory to play?
5. Do you think that theory in education research and [home discipline] are different?
 - a. [Yes] In what ways?
 - b. [No] How are they similar?
6. What kinds of things are you expecting to learn about at PEER?
 - a. [If they don't mention theory] Might you learn things about theory there?
 - b. What about theory would you like to learn?
 - i. Scope?
 - ii. Specific application?
 - iii. Purpose?

Post-Interview Questions

Background

1. What is your current position?
2. What is your home discipline?
3. What are the expectations for you in your job, and as a member of that discipline?

Conceptualizing Theory

1. How do you engage with theory in [home discipline]?
 - a. Concrete example?
2. What role does theory play in a research project in [home discipline]?
 - a. Continue with previous context
3. How do you conceptualize theory in [home discipline]?
4. How did you engage with theory at PEER?
 - a. What did you learn about?
 - b. What was the role of theory?
 - c. Scope?
5. Did you gain a better understanding of theory at PEER?
 - a. What kinds of things did you learn?
 - b. Were there things you would like to have learned, but did not?
6. Conception of theory post PEER.
 - a. What would you say theory is in education research now?
 - b. What role do you expect theory to play in your education research projects?
 - c. How does this compare to what theory does in your home discipline?
7. Are theory in education research and theory in your home discipline different?
 - a. Do they serve different purposes?
 - b. Are the goals of theory and theoretical development the same or different?
 - c. Do they support research projects in the same or different ways?

Wrap up

1. *[At 50 min:]* I'm mindful of your time; do you need to go right at XX time?

2. Before we close, is there anything you'd like to add, or anything we should have asked you about, but didn't?
3. [Pre-Interview only] Would you be willing and able to join us for a follow up interview after PEER-Chicago?
4. Are there any questions that you have for us?

“Thank you so much for your time! This was very useful and we really appreciate it.”

Appendix B

Participants Summary

This appendix contains a table summarizing the participants in the PEER dataset. It details their pseudonyms, disciplines, job positions, pronouns, which interview protocol(s) they were interviewed with, and which if any chapters they are directly quoted in.

Table B.1: Our dataset includes 38 separate people and 43 interviews. Here is a complete list of the interviewees, the field school they attended (if any), their discipline, and the data set they were a part of along with the interview protocol used for their interview.

Pseudonym	Pronouns	PEER field school	Data Streams	Position	Department / Subject	Is quoted in	Protocol
Akemi	She/Her	PEER-Chicago 2021	Pre and Post Interviews	Visiting Scholar	Physics		Pre PEER Interview Protocol Post PEER Interview Protocol
Alex	They/Them	None (EDBER)	EDBERs Interviews	Assistant Professor	Math	Roles, Fear	EDBERs Original Protocol
Andrea	She/Her	None (EDBER)	EDBERs Interviews	Associate Professor	Math	Fear	EDBERs Original Protocol
Ashley	She/Her	PEER-Chicago 2021	Pre Interviews	Tenure track position, unspecified	Math		Pre PEER Interview Protocol
Ava	She/Her	PEER-Chicago 2021	Post Interviews	Assistant Professor	Math	Theory	Post PEER Interview Protocol
Beatrice	She/Her	PEER-Chicago 2022	Theory Pre Interviews	Assistant Professor	Chemistry		What is Theory-Pre
Brooke	She/Her	None (EDBER)	EDBERs Interviews	Assistant Professor	Math	Roles, Fear	EDBERs Original Protocol
Chaital	He/Him	PEER-Chicago 2022	Theory Pre Interviews	Assistant Professor	Physics		What is Theory-Pre
Chandrika	She/Her	PEER-Chicago 2021	Pre Interviews	Assistant Professor	Math		Pre PEER Interview Protocol
Cole	He/Him	None (EDBER)	EDBERs Interviews	Associate Professor, Department Chair	Math	Roles, Fear	EDBERs Original Protocol
Edna	She/Her	PEER-Chicago 2022	Theory Pre Interviews	Independent Business Owner	Physics/CS		What is Theory-Pre
Emma	She/Her	PEER-Chicago 2021	Pre Interviews	Highschool Teacher	Other		Pre PEER Interview Protocol
Geraldine	She/Her	PEER-Chicago 2022	Theory Pre Interviews	Associate Professor	Physics		What is Theory-Pre
Harriet	She/Her	PEER-Chicago 2022	Theory Pre Interviews	Associate Professor	Biology		What is Theory-Pre
Ida	She/Her	PEER-Chicago 2022	Theory Pre Interviews	Professor	Chemistry		What is Theory-Pre
Jacob	He/Him	PEER-Chicago 2021	Pre Interviews	Graduate Student	Physics	Theory	Pre PEER Interview Protocol
Jacob Junior	He/Him	PEER-Chicago 2022	Theory Pre Interviews	Assistant Professor	Ed Leadership		What is Theory-Pre
James	He/Him	None (EDBER)	EDBERs Interviews	Associate Professor, Department Chair	Math	Roles, Fear	EDBERs Original Protocol
Jessica	She/Her	PEER-Chicago 2021	Pre Interviews	Assistant Professor	Math		Pre PEER Interview Protocol
Katherine	She/Her	PEER-Chicago 2022	Theory Pre Interviews	Assistant Professor	Geology		What is Theory-Pre
Kaylee	She/Her	None (EDBER)	EDBERs Interviews	Assistant Professor	Math	Roles, Fear	EDBERs Original Protocol

Table B.2: Our dataset includes 38 separate people and 43 interviews. Here is a complete list of the interviewees, the field school they attended (if any), their discipline, and the data set they were a part of along with the interview protocol used for their interview.

Lily	She/Her	PEER-Chicago 2021	Pre Interviews	Instructional Faculty	Math	Theory	Pre PEER Interview Protocol
Madison	She/Her	PEER-Chicago 2021	Pre and Post Interviews	Associate Professor	Physics		Pre PEER Interview Protocol Post PEER Interview Protocol
Marcus	He/Him	PEER-Chicago 2021	Post Interviews	Associate Professor	Math		Post PEER Interview Protocol
Mariah	She/Her	PEER-Chicago 2021	Pre Interviews	Graduate Student	Physics		Pre PEER Interview Protocol
Mary	She/Her	PEER-Chicago 2022	Theory Pre Interviews	Assistant Professor	Teacher Education		What is Theory-Pre
Melinda	She/Her	None (EDBER)	PEER Interviews Round 3	Assistant Professor	Biology	Roles	Revised General Protocol
Olivia	She/Her	PEER-Chicago 2021	Pre and Post interviews	Professor	Math	Theory	Pre PEER Interview Protocol Post PEER Interview Protocol
Penelope aka Purple Princess	She/Her	PEER-Chicago 2021	Post Interviews	Assistant Professor	Math	Theory	Post PEER Interview Protocol
Peter	He/Him	PEER-Chicago 2021	Post Interviews	Professor	Math	Theory	Post PEER Interview Protocol
Priyanka	She/Her	PEER-Chicago 2021	Pre Interviews	Mid/Late Career Mathematics Instructor	Math		Pre PEER Interview Protocol
Raya	She/Her	PEER-Chicago 2021	Post Interviews	Assistant Professor	Math		Post PEER Interview Protocol
Rebecca	She/Her	None (EDBER)	EDBERs Interviews	Associate Professor	Math	Roles, Fear	EDBERs Original Protocol
Robert	He/Him	PEER-Chicago 2022	Theory Pre Interviews	Sessional Instructor	Physics		What is Theory-Pre
Ryan	He/Him	PEER-Chicago 2021	Pre and Post interviews	Post Doctoral Fellow	Math	Theory	Pre PEER Interview Protocol Post PEER Interview Protocol
Samuel	He/Him	PEER-Chicago 2021	Pre and Post Interviews	Graduate Student	Physics		Pre PEER Interview Protocol Post PEER Interview Protocol
Tabitha	She/Her	None (EDBER)	PEER Interviews Round 3	Professor	Biology		Revised General Protocol
William	He/Him	PEER-Chicago 2021	Post Interviews	Visiting Professor	Math		Post PEER Interview Protocol

Appendix C

A list of PEER modules with brief descriptions

The PEER program has a modular structure in order to better respond to the needs and interests of participants. Each PEER field school or workshop is constructed from a combination of several modules based on the needs and interests of attendees, and the discretion of PEER facilitators. In this appendix I have listed all of the currently available modules and brief descriptions of them for context.

- Ethics:
 - Authorship: norms and ethics for deciding authors, author order, and tools for navigating authorship conversations.
 - Human Subjects Research: advice and information about ethics laws within the United States of America, institutional review boards, and ethical decision making.
 - Collaboration: norms for managing collaborations, establishing expectations, and maintaining safe and ethical collaborations.
- Research Design:

- Research questions: designing and smithing research questions, research questions as living questions.
- Data & access: recognizing the data you do and don't have access to, and thinking about how to make the most of it.
- Case versus recurrence: thinking about research generalizability, and research as a case of something versus research to identify patterns.
- Finding a group: how to find people to work with.
- Project planning: deadline and goal setting, resource management.
- Theory: what is the role of theory in research, and how do you choose theories.
- Analysis:
 - Video coding: practical and principled advice for video data analysis.
 - Emergent coding: how do you handle patterns emerging from data, and formalize noticing.
 - Doing interviews: interviews come in many varieties, and are a complicated task. How do you choose and interview type, and conduct a good interview.
 - Quantitative research with R: statistics and data processing in R.
- Communication:
 - Literature reviews: how do you conduct a literature review, and where do you start.
 - Paper structure: how are papers structured in education research, and why.
 - Choosing a journal home: where should you try to publish your results, and how do you decide.
 - Skeptical audiences: how do you hold conversations with people who question the validity of education research, and your place within a disciplinary department.

- Beautiful posters: how do you make posters that are more impactful than traditional 3 column text walls.
- Research Life:
 - Personal paths: how did the facilitators get where they are in education research.
 - PEER principles: why does PEER operate how it does, and how should we conduct ourselves during the program.
- Teaching:
 - Listening to students: how to hear what students are saying, teach responsively, and build student agency into your teaching.
 - Fostering equity in the classroom: how do you incorporate equitable teaching practice into your classes.