"THEORY AT THE CROSSROADS": MAPPING MOMENTS OF MATHEMATICS EDUCATION RESEARCH ONTO PARADIGMS OF INQUIRY[1]

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In this essay, traveling through the past half-century, the authors illustrate how mathematics education research shifted, theoretical, beyond its psychological and mathematical roots. Mapping four historical moments of mathematics education research onto broader paradigms of inquiry, the authors make a case for the field to take up a theoretical "identity" that refutes closure and keeps the possibilities of mathematics teaching and learning open to multiple and uncertain interpretations and analyses.

Keywords: Equity and Diversity, Research Methods

Introduction

Over the past half-century, mathematics education research could be characterized as shifting from searches for certainty to acknowledgments of doubt (cf. Skovsmose, 2009). Discussions about theory during this time have grown from being nearly nonexistent in the 1960s to filling a visible and frequently contested space for productive scholarly debate in more recent times. For instance, in the mid-to-late 1990s, Steffe, Kieren, Thompson, and Lerman debated the often-dichotomized theoretical traditions of radical constructivism and social constructivism (Lerman, 1996, 2000a; Steffe & Kieren, 1994; Steffe & Thompson, 2000). In the late 2000s, Gutiérrez and Lubienski debated the uses (or not) of broad socio-cultural and -political theories (and methods) when reporting on the mathematics "achievement gap" (Gutiérrez, 2008; Lubienski, 2008; Lubienski & Gutiérrez, 2008). And Confrey and Battista (Battista, 2010; Confrey, 2010), individually, in the early 2010s, responded to Martin, Gholson, and Leonard's (2010) rejoinder to the assumptive question: "Where's the math (in mathematics education research)?" (Heid, 2010, p. 102) These debates hinged largely on the theoretical traditions taken up by the researchers, which, in turn, determined what questions might be asked and how data might be collected, analyzed, and represented (see Lester & Wiliam, 2000; Valero, 2004).

The productive theoretical debates that have engaged mathematics education researchers since the 1990s are in stark contrast to the debates (or lack thereof) from the 1960s and 1970s. In those early developmental years of mathematics education research, the chief method of establishing legitimacy for the field was for researchers to align themselves with the existing epistemologies of mathematics and the developing theories of psychology (Kilpatrick, 1992). This allegiance was formally instituted in 1976 when the International Group for the Psychology of Mathematics Education was founded during the 3rd International Congress for Mathematical Education (ICME-3). Overall, in research reporting during these early developmental years, theoretical considerations were merely implicit. When researchers discussed theory, it was most often in the context of developing a single theory or theoretical network specific to research on mathematics teaching and learning (e.g., Becker, 1970).

The Emergence of Theoretical Discussions

The allegiance to "traditional" psychology waned in the late 1970s and early 1980s, as theories (and methodologies) began to be adapted from the disciplines of anthropology, cultural and social psychology, history, philosophy, and sociology (Lester & Lambdin, 2003). Over three decades ago, Higginson (1980) proposed that mathematics education be informed not simply by mathematics and

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psychology, but also by sociology and philosophy. He noted that allegiance to mathematics is self-evident and that the "battle for the recognition of a psychological dimension in mathematics education has been won, for almost all purposes, for some time now" (p. 4). Higginson then made a two-pronged argument for the recognition of a sociological dimension: (a) the need to more fully understand the social role of schooling and the interpersonal and intrapersonal dynamics among teachers, students, and the mathematics being taught and learned; and (b) the need to more fully understand the influences of cultural values, economic conditions, social structures, and emerging technologies on schools generally and on teaching and learning specifically.

In arguing for the inclusion of philosophy, Higginson (1980) cautiously noted that with the inclusion of sociology, "it might appear [to some] that the gates have been open too far already" (p. 4). But for Higginson, the inclusion of philosophical considerations in mathematics education (research or otherwise) was important because all human "intellectual activity is based on a set of assumptions of a philosophical type" (p. 4). These assumptions, he argued—

will vary from discipline to discipline and between individuals and groups within a discipline. They may be explicitly acknowledged or only tacitly so, but they will always exist. Reduced to their essence these assumptions deal with concerns such as the nature of "knowledge", "being", "good", "beauty", "purpose" and "value". More formally we have, respectively, the fields of epistemology, ontology, ethics, aesthetics, teleology and axiology. More generally we have the issues of truth, certainty and logical consistency. (p. 4)

Higginson's (1980) point was soon taken up. For example, in 1984 a new Topic Study Group on Theory in Mathematics Education [TME] was formed at ICME-5. The purpose of the group, as Steiner (1985) summarized, was "to give mathematics education *a higher degree of self-reflectedness* and *self-assertiveness,* to *promote another way of thinking* and of *looking* at the problems and their interrelations" (p. 16; emphasis in original). Steiner also provided a list of 10 topics that the TME Group might explore in the future; these topics included (among others): definitions of mathematics education as a discipline; use of models, paradigms, theories in mathematics education research; relationships between theory and practice; and explorations of ethical, societal, and political aspects of mathematics education.

Mathematics education research of the 1990s and beyond certainly reflects this list of topics, broadening not only possible theoretical traditions that might be taken up but also expanding the very identity of mathematics education as a research domain (see Sierpinska & Kilpatrick, 1998). By way of example, conferences held since the mid-1980s include Political Dimensions of Mathematics Education (1990, 1993, 1995); Critical Mathematics Education: Toward a Plan for Cultural Power and Social Change (1990); Mathematics Education and Society (1998, 2000, 2002, 2004, 2008, 2010, 2013, 2015, 2017); and Mathematics Education and Contemporary Theory (2011, 2013, 2016). Furthermore, edited books published since that time include *Equity in Mathematics Education*: *Influences of Feminism and Culture* (Rogers & Kaiser, 1995); *Ethnomathematics*: *Challenging Eurocentrism in Mathematics Education* (Powell & Frankenstein, 1997); *Sociocultural Research on Mathematics Education* (Atweh, Forgasz, & Nebres, 2001); *Which Way Social Justice in Mathematics Education* (Burton, 2003); *Mathematics Education within the Postmodern* (Walshaw, 2004); and *Culturally Responsive Mathematics Education* (Greer, Mukhopadhyay, Powell, & Nelson-Barber, 2009). These listings are by no means exhaustive but merely illustrative of the conferences and books that have assisted in shifting mathematics education research beyond its psychological and mathematical roots.

Theory Defined

Conferences and books like those mentioned have indeed contributed to the broadening of theoretical (and methodological) traditions within mathematics education research. However, we

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have not yet defined or described what we mean by *theoretical tradition* or *theory* here. This is an intentional omission. In our view, theory often conveys different meanings and assumes different purposes. For instance, Sriraman and English (2010) have drawn attention to the notion of a "grand" theory sought by some researchers (e.g., Becker, 1970; Silver & Herbst, 2007), while Lester (2005) has suggested that mathematics education researchers adapt theoretical concepts and ideas from a range of perspectives. Brown and Walshaw (2012) have argued that mathematics education researchers use "theory as a vehicle for new productive possibilities in mathematics education" (p. 3).

These different purposes signal that theory is being conceptualized at different levels. To that end, E. A. St. Pierre (personal communication, June 2000) has proposed a three-tier structure for discussing theory: high-level, mid-level, and ground-level theories. High-level theories are the larger philosophical traditions in which a researcher might position her or his science (e.g., analytic philosophy or continental philosophy). These traditions rest on a set of assumptions about epistemology, ontology, ethics, aesthetics, teleology, and axiology or, more simply stated, about truth, certainty, and logical consistency (Higginson, 1980). Mid-level theories are the various theoretical traditions and ideas that might be derived from one or more broader philosophical traditions (e.g., activity theory, cognitive theory, constructivist theory, critical theory, poststructural theory, sociocultural theory). Ground-level theories, not to be confused with grounded theory (Glaser & Strauss, 1967), are the theories or models developed or used to make sense of the data collected during data analysis; that is, the theory that is on the ground, closest to the data (e.g., cognitively guided instruction; see, e.g., Fennema et al., 1996). It is important to note, however, that a specific ground-level theory is only possible through the set of philosophical and theoretical assumptions, beliefs, values, and perspectives operating in the context of the high- and mid-level theories taken up by the researcher (E. A. St. Pierre, personal communication, June 2014). The danger in too much of the existing mathematics education research, however, is that researchers often do not acknowledge the philosophical assumptions present in the high- and mid-level theories that make the ground-level theories they develop or use possible.

For our purposes here, our focus is on high- and mid-level theories or what taken together could be called the *paradigm of inquiry* in which the researcher resides. That is, when using the word theory or the phrase theoretical tradition we are concerned about the epistemological stance of the researcher as she or he conducts research within a set of assumptions about truth, certainty, and logical consistency, being mindful that science, social or otherwise, is always already entangled with and in these broader concerns of philosophy (St. Pierre, 2011).

The Paradigm Wars and Education Research

Generally speaking, the broadening of theoretical traditions in mathematics education has been played out in the larger paradigm wars of education social science (see Gage, 1989; Guba & Lincoln, 1994; Lather, 2006; St. Pierre, 2006). The use of Kuhn's (1962/1996) concept *paradigm* is meant to describe shifts in the traditions of "normal science" (i.e., firmly based historical traditions of science) that are differentiated not by failure of one method to another but rather by the "incommensurable ways of seeing the world differently and of practicing science in it" (p. 4). Although the use of the term paradigm in social science research has been contested (see Donmoyer, 2006), Guba and Lincoln (1994) have pointed out that inquiry paradigms highlight for researchers "what it is they are about, and what falls within and outside the limits of legitimate inquiry" (p. 108). Inquiry paradigms, they have argued, are defined by responses to three fundamental and interconnected questions—the ontological question, the epistemological question, and the methodological question. The three questions are interconnected "because the answer given to any one question, taken in any order, [more times than not] constrains how the others may be answered" (p. 108).

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Much has been written in the past 50 years or so about the beginning (early 1960s), the aftermath (late 1980s), and the resurgence (early 2000s) of the paradigm wars (see Lather, 2006; St. Pierre, 2006). Writing in 1989, in a futuristic account of education research at the turn of the 21st century, Gage proposed (and hoped for) an armistice of sorts as "researchers came to a new realization that paradigm differences do not require paradigm conflict" (p. 7). But rather than an armistice, paradigm conflicts have seen a resurgence as both experimental and quasi-experimental research have been hailed as the "gold" standard in educational research (see, e.g., National Research Council, 2002). St. Pierre (2006), underscoring the gravity of the resurgence, has argued—

> The stakes are high because the very nature of science and scientific evidence and therefore the nature of knowledge itself is being contested by scholars and researchers who think and work from different epistemological, ontological, and methodological positions as well as by those postmodernists who challenge the metaphysical project altogether. If one believes that different theoretical frameworks are grounded in and structured by different and, perhaps, incommensurable assumptions about the nature of knowledge, truth, reality, reason, power, science, evidence, and so forth, then one can see why educators are taking sides in this debate that is already organizing the limits and possibilities of what we can think and know and, thus, how we can live in the complex and tangled world of educational theory, research, policy, and practice. (pp. 239–240)

Within the complex and tangled world of U.S. mathematics education research, this resurgence of paradigm conflicts is visible within the pages of *Foundations of Success*: *The Final Report of the National Mathematics Advisory Panel* (NMAP; 2008) and in a special issue of the *Educational Researcher* (Kelly, 2008) published in response. Throughout the pages of both the final report and the response special issue it is often noted, explicitly and implicitly, that supporting certain theoretical and methodological traditions does not mean complete abandonment of others. The authoring committee of the NMAP final report, however, included only experimental and quasi-experimental research to make evidential knowledge claims about mathematics teaching and learning. So as politics took the place of scientific inquiry (Boaler, 2008), the authoring committee took direct aim at some epistemological possibilities, and thus theoretical and methodological possibilities. For instance, they erased "race" from the conversation on mathematics teaching and learning altogether (Martin, 2008). In the end, as a proliferation of paradigms to think about and do science became possible within the decades of the 1980s and 1990s (Lather, 2006), both education research in general and mathematics education research in particular experienced a backlash in the early 2000s and beyond. The war rages on as the battles over the nature of knowledge, truth, reality, reason, power, science, evidence, and so forth, continue.

Mapping Moments to Paradigms of Inquiry

In an attempt to make sense of the proliferation of theoretical traditions used in mathematics education research since the 1970s, Stinson and Bullock (2012) have identified four distinct yet overlapping and simultaneously operating shifts or historical moments: (a) the process–product moment (beginning in the 1970s); (b) the interpretivist–constructivist moment (beginning in the 1980s); (c) the social-turn moment (beginning in the mid-1980s); and (d) the sociopolitical-turn moment (beginning in the 2000s). These moments of mathematics education research are not intended to suggest that movement among the moments occurs in some linear fashion, arriving at a "best" or "better" place across a continuum. Rather, the moments are merely arranged in loose historical chronological order. As a case in point, Frankenstein (1983) and Skovsmose (1985) began exploring the sociopolitical implications of critical mathematics education several years before the sociopolitical-turn moment identified as beginning in the 2000s. Table 1 maps the four moments of

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mathematics education research onto one and, in some cases, two paradigms of inquiry. Representing an adaptation of a conceptualization offered by Lather and St. Pierre (see Lather, 2006), four broad paradigms are singularly worded by their general intentions: prediction, understanding, emancipation, and deconstruction (see Stinson & Bullock, 2015).

Table 1: Mapping Moments of Mathematics Education Research to Paradigms of Inquiry

- Process–Product Moment (1970s–)→***Predict***
- Interpretivist–Constructivist Moment (1980s–)→***Understand***
- Social-turn Moment (mid 1980s–)→***Understand*** (albeit, contextualized understanding) or ***Emancipate*** (or oscillate between the two)
- Sociopolitical-turn Moment (2000s–)→***Emancipate*** or ***Deconstruct*** (or oscillate between the two)

Paradigms of Inquiry

Predict	***Understand***	***Emancipate***		***Deconstruct***
*Positivist	*Interpretivist	*Critical		*Poststructural/
Experimental	Social Constructivist	<Feminist>		Postmodern
Quasi-experimental	Radical Constructivist	Critical Race Theory>	*BREAK*	Postcritical
Mixed Methods>	Sociocultural>	Latino/a Critical Race		Postcolonial
	Phenomenological	Theory>		Posthumanist
	Ethnographic	Critical Theories of Race>		Post-Freudian
	Symbolic Interaction	<Participatory Action		<Discourse Analysis
		Research		
		Critical Ethnography		

*Indicates the term most commonly used < or > Indicates cross-paradigm movement

The Break in the original Lather and St. Pierre table indicated a shift from the Enlightenment humanist paradigms on the left to the post-Enlightenment, posthumanist paradigm on the right. Here it indicates a hybrid, in-between space where the researcher might adopt a critical postmodern theoretical tradition (see Stinson & Bullock, 2012, 2015).

Paradigms of Inquiry adapted from Lather and St. Pierre in Lather, 2006, p. 37.

The purpose in mapping the moments to larger inquiry paradigms is to illustrate the different theoretical and methodological possibilities within each moment. Although the table does not exhaust all possibilities, it does provide an expansive list of the kinds of research that might be undertaken within mathematics education. For instance, Table 1 illustrates that research in the process–product moment (beginning in the 1970s) is marked by attempts to predict "good" mathematics teaching by linking mathematics teachers' classroom practices (process) to student outcomes (product). Grounded both theoretically and methodologically in positivist inferential statistics, cognitive and behavioral theories derived from experimental psychology and behaviorism are the primary theoretical traditions (e.g., Good & Grouws, 1979). The interpretivist–constructivist moment (beginning in the 1980s) attempts to understand mathematics teaching and learning rather than to predict it; interpretivist and constructivist theories derived principally out of sociology and developmental psychology are the primary theoretical traditions (e.g., Steffe & Tzur, 1994; Thompson, 1984). The acknowledgement that meaning, thinking, and reasoning are products of social activity in contexts marks the social-turn moment (beginning in the mid-1980s; see Lerman, 2000b); theories drawn from disciplines such as cultural and social psychology, anthropology, and cultural sociology are the primary theoretical traditions (e.g., Boaler, 1999; Zevenbergen, 2000). And a shift toward recognizing knowledge, power, and identity as interwoven and arising from and constituted with and in sociocultural and sociopolitical discourses distinguishes the sociopolitical-turn moment (beginning in the 2000s; see Gutiérrez, 2013); here critical and poststructural theories are the primary traditions (e.g., Gutstein, 2003; Walshaw, 2001).

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Closing Thoughts

In the foreword to Mathematics Education as a Research Domain: A Search for Identity, Sierpinska and Kilpatrick (1998) wrote—

> The theme of the ICMI Study reported in this book was formulated as a question: 'What Is Research in Mathematics Education and What Are Its Results?' No single agreed-upon and definite answer to the question, however, is to be found in these pages. What the reader will find instead is a multitude of answers, various analyses of the actual directions of research in mathematics education in different countries, and a number of visions for the future of that research. (p. x)

These multiple answers and various analyses are clearly visible within the moments of mathematics education research as depicted in Table 1. Indeed, similar to researchers in education generally, researchers in mathematics education have experienced a proliferation of paradigms to think with when conducting research on the teaching and learning of mathematics. Similar to Lather (2006), we believe that this proliferation of paradigms is a good thing. Is it possible, then, to characterize mathematics education research? What can we say about its identity? In our view, an identity for mathematics education research is one that is fragmented, incomplete, and continually reconstituted within sociopolitical relations of power. Such a perspective refutes closure and keeps the possibilities for mathematics teaching and learning open to multiple and uncertain interpretations and analyses.

Endnotes

1. The text in this essay was extracted and revised from Stinson and Walshaw (in press).

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