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DIVERSITY IN METHODOLOGY: DIFFERENT POSSIBILITIES FOR DATA COLLECTION, ANALYSIS, AND REPRESENTATION

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Mathematics education research over the past half century can be understood as operating in four distinct yet overlapping and simultaneously operating historical moments: the process–product moment (1970s–), the interpretivist–constructivist moment (1980s–), the social-turn moment (mid 1980s–), and the sociopolitical-turn moment (2000s–). Each moment embraces unique theoretical perspectives as it critiques or rejects others. Moreover, because methodology is inextricably linked to theory, each moment calls forth unique methodological perspectives. Using exemplars of research articles from each moment, the authors illustrate how each moment provides different possibilities for data collection, analysis, and representation.

Keywords: Research Methods

Introduction

Elsewhere, in an attempt to make sense of the complexities of divergent theoretical perspectives in mathematics education research, we, Stinson and Bullock (2012a, 2012b), identified four distinct yet overlapping and simultaneously operating (therefore no end dates) historical shifts or moments in mathematics education research over the past four decades: the process–product moment (1970s–), the interpretivist–constructivist moment (1980s–), the social-turn moment (mid 1980s–), and the sociopolitical-turn moment (2000s–). We showed that each moment (more or less) embraces unique theoretical traditions as it rejects others. We also made an argument for a hybrid critical postmodern theoretical approach to conducting mathematics education research where the researcher continually and simultaneously negotiates the praxis of the critical and the uncertainty of the postmodern (see also Stinson, 2009). Here, given that methodology is inextricably linked to theoretical perspective (LeCompte, Preissle, & Tesch, 1993), we extend our previous discussion to explore possibilities for data collection, analysis, and representation—that is, methodological possibilities—through the four shifts or moments. We claim that each of the four moments of mathematics education identified can be mapped more or less to one or two paradigms of inquiry—predict, understand, emancipate, and/or deconstruct (see Lather, 2006, p. 37)—which, in turn, provide different possibilities for data collection, analysis, and representation. We use "effective" or "good" mathematics teaching as just one example of a research strand in which the differences and commonalities among methodological approaches might be highlighted.

Methodologies across the Moments: Research on Effective Mathematics Teaching

Process–Product Moment

The process–product moment (1970–) is characterized by linking processes of classroom practice to student achievement outcomes or "products." Clearly positioned in the *predict paradigm of inquiry* (Lather 2006, p. 37), theoretically and methodologically, researchers in this moment rely primarily on quantitative statistical inference as a means "to 'predict' social phenomena by 'objectively' observing and measuring a 'reasonable' universe" (Stinson & Bullock, 2012a, p. 43). An exemplar of process–product research is Good and Grouws's (1979)

article "The Missouri Mathematics Effectiveness Project: An Experimental Study in Fourth-Grade Classrooms." It reports a research project that sought to create a single picture for all contexts of what the effective mathematics teacher does in the classroom. Initial data collection for the project included pre- and post-test data on student achievement to select teachers across a school district who were "consistent and relatively effective or ineffective in obtaining student achievement results" (p. 355). Once "labeled," these teachers were observed in their classrooms for approximately three months, and based on analyses of tallied behaviors observed a behavioral profile was created for each teacher. Good and Grouws then separated the teachers who they had labeled as "effective" and "ineffective" from the achievement test data and created a composite profile of both groups. They used the differences between those profiles to develop a set of characteristics of teacher effectiveness. Data representation consisted of a table indicating "Key Instructional Behaviors": observed behaviors from the effective teachers along with the time spent on each behavior. The table was presented as a rubric of sorts that administrators and mathematics teacher educators might use to "train" teachers to "perform" in ways that student achievement outcomes could be predicted.

Interpretivist–Constructivist Moment

In the interpretivist–constructivist moment (1980s–) the aim of the researcher is no longer to predict social phenomena but rather to understand it. Here, and elsewhere (see Stinson & Bullock, 2012a), due to their near-simultaneous occurrence in mathematics education research in the 1980s, interpretivist research and constructivist research is combined into a single moment. Nevertheless, it is important to note that although both of these two research strands are securely positioned in the *understand paradigm of inquiry* (Lather 2006, p. 37), they seek understanding in different ways. Therefore, they take up different theoretical and methodological possibilities.

At one end, the interpretivist researcher seeks to understand social phenomena by attempting to access the meaning(s) that people assign to social phenomena. An example is Wilson, Cooney, and Stinson's (2005) article "What Constitutes Good Mathematics Teaching and How it Develops? Nine High School Teachers' Perspectives." It reports results of a project that examined the "views of nine experienced and professionally active teachers about what they consider good teaching to be and how it develops" (p. 83). In the project, Wilson and colleagues inferred notions of good mathematics teaching from case study data related to the participating teachers' beliefs and attitudes about effective teaching. Methods of data collection comprised of conducting and transcribing three, semi-structured interviews with seasoned teachers who were mentoring student teachers. To analyze the data, Wilson and colleagues used a qualitative coding approach: developing a preliminary coding scheme in an initial analysis and modifying that scheme as they repeatedly moved through the data. Data representation consisted of several direct quotations from the interview transcripts and a modified frequency table, describing the characteristics of effective teaching that the teachers identified and how they believed those characteristics were best learned.

At the other end, the constructivist researcher understands meaning(s) as something that is constructed through experience. Or, said in another way, the focus of research is on understanding and identifying the processes of how people acquire or construct different meaning(s) over time. For instance, in "Reflective Reform in Mathematics: The Recursive Nature of Teacher Change," Senger (1998–1999) investigated how elementary teachers' changed (or constructed) their beliefs about good mathematics teaching in the context of curriculum reform. Videotaped lessons, field notes, and audiotaped interviews from a purposeful sample of elementary teachers comprised data collection. Analytical tools incorporated qualitative data

analysis software and discourse analysis as a means to ground a theory of how teachers might change their beliefs about good mathematics teaching through Deweyian reflection. This analysis "revealed that the integration of a new belief did not occur suddenly or as a single event—that is, from new information directly to new belief—but rather as a complex and thoughtful process over time" (p. 214). Data representation consisted of teacher narratives and a table comparing snapshot data from three of the teachers. Additionally, a schematic model of "Teachers' Ways of Perceiving Mathematics Reform" was presented—a flowchart of sorts of teacher change. Although Senger presented a schematic model, she did not position teachers as reaching a goal of being "good teachers" but rather used systematic teacher reflection to show progression along a continuum of teacher effectiveness.

Social-turn Moment

Researchers whose work is positioned in the social-turn moment contend that understanding social phenomena is intimately attached to the sociocultural contexts in which phenomena occurs. In that, meaning, thinking, and reasoning are understood as products of social activity in contexts (Lerman, 2000). Research in this moment can be located in the *understand* or *emancipate paradigm of inquiry* (Lather 2006, p. 37) or osculate between the two. For example, in "Culturally Relevant Mathematics Teaching in a Mexican American Context," Gutstein, Lipman, Hernandez, and de los Reyes (1997) make the social turn by placing culture and context at the center of their Freirean participatory project. The purpose of the project was "to contribute to a theory of *culturally relevant teaching*…of mathematics in a Mexican immigrant community" (p. 709). It is important to note, however, that Gutstein and colleagues saw their work as a contribution to the existing body of knowledge; they did not profess to be creating *a* theory that would predict mathematics success for all Mexican immigrant children. Several data sources were used. Demographic and contextual data (nearly two pages) about the school and participants were included as well as observations, interviews, reflections, and classroom documents. In contrast to studies in other moments, Gutstein and colleagues positioned themselves within the classroom as participant observers—including their own reflections as data—and framed the study as a form of action research—including the teachers as co-researchers. Grounded theory methods guided by literature on culturally relevant pedagogy were employed as a means of data analysis. Data representation presented extended participant quotes and descriptive vignettes, maintaining the integrity of the data by revealing the complexities of mathematics teaching and learning embedded in a Mexican American context.

Sociopolitical-turn Moment

Researchers who explore the wider social and political picture of mathematics education characterize the sociopolitical-turn moment (2000s–). This moment signals a shift toward "theoretical [and methodological] perspectives that see knowledge, power, and identity as interwoven and arising from (and constituted within) social discourses" (Gutiérrez, 2013, p. 40). Similar to the social-turn moment, research in the sociopolitical-turn moment can be located in one of two paradigms—*critique* or *deconstruct*—or osculate between the two (Lather 2006, p. 37). For instance, in "Plotting Intersections Along the Political Axis: The Interior Voice of Dissenting Mathematics Teachers," de Freitas (2004) used "fiction-as-research" to access inner dissenting voices to illustrate how the discursive practices of mathematics instruction are determined by the regulative and normative discourses that frame society. de Freitas was compelled to use fiction (as data) in her postmodern project as only through fiction can dissenting voices of mathematics teachers be explicitly heard. In that, "fiction, as a methodology, has the potential to defamiliarize, to cross boundaries, to transgress cultural norms" (p. 272).

Data analysis was storytelling, as "data representation" consisted of Agnes's, the fictional teacher of de Freitas's inquiry, reflections upon her experiences as both a student and teacher of mathematics. Agnes recalled times when, as an exemplary mathematics student, she questioned the purpose of the mathematics tasks that she encountered, surmising that the only one who stood to benefit was the teacher. As the student, Agnes believed her spoken voice was mere disruptive interference. Agnes lamented that now as the mathematics teacher she was "part of the fraudulence that torments youth" (p. 268) and expressed remorse for the students for whom she continued to surrender to normative expectations due to their exhaustion produced by resistance. Nevertheless, Agnes emerged resolutely from her guilt and confusion determined to expose the scandalous foundation of mathematics to right a terrible wrong.

Closing Thoughts

Each of the four moments of mathematics education identified—process–product, interpretivist–constructivist, social-turn, and sociopolitical-turn—can be mapped more or less to one or two paradigms of inquiry—predict, understand, emancipate, and/or deconstruct. Consequentially, each moment depends primarily on different epistemological and methodological perspectives and thus on different methods of data collection, analysis, and representation. We believe that embracing methodological diversity assists in expanding the landscape of mathematics education research so to address persistent inequities in new ways (Bullock, 2012).

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