Un-bordering Early Mathematics Pedagogy: Culture, Content, and Identity in Critical Professional Development

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Abstract

On the whole, primary grade teachers present s light content knowledge backgrounds in mathematics, and this bodes poorly for their preparedness to provide learning experiences that promote deep understanding for the children they teach. For many of these teachers calls for equity in mathematics instruction, in the context of contemporary culturally diverse U.S. schools, can constitute an overwhelming professional and personal challenge. For others, however, juxtaposing the issues of high-quality mathematics instruction, cultural diversity, and equity can represent a welcomed impetus to challenge themselves to examine critically the substance of their pedagogy. This paper describes one such teacher and how she was affected by the experience of participating in a multi-year professional development research project.

Keywords: Early mathematics pedagogy, critical professional development

Introduction

The nature and substance of the learning opportunities afforded children in kindergarten, first, and second grade classrooms establish an important foundation for their academic success in later grades. Arguably, in no area of study is a strong foundation in these earliest grades more far-reaching than in the discipline of mathematics. As a subject in the standard U.S. elementary school curriculum, mathematics has now attained a status commonly associated with literacy instruction. This is to say researchers report that children's understanding of early mathematics concepts may represent a critical bellwether for their later success in other school subjects including literacy (Cross, Woods, and Schweingruber, 2009). Unfortunately, many children do not acquire deep understanding of the most elemental ideas in mathematics. Consequently, this situation can cast these children into symbolically bordered academic territory that negatively impacts their attitudes toward mathematics and school in general.[1] A disproportionate number of the youngsters in the U.S. who experience this outcome in mathematics are those from ethno-racial minority and economically poor backgrounds. Primary grade teachers figure prominently in disrupting practices that foretell such academic outcomes for these children; yet to do so teachers must recognize, and work to dismantle, borders which demarcate their *own*

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[1] In schools where ability grouping and tracking are prevalent, students are often literally assigned to demarcated spaces commonly characterized by curriculum that lacks rigor and teaching practices that fail to promote deep mathematical understanding.

mathematics knowledge and pedagogy, and thereby deskill and de-professionalize them in their work spaces.

This paper describes a multi-year professional development research study that sought to "un-border" early mathematics pedagogy. Using the case of one first-grade teacher, we highlight significant aspects of this teacher's journey toward critical awareness and understanding of three symbolic borders surrounding her professional practice. We detail how her participation in a multi-year research project ultimately paved the way for her to begin enacting a professionally challenging and personally emancipating critical pedagogy.

Theoretical Framework

Nurturing Mathematics Dreamkeepers (NMD)[2] was a quasi-experimental, longitudinal professional development intervention study designed to explore how K-2 teachers understand and adopt standards-based teaching practices (National Council of Teachers of Mathematics, 2000) that have potential to promote young children's deep understanding of early mathematics concepts. Two ideas formed the NMD conceptual framework and served as the focus of the study's professional development intervention. These ideas were *standards-based mathematics instruction* and *cultural relevance*. Both are theoretically situated in social constructivist conceptions of the teaching-learning process (Palincsar, 1998). Hence, NMD supported the notion that teachers need to acquire critical understanding of the socio-cultural contexts in which children develop as well as the manners in which outside of school realities impact children's mathematics learning in schools.

The orientation to standards-based mathematics instruction adopted for the NMD project was grounded in the assumption that children's mathematical realities are not independent of their established (i.e., home/cultural community influenced) ways of being. It suggests that what a child sees, understands, and learns is constrained and afforded by what that child *already* knows, and that mathematical learning is a process of transformation of one's knowing and ways of acting (Simon, Tzur, Heinz, Kinzel, and Smith, 2000, p. 584). In the classroom context standards-based instruction manifests in the teacher's recognition that children themselves must construct meanings for mathematical ideas on the basis of their extant conceptions that may be quite different from those of the teacher (Tzur, 2002). This perspective of mathematics teaching represents a difficult shift in the ways many primary level teachers think about what young children know and understand about mathematics (Simon, et al., 2000). Teachers must let go of the notion that "we understand what we see" and recognize that "we see what we understand" (p. 585). Moreover, teachers must acknowledge that what we "understand" as well as what we "see" are greatly informed by our culture. For the NMD project, culture was defined as "the consistent ways in which people experience, interpret, and respond to the world around them" (Marshall, 2002, p. 8) including the

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tendencies, styles, and/or orientations commonly exhibited in academic contexts by children from the same cultural/ethno-racial communities or backgrounds.

Drawing on this broad interpretation of culture, the NMD study participants were introduced to the notion of cultural relevance as a critical element in an equity-based pedagogical orientation. At its core cultural relevance promotes *cultural centering*, which Marshall (2002) defined as "the deliberate efforts of teachers to lessen incongruities among curricular content, the techniques and strategies they use in the teaching-learning process, and the cultural worldviews of their students" (p. 297). According to Ladson-Billings (1994) there are three primary tenets of cultural relevance: *high academic achievement*, *cultural competency*, and *sociopolitical consciousness*. Teachers who effectively promote high academic achievement among students use an array of resources and presentation styles that align with their students' unique learning tendencies. They incorporate students' cultural realities into instruction and in so doing, create a learning atmosphere that is unique to the children in the class in order to enhance interests in academic learning. In a similar vein, cultural competency refers to teachers' abilities to "capitalize on the cultural practices and sensibilities of their students" (Nasir, Hand and Taylor, 2008, p. 219). Yet it also addresses teachers' abilities to acknowledge themselves as cultural beings, and to recognize that without critical awareness of the subjectivities undergirding their pedagogy, teachers can inadvertently diminish (rather than promote) learning. Students most vulnerable to experiencing academic underachievement or failure in such circumstances are those whose ways of being and worldviews do not align with those explicitly or symbolically reified through classroom/school protocols. Lastly, sociopolitical consciousness speaks to teachers' knowledge of structural inequities (e.g., status, resource, and power differentials among diverse groups) in the larger U.S. society and how these manifest in schools. Despite Civil Rights legislation and the anti-discrimination policies enacted in many schools, in the U.S. a child's race/ethnicity and economic class, more commonly than not, still do matter in whether that child will gain access to high quality schooling (Noguera, 2001; Orfield and Lee, 2006). Teachers who adopt cultural relevance as a professional orientation work with colleagues, parents, communities and the students themselves to prevent this probability or neutralize it affects.

Our goal in NMD was to capture and analyze the extent, if any, to which teachers incorporated tenets of cultural relevance into their pedagogy in general, and their mathematics instruction in particular. This meant that where possible, through the project intervention we sought to facilitate an epistemological shift in the pedagogical orientations (Gay, 2002; Haberman, 1991; Hooks, 1994; Simon, Tzur, Heinz, and Kinzel, 2004) of the K-2 teachers, and thereby promote (provoke) changes in their classroom interactions and professional worldviews. The idea of *pedagogical orientation* was interpreted as the actual techniques and strategies used to deliver mathematics lessons; yet it also encompassed the substance and focus of the teacher's articulation of pre-teaching intents and post-teaching reflections. The "shift" we sought involved the teachers themselves perceiving a need to alter, or change outright, their pedagogy in response to being challenged to 1) examine impacts of culture on the teaching-learning process; 2) confront their own mathematics content knowledge; and

3) reflect on the implications of adopting *culturally relevant pedagogue* as a professional identity with a focus on self as teacher *and* learner of mathematics.

Method

Elementary (K-5) schools located in the same large urban school district, and that met pre-established selection criteria, were solicited to join NMD. Over a five-year period the student population in this school district (located in a southeastern state of the U.S.) grew from 125,000 to its current 137,700. Comprised mostly of small rural districts, historically the ethno-racial composition of the student population in this state has been more than 70% White American and approximately 25% African American with "other" groups comprising the remaining trace percentages. Presently, the state's student population is 54.3% White American, 31.2% African American, 2.5% Asian-Pacific Islander, 10.7% Hispanic American, and 1.4% American Indian. Persons moving to the state from other regions of the U.S., as well as immigrants from Central and South America account for the demographic shift. Even so, the ethno-racial diversity among the state's student population contrasts sharply with that of its elementary teacher population. Remaining largely unchanged since at least the 1990s, it is currently 84.4% White American, 12.6% African American, and 3% "other".

Participants

Each school solicited to join NMD in the initial recruitment year was required to have at least 3 classes at each of the targeted grade levels (K, 1, 2), a racially diverse student population, and a documented mathematics achievement gap between African American and White American student groups in the school as determined by a district assessment administered to students at the start of third grade. A minimum of 4 teachers was invited to participate from each school that accepted the solicitation, with the expectation that eventually all teachers in the school from the targeted grades would participate in the project.[3] By the final recruitment year, the experimental/intervention group participants were drawn from six elementary schools in vastly different areas of the district. Composition of the NMD intervention group[4] was made up of practicing kindergarten, first, and second grade female teachers (n=49) organized into three different "cohorts" based on the year they joined the study. Recruitment of Cohort I took place during summer 2005, Cohort II during summer 2006, and Cohort III during summer 2007; thus, Cohort I teachers participated in NMD for three years, Cohort II for

[3] The longitudinal design of NMD necessitated that each Year I school be invited to participate multiple years. As required by the University's Institutional Review Board teachers were informed they could opt not to participate even if their school had joined. Correspondingly, for every year of participation, each teacher completed an Informed Consent stipulating she could discontinue participation at any time. In Year I each school identified two teachers from each of three grades (K, 1, 2) or two teachers from each of two consecutive grades (K -1, 1-2); whereas in the subsequent year(s) schools were expected to bring on additional teachers from each grade that had joined previously. Not all schools could honor the multi-year commitment, thus in Years II and III new schools were solicited to join NMD.

[4] In the final data collection year, a control group of 16 teachers drawn from a seventh school was added to the study.

two years, and Cohort III for one year. During the second and third years of the study, three of the six intervention group schools had multiple cohorts of NMD teachers. At each school participants were organized into peer or "buddy" groups of 2-3 same-grade NMD teachers. As part of their participation, all were required to be videotaped teaching mathematics lessons, observe their buddy(ies) teaching mathematics lessons, participate along with their buddy(ies) in post-teaching guided reflection sessions, attend NMD retreats, complete project data instruments, and participate in one-on-one interviews at the start and conclusion of each project year. All intervention group teachers received a $1,000 stipend each year they participated in NMD. This paper focuses on one intervention group teacher who was a member of Cohort I. A profile of the teacher and her school site are presented later in this discussion.

The Intervention

A series of 2-day "retreats" spaced throughout each academic year and totaling approximately 90 hours of professional development over the course of each project year constituted the NMD intervention. Retreats took place on school days during normal teaching hours (8:00- 16:00). Sessions were organized into 1½-2 hour segments and included a combination of brief lectures, small group work sessions, small and large group discussions, and group simulation activities.[5] Additionally, teachers shared and analyzed student work samples, engaged in reflective writing activities about cultural relevance (in general and in their own teaching), and completed private viewing and evaluation of their own videotaped mathematics lessons. Each retreat included opportunities for teachers to work with professional peers in same grade, cross-grade, same school, and cross-school configurations. Also teachers were commonly grouped to facilitate diverse ethno-racial and professional experience interactions. Content for retreats was drawn from the two conceptual themes for the project (i.e., standards-based mathematics teaching and cultural relevance). Among the mathematics topics were *number representation* and *decomposition*, *place value*, *patterns* and *sequences*, *problem solving*, and *algebra*; whereas cultural relevance topics included *cultural normalization* and *devaluation*, *group values*, *intercultural sensitivity*, *U.S. dialects* (with a focus on *African American Vernacular English*), and *ethnic and racial identity development.*

Data Sources and Collection Protocol

There were eleven different data sources (quantitative and qualitative) for the NMD project some of which occurred at the school sites and others as part of retreat

[5] Each cohort attended a separate collection of retreats. The content covered in Year I for Cohort I was repeated for the initial year of Cohort II and the single year for Cohort III. During Year III, Cohort II retreats were similar to those that had occurred for Cohort I in its second year. Also, in Year III Cohort I teachers participated with the NMD PIs/authors in planning and delivering retreat sessions to Cohort II or Cohort III teachers. All but a few retreats were held on the University campus with breaks scheduled and meals catered to eliminate the need for teachers to leave the site until the conclusion of the day's retreat. The grant paid for substitute teachers and, to avoid conflicts with teachers' other professional obligations, dates for each retreat were pre-selected at the start of each NMD year based on the district-wide calendar of events.

sessions. Classroom and school-based data were compiled by a team of research assistants (RAs) who had completed extensive training in use of camcorders for data collection purposes. Additionally, the RAs received training in how to conduct one-on-one interviews, facilitate post-teaching guided reflection sessions, analyze lessons, and code interview and guided reflection session transcripts. To complete this case study, we used a mixture of quantitative and qualitative findings drawn from three project data sources. The next sections provide a description of each.

Teacher Mathematics Survey.

Designed for NMD, the *Teacher Mathematics Survey* was used to assess teachers' understanding of various mathematical concepts (the "big" ideas) commonly taught in K-2 classrooms. Items addressed the strands as defined by the National Council of Teachers of Mathematics (2000) including: *number* and *operations, algebra, geometry, measurement,* and *data analysis*. Completion of the questionnaire items required teachers to solve a series of mathematical problems and to provide an explanation for each solution. Scoring focused on correctness as well as the quality of the explanation provided for each item, with greater emphasis placed on the latter as an indication of the depth of the teachers' own content knowledge and understanding of the concepts.

Videotaped Mathematics Lessons.

Teachers were recorded teaching mathematics at four separate intervals during each academic year they participated in NMD. Each recording session comprised two lessons occurring on two consecutive school days. Analysis of the mathematics lessons was completed using a three-phase process: (1) lesson mapping; (2) lesson rubric coding; and (3) transcription of verbal communications. Lesson mapping comprised a written description of the structure of individual mathematics lessons with primary focus on the teacher's actions. Categories included *whole class* or *small group instruction*, *exploration*, *review*, and *sharing*. The second phase, lesson rubric coding, involved use of an instrument we designed to track the frequency of teacher-initiated verbal communication that aligned with the tenets of cultural relevance. Also, lesson rubric coding was used to track the teacher's verbal communications intended to highlight, clarify, and/or utilize students' mathematical thinking during a lesson. Categories for the rubric included *learning connecting*, *illuminating thinking*, *affirming multiple representations*, *extensions of tasks*, *language matching*, *relevance making*, *cultural connecting*, and *communalizing*. The entirety of each lesson was coded using tallies to designate each time verbal communication categories occurred within each two-minute interval. The last phase of lesson analysis was transcription of the verbal communications. After each lesson was coded with our rubric, the verbal communication represented by each tally was transcribed verbatim.

Interviews

Teachers participated in one-on-one interviews, post-teaching guided reflection sessions, and (in some cases) a post-intervention focus group conversation[6]. All were video recorded and transcribed. Each data source was analyzed separately using the same thematic content analysis process (Coffey and Atkinson, 1996). Separate codebooks for each type of interview using both theoretical (based on the NMD conceptual framework themes) and data-driven codes were created (DeCuir-Gunby, Marshall, and McCulloch, in press). For each codebook, we examined the relationships between the codes, theory, and our research study goals (Coffey and Atkinson, 1996). Codes were first organized into larger themes/categories by examining the relationships between codes and then grouping all related individual codes together. We then made connections between the larger themes/categories, compared these to our larger research goals, and interpreted the findings.

Case Study of a First Grade Teacher

The case study teacher, Johnetta Winspring, was a member of NMD Cohort I. In the first year of the study Cohort I consisted of 21 teachers from three area schools. At 49 years old, Johnetta was one of the more mature and more professionally experienced teachers in Cohort I. She taught first grade at Rhine River Elementary[7], a culturally diverse school with a student population comprised primarily of White Americans (66.9%), African Americans (15.8%), and Hispanics (10.3%). Additionally, 25% of the students at Rhine River were eligible for free or reduced-price lunch while approximately 8% did not speak English as a first language. Located on the outskirts of the district, Rhine River is a sprawling one-story complex with a bright and welcoming atmosphere. Classroom corridors displayed children's writings and artwork, and the hallway at the main entrance to the school showcased faculty and staff who were distinguished in some manner. Among the categories were National Board Certified Teachers[8], National Board Certified Candidates, Teachers with Master's Degrees, Teachers in Graduate School, Professional Learning Community Leaders, Teacher Assistants with Degrees, Community Involvement Leaders, and Dreamkeepers. The NMD teachers (aka "Dreamkeepers") at this school were very well represented in this showcase, and some of them appeared in two or three different categories.

[6] Select teachers from all three cohorts were invited to participate in a focus group interview/conversation one year after the study concluded. The teacher presented in this case study report was among that group.

[7] The teacher and school names are pseudonyms. By Year III, only 8 Cohort I teachers remained in the study. Eleven left at the end of Year I due to unanticipated circumstances including involuntary transfer/re-assignment to new schools, family relocations to different states, and pregnancy. Only one Cohort I teacher noted "personal reasons" for leaving the study after the first year. In Year II, one additional Cohort I teacher left the study due to childbirth.

[8] In the U.S., National Board Certification is an advanced teaching credential valid for 10 years and achieved upon successful completion of a voluntary assessment program. Trained teachers in the particular certificate area evaluate each applicant's teaching competence on10 different assessments. For more information visit http://www.nbpts.org.

Rhine River joined NMD under the leadership of an enthusiastic and well-regarded principal whom Johnetta affectionately characterized as a "math person"[9]. By all accounts theirs was a good teacher/principal relationship although on several different occasions during her 3-year tenure in NMD, Johnetta acknowledged that it had not been the mathematics, but rather "the culture piece", which initially sparked her interest in the project. Both Johnetta and her principal are African American. At the time she joined NMD, Johnetta had been teaching over 25 years, five of which had been at Rhine River. Prior to securing a position at Rhine River, however, Johnetta had taught in a small rural school district in an area of the state where she had been born and raised. For Johnetta, that area was distinguished by the fact that as late as the 1980s black/ white race relations had not changed significantly from the 1960s when Johnetta had been an elementary student.

Johnetta displayed a positive and largely confident professional demeanor and this was partly evidenced by the information that appeared in her electronic signature block. It informed all recipients of emails from her that Johnetta is a Nationally Board Certified teacher. Throughout her three years in NMD she maintained a focus on the study's questions surrounding the impact of culture on the teaching-learning process although near the end of the first year she had begun to exhibit acute interest in the mathematics as well. Still and all, Johnetta revealed that she was initially apprehensive about NMD and wondered whether its *real* intention was to showcase the shallowness of the teachers' mathematics content knowledge. Further, she wondered if the plan was to spotlight African American teachers in particular as those most in need of professional development in mathematics. By the end of the study, Johnetta had shown considerable evidence that she was no longer suspicious of its purpose but rather had come to embrace the goals of NMD as consistent with her own professional goals.

Findings and Discussion

In this section we present a discussion of the nature and progression of Johnetta's recognition and critical awareness of borders surrounding her pedagogy in general, and her mathematics pedagogy in particular, during the span of her three-year tenure in the study. The three interrelated foci examined include: 1) how she confronted and dealt with a restricted understanding of the notion of *culture* and its impact on the teaching-learning process; 2) the absence of depth in her mathematics content knowledge and its influence on the substance of the opportunities to learn afforded children in her classes, and 3) the nature of her personal identity as a mathematics learner and her professional identity as a culturally relevant pedagogue.

[9] Rhine River had two principals (both African American females) during the span of the NMD project. Johnetta referred to the first principal in this manner, and she appeared to have developed a similarly easy relationship with the second principal as well. At Year III, Rhine River was the only school in the study with teachers in all three NMD cohorts.

Culture in the Teaching-Learning Process

There were several objectives we pursued in conjunction with the plan for NMD participants to acquire critical understanding of culture in the teaching-learning process. First, we wanted to help the teachers recognize culture as a multifaceted phenomenon that is fundamental and thereby significant to most, if not every, facet of schooling (Gay, 2002). Secondly, the teachers were to become attuned to the impact or implications students' cultures (i.e., frames of reference, experiences outside of school, language, etc.) present for their success in school. This meant the teachers were made aware of how, for some children, common school conventions create a high-stakes absence of synchronization (Irvine, 1991) between outside of school versus inside school opportunities for learning. Yet a third objective (which for some teachers was far more challenging and thereby more elusive) was recognizing self as cultural being, and engaging in critical examination of the taken for granted experiences, frames of reference, and general worldviews they, as instructional leaders, bring to the teaching-learning process. By accepting the challenge to turn the analytic lens on self, the teachers were expected to begin questioning the degree to which their own cultural frames of reference (including their very conception of what constitutes culture) facilitated or had potential to hinder learning for students who did not share the teacher's worldview or cultural background. In short, the teachers were challenged to consider what it means to acquire and enact K-2 mathematics pedagogy from a position of critical cultural consciousness.

Unlike many of the other teachers in the project as a whole, and most of the teachers in the initial year of Cohort I, Johnetta was eager to engage in dialogue about the impact of culture on the teaching-learning process. It soon became apparent, however, that her interest and willingness to engage in such dialogue, as well as the substance of her understanding of the various issues raised, were not based entirely upon her experience as a teacher. Instead, Johnetta frequently drew upon her own background as a member of a U.S. racial minority group and her related life experiences to make sense of the culture-school connections. In a post NMD interview, for example, she noted that her interest in the culture aspect of NMD was directly tied to her own life experiences.

> The culture I embrace I guess because I lived so much of that. Like I shared one time I didn't know how to put a name with [it]… because I saw this strictly as a racial thing….When] people don't understand your culture … it looks like they don't understand you as a whole race of people. So, that culture piece just fit right in. I mean I was embracing that every which way I could because I thought oh, finally it makes sense that that's not [just] all in my head…. [Focus Group Interview]

Johnetta perceived that her lived reality, which was marked by early experiences with hostile black/white race relations in this U.S. southern state, provided unique insights into the role teacher understanding and appreciation for cultural diversity perhaps should have on the teaching-learning process. By drawing on personal

experience she demonstrated empathy for students from backgrounds (not unlike hers) that some teachers still perceive as pathological and are therefore devalued in schools. Even so, when describing her thoughts on how students learn, there is evidence of what might be described as an internal contradiction. Hence, the initial sentiment in her comment below is decidedly contrary to the focus of NMD. Asked how children's backgrounds contribute to their learning, she responded

> Students whose parents talk at them instead of to them, and [those for whom] exposure is not as great, I think sometimes have a tendency not to initially do as well. But [I'm] not saying they don't have the tools, but maybe it hasn't been tapped into. … [Interview/Yr II]

The above response includes Johnetta's allusion to a deficit viewpoint about the backgrounds/ home lives of some children ("… *parents talk at ... instead of to* …") while at the same time it includes acknowledgement that the substance of a student's knowledge base may be unknown to a teacher *("... but maybe it hasn't been tapped into*...*"*). Thus, in the midst of articulating her ideas about children's learning, she seemed to engage in a kind of self-correction that perhaps was grounded in a sensitivity we discovered was borne out of her personal experience with having been a learner whose background knowledge and very being was de-valued in schools.

When as a follow-up to the above response Johnetta was asked the more specific question of how children's cultural backgrounds contribute to *learning math*, she replied "'pretty much the same answer that I gave you the first time. I really think it's their environment, what they're exposed to, what's important to the family. …". On first blush, this response seems to reinforce the suggestion that Johnetta's understanding of culture in the teaching-learning process was bordered and weighted down by an underlying deficit viewpoint. Yet, making a direct connection to her *own* background, she broadened her response and presented thoughts that were clearly devoid of the specter of deficit thinking thus revealing that her ability to appreciate the issues being raised in NMD about culture were being contextualized in her own school experience. She noted,

> In my household, for example, behavior and not getting in trouble … appeared [to be] … more important than [whether] I get [sic] the math concepts, ... Now, when it came time to cook, and things of that sort, measurement was taught. But it wasn't taught that this is math. [Instead the emphasis was on] this is how I want this [dish] to turn out. …. If we had chores outside, the mathematical piece was there, but not in [specific school-related] terms. So, I'm not sure I can even say culturally, that [certain] children aren't exposed. It's probably [that they're exposed] in a different manner. [Interv/Yr II]

Johnetta acknowledged in the focus group interview (which occurred one year after the formal data collection for the project had been completed) that prior to NMD

her notion of culture had been limited to *race* – specifically African Americans and Caucasians. All the same, in early interviews she showed signs of rejecting (or at least not accepting) a longstanding U.S. cultural dichotomy wherein the overall population is typically bi-modally divided into majority (white Americans) and minority (all persons not classified as racially white). Asked to share her concerns about drawing on students' cultural backgrounds when she teaches math Johnetta shared "[m]y biggest concern would be a misconception that I may have about their cultural background. Because my exposure has been limited pretty much to two races of people." Her expansion on this response demonstrates that by the start of Year II of the project, she had begun to understand the notion of culture more broadly and inclusively suggesting that the narrowing border that is "race" as the sole facet of culture for Johnetta, was being dismantled. She continued "[p]robably the socioeconomic part, probably [my exposure is] very limited. So, a lot of it [what I would draw upon] would be built on what I've 'heard' or what I've read, or what I 'think' I know…."

Another noteworthy finding regarding Johnetta's understanding of culture was related to the nature of the introspection in which she engaged as the project progressed. As noted, at the start of her second year she had already begun to think about culture beyond her experiential "black/white" prism. Asked what she would like to learn during the second year of the project she replied

> …how the culture maybe of other ethnic groups like the Hispanic group or the Asian group, or the Hmong group, how their culture plays a part in the mathematical piece. So, I'd like to see or experience how it impacts what … I do different as an educator [for those groups]. [Interv/Yr II]

Then, expanding on her response to the above question, she recognized and arguably exhibited a deeper understanding of the culture/teaching/learning connection, when she acknowledged that her own background may provide particular advantages in her classroom for children who share her race/culture (i.e., African American children). She added, "… as an African American teacher, based on my teaching style, I think the African American students possibly will be okay. It's the other group[s] that I have no personal experiences with." It is noteworthy that Johnetta did not use definitive phrasing to express the academic advantage she seemed to imply could result for African American children in her class. Instead, her phrasing is tentative and measured ("… *possibly will be okay* ...") which we believe suggests that she was beginning to acquire a more complex understanding of the notion of culture as manifested in the realities of intra-group diversity.

Confronting Mathematical Knowledge

Earlier we noted that when she began the NMD project Johnetta was quite apprehensive of its focus on mathematics. She recognized that her knowledge of mathematics was not where it needed to be and this was aggravated to some extent by her leeriness of the white male who served as the mathematics PI during the first year of

the project.[10] While she had not always disliked math, she noted in an interview that it was a particular white male teacher in high school that changed things dramatically for her. Of her success with math in that class she said, "[i]t was based on who I was and what I look like. And he taught to the Caucasian males. So then that shift started. [I began to think] well something's wrong with me that I can't get this. And he pretty much confirmed yes, something is wrong with you." Johnetta went on to graduate from high school and enter college where she got a tutor and barely made it through her one required math class. At that point she acknowledged, "I knew I had better be an elementary school teacher because if I had to do math higher than third grade some child would be in trouble."

When she joined NMD Johnetta's knowledge of elementary mathematics was indeed slight. Johnetta's correctness score was 35.7% on the NMD *Teacher Mathematics Survey*, almost 20 points below the Cohort I mean. Her quality of explanations score was 42.8%, 6 points below the Cohort I mean. Reflecting on her first year in NMD Johnetta noted that her lack of knowledge made the experience so frustrating that she considered quitting.

> The first mathematical experiences that we got from the instructor were so far beyond [what I knew mathematically]. I mean I'm a college graduate but still not math – no it was enough to get by but never embracing [it fully]. So the things he was asking even during the activities was very frustrating. Frustrating to the point that I really wanted to quit that whole program because of the math. Not the culture piece but the math.

When asked if she thought other participants felt similarly she replied:

> Even the ones that were good at math got frustrated. But I think their frustration was 'I should know this and I don't'. My frustration was 'I know I don't know it, and you're talking basically Greek'. So I really didn't like it. And I'm the type that I want to ask questions and then [I discovered that] I couldn't get a clear-cut answer because he was trying to make me think about my math. Well there was nothing to think about because there was nothing there. So it was very frustrating.

Johnetta identified one particular NMD retreat activity as being very impactful on her views of self as a mathematics learner, the mathematics autobiography. When reflecting on the experience of writing her mathematics autobiography, she shared that upon joining NMD she had thought,

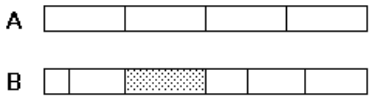
> Well something's wrong with me that I can't get this. And he [the high school teacher mentioned earlier] pretty much confirmed yes, something is wrong with you…After the NMD experience and I

[10] There were three different co-PIs for mathematics during the span of the NMD project. The second co-author of this paper served as the third co-PI for mathematics.

> was able to put a face with all of that stuff that had been burned inside of me for years that what I do as an educator can impact the student years down the road. And then that just gave me the freedom to say there wasn't anything wrong with me…. [Focus Group Interview]

Throughout the second and third years of the NMD project we witnessed Johnetta fully engaging in every mathematics activity that was presented to her. She openly asked questions of both the researchers and her peers. Similarly, she continuously pressed herself to understand why something worked the way it did, and when she felt she understood she was quick to turn to others to push them as well. The final time she completed the *Teacher Mathematics Survey* we saw marked improvements in Johnetta's explanations of elementary mathematics. Her correctness score increased from 35.7% to 44.8% (still 20 points below the mean) and her quality of explanation score increased from 42.8% to 58.6% (6 points below the mean). To illustrate the nature of the growth in Johnetta's mathematical understanding consider the following problem:

In the picture you see two candy bars of exactly the same size, *A* and *B*.
Candy bar *A* is partitioned equally into four pieces.
Candy bar *B* has six, unequal pieces.
The shaded piece on candy bar *B* is exactly the same size as the part above it on candy bar *A*.
a. What fraction is the shaded piece of candy bar *B*? Explain.
Answer: The shaded part is _____ of candy bar *B*.
Explanation:
b. What fraction is the shaded piece of the two candy bars combined? Explain.



Answer: The shaded part is _____ of both candy bars.
Explanation:

In fall 2005 Johnetta provided the correct answer to part *a* (¼) along with an incomplete mathematical explanation. She wrote, "It is the only equal part of the candy bar based on candy bar A." For part *b* she responded incorrectly (½), with an accompanying explanation of ¼ + ¼ = ½. In spring 2008 Johnetta provided very different responses. To part *a* she answered correctly again (¼), but her explanation was both mathematically correct and complete. She wrote, "There are 6 unequal pieces but 4 equal pieces if you combine the 2 smaller pieces as a whole." For part *b* she answered correctly as well (1/8) along with the following explanation extending from her explanation for part *a*, "There will be 8 equal parts." Based on these responses there is no doubt that Johnetta's understanding of fraction improved during her participation in the NMD project.

While as measured by the project's *Teacher Mathematics Survey* Johnetta's content knowledge of K-2 mathematics has only slightly increased, we see discernible differences in the way she thinks about the teaching and learning of mathematics. When explaining how NMD has changed the way she teaches math Johnetta explained that she used to think

> I'll teach you the steps and if you don't do the steps the way I do the steps then you didn't get it. So it was not looking at well how would you do this? What do you already know about doubling or word problems or any mathematical concepts. I taught procedures. [Focus Group Interview]

By the end of the project, she expressed the following sentiment.

> I can put a word problem up and talk about the word problem and make sure they understand what I need. And then show me how you would answer that. Why did you do it that way? And trying to get a variety of children on different levels to show how they would. Which also teaches other kids oh I didn't think of it that way. [Interview/Yr III]

The change did not come easily. We see in video recordings of Johnetta's math lessons and in her reflections that this change in thinking about mathematics teaching came over time. Johnetta readily acknowledged that the change was not easy,

> Because I knew the ways to do it. I knew my way would get you the results that I was looking for. So turning that loose mean[t] I'm giving my power and ownership away not realizing it wasn't about me anyway. I already knew how to do it. But just because I knew how to do it didn't mean there weren't other avenues. [Interview Yr III]

During her participation in NMD Johnetta was forced to confront her mathematical content knowledge (or lack thereof). Through reflecting on her experiences as a learner of mathematics and engaging in mathematical activity that pushed her to deepen her current understandings, Johnetta pushed through a border that she had erected (in no small part with the assistance of insensitive teachers) for herself long ago. The removal of this border in her own understanding has positively impacted her mathematics teaching practices in ways that are sure to remove secondary borders she undoubtedly albeit inadvertently created around the mathematics understanding of her students. In her mathematics autobiography Johnetta wrote,

> Odd but true, being in [NMD] … has helped me to deal with the demons of math. I finally enjoy teaching math to my young students, but I am well aware of my shortcomings. I am a better math teacher today than I was five years ago. I love listening to

> my students discover their strengths in the area of math. I feel I have given them the freedom to make mistakes and learn from them and to keep plugging onward. [Year III Math Autobio].

Professional Identity

Through the NMD focus on cultural relevance as a critical pedagogical orientation, we sought to affect more than just the teachers' instructional methods and knowledge of diverse learners. Instead, our aim was to impact the very identities of the teachers by directly challenging them to grapple with what it means to be an educator in a primary grade context. To this end, they were invited to wrestle with the implications of shoring up one's content knowledge, instructional skills, and attitudes in order to make a firm claim on the identity of *professional* as it relates to the early mathematics teaching-learning process. The teachers were guided through discussions of the intellectual nature of classroom teaching (i.e., the notion of continual teacher growth and development). They were invited to contemplate the gravity of children not receiving high-quality mathematics instruction in the earliest grades along with the long-term sociopolitical consequences of innumeracy (Moses and Cobb, 2001; Paulos, 1988). Further, we attempted to promote critical consciousness by inviting them to consider manners in which typical elementary school work environments often de-professionalize teachers through de-skilling and intensification (Apple and Jungck, 1990). During the first year of each NMD cohort, the teachers engaged in a self-reflection/identity exercise wherein invariably they would all characterized themselves as *professionals*; yet when probed further nearly all agreed that others (e.g., parents, citizens, other educators) perceive K-2 teachers quite differently. It was our hope that the NMD teachers would recognize that absent a critical pedagogy, ultimately all teachers engage as little more than semi-skilled technicians in the complex context of contemporary culturally diverse schools.

By Year III Johnetta was self-identifying as a *culturally relevant mathematics teacher*. And in conjunction with this identity she was demonstrating ability to engage in substantive self-critique of her classroom practice as well as openness to acknowledging (and addressing) the limitations of her mathematical content knowledge. Owing to her deep interest in the "culture piece" of NMD, Johnetta also had begun to see herself as an active agent in the delivery, if not the construction, of knowledge about teaching diverse students to her Cohort II and III colleagues. Similarly, she had begun to recognize the importance of engaging non-NMD teachers at her school in conversations about culture in mathematics teaching and learning if the impact of NMD was to spread beyond the eleven teachers at Rhine River Elementary who had volunteered to be part of the project.

Although in many ways Johnetta successfully reached the hoped for "pinnacle" of the NMD experience, her affinity for a critical pedagogy of possibility was initially obscured by hints of a pedagogy of poverty (Haberman, 1991). This situation became apparent as part of a post-teaching guided reflection session during her first year. When asked to reflect on aspects of her buddy's lesson that may have hindered learning, instead of directing comments toward the actions of the teacher, Johnetta focused on a particular student. She replied, "I think he [the student] hindered the lesson by his lack

of understanding, or his … not wanting to understand. I'm not sure what it was with him." This jarring indictment of the student for the apparent instructional missteps of the teacher is a common explanation of instructional failure in the pedagogy of poverty. Nevertheless, it is somewhat difficult to discern whether Johnetta's response reflected a predisposition to (exclusively) hold students accountable for not learning, or whether it represented an awkward attempt to avoid finding fault in the instruction of her buddy teacher. Either way, the comment offers some evidence of a border surrounding Johnetta's early interpretation of the nature and purpose of peer reflection in *professional* development.

Like Johnetta, many of the NMD teachers (particularly in Cohort I) were initially quite uncomfortable offering professional critique of their buddy's instructional practices. But by the second year of the project, this had changed when several Cohort I teachers shared with the lead PI/author their desire for less "nice-nice" interaction during reflective sessions. In post-NMD reflections, Johnetta had the following to say about the nature of interactions during the reflection sessions.

> And with Cohort One, … I think there was probably more of a [need for] trust building before or once we got engaged. [This is because]… initially it was kind of tip toeing through the tulips. Once you [got to] know people's personalities – she's very straightforward, I'm very much straightforward… most people who are straightforward have to be able to take it too so I think I tried to set the tone. I want to be a better educator so [my buddy needed to understand] don't sugarcoat it because what I'm doing is impacting student learning. If I want to be a better person and my students [to] be more successful, I need for you to be very honest in what you see because even being an experienced teacher I was still taught an old way. [Focus Group Interview]

To the extent that Johnetta's reply in Year I (noted earlier) reflected aspects of a pedagogy of poverty in her own practice, by Year II it had largely been replaced. For example, when asked to describe her biggest concerns about teaching math she noted, " [s]ometimes … [I wonder] am I getting across to the students what I really want them to learn? And I have a tendency to adjust the lesson so many times that I wonder if I have confused the students" [Interv/Yr II]. In that same interview there is even evidence of a nascent sociopolitical consciousness of the implications a strong mathematics foundation presents for a child's future academic success as well as an un-bordering of Johnetta's identity as a mathematics learner. When asked how she views herself as a teacher of math, Johnetta replied

> I think one thing that I have tried to really incorporate is I'm not teaching math just to be teaching math. … I think … it's trying to make that real-life application --to let them know that we're not just doing this just because I need to fill up some space for a particular day. That the reason I am --- I'm teaching math is because there's somewhere in your life that you are going to have to use these skills, apply these skills. And this is a foundation. I'm building your

> foundation for what you're going to do in second grade. So, I view myself as a mathematical teacher that's passionate about teaching the math because I do want them to have a[n] understanding of what it is we're doing and why we're doing it. And that it's making them – or it's part of what they will become, which is lifelong learners. So, I think I'm a very conscientious mathematical teacher. I've got a lot of areas I still need to work on and perfect, but overall I don't take it lightly. [Interview/Yr II]

Finally, we believe the un-bordering of Johnetta's identity as a mathematics learner (evidenced by her above comment) is especially striking when juxtaposed with the following response to a question about how NMD had impacted her attitude toward math. Herein she exposed, perhaps subconsciously, a palpable sense of defeat through her abundant use of terms evoking personal disempowerment.

> Yes. I was in a cage or in bondage. And so that face [of that teacher] that attitude all that put me in bondage for years. [I had once believed] I can't do this or I'm not good at this. And so once I was able to face that demon, --- because that's what it was … [Focus Group Interview]

Conclusion

In this paper we described our multi-year professional development research study targeting K-2 teachers and focused on cultural relevance in conjunction with standards-based teaching practices in early mathematics. Using one first grade teacher who participated in the study for three consecutive years, we described and analyzed how through participation in an extensive intervention she eventually was able to "un-border" her pedagogy and embrace cultural relevance as a professional orientation. One goal of our study was to improve the content knowledge of the teachers through engagement in meaningful mathematics activities that challenged them to acquire their own deep understanding of the concepts while identifying ways to enhance the knowledge of the children they teach. Additionally, we sought to facilitate critical awareness of the impact of cultural diversity on the teaching-learning process and in so doing, challenge teachers to identify ways to make meaningful connections between children's diverse out of school experiences with mathematics, and the experiences the teachers provided in classroom contexts. In general, most elementary teachers have a shallow background in mathematics content (Ball, 2000; Ma, 1999); and scholars have reported that many teachers resist explorations of cultural diversity and its related issues such as racism (Irvine, 1991; McAllister and Irvine, 2000; Tatum, 1992). Thus, we were aware that merging these two foci in NMD could result in an intervention that was significantly intriguing for some teachers while drastically alienating for others. Our ultimate goal was to impact the professional identity of the teachers, and thereby provoke change in their overall pedagogical orientation. Through an examination of the NMD experience of one first grade teacher Johnetta Winspring, we detailed how this teacher successfully grappled with three "borders" surrounding her pedagogy.

These borders included understanding of the notion of culture and its various impacts on teaching and learning, absence of depth in her mathematical content knowledge, and tentative identity as a professional educator. In our estimation, Johnetta was a sparkling example of the ability of a primary teacher to un-border her own mathematics pedagogy. Her commitment to the goals of the project impacted her interactions at her school. In this regard, she responded to the call from her current school principal to present two professional development sessions (to her non-NMD colleagues at Rhine River Elementary) related to culture in the teaching-learning process. Moreover, as a direct result of her NMD experience Johnetta made the decision to pursue a graduate degree during her second year in the project. On one occasion she boasted how she had introduced peers in a graduate course to culturally relevant pedagogy and her experience in NMD. Recently, Johnetta graduated with her master's degree in school administration. In light of the impact of NMD on Johnetta, we offer three conclusions or "take away lessons" from this case study that have implications for future professional development with primary level teachers (or elementary grade teachers in general) that specifically focuses on the issues of equity and the promotion of children's conceptual understanding in early mathematics.

Initially, the promotion of change in teacher's pedagogy is effectively facilitated through peer reflection upon practice. This lesson supports Simon's (2000) work developed through his Teacher Development Experiment (TDE) wherein the critical concept, *knowing-in-practice*, was used to imply reflectivity in teachers' practice. Through the TDE, teacher development is theorized as a process occasioned by changes in the conceptions of teachers through interactions with others, particularly peers, rather than as a distinct end product fashioned in isolation. Johnetta's thought on the power of the buddy reflection feature of NMD supports this idea.

> The second year … [is when] I saw the impact of the program as far as with my math lessons. And one of those things that had the biggest impact was the buddy system where I actually went in and watched a colleague teach a lesson and then had time to talk about each other's lesson. That was a real trust building factor also because it was persons that you maybe work with but you didn't open yourself up to that person having constructive criticisms about a particular lesson you may have been doing. [Interview/Yr III]

Secondly, teacher educators and researchers are well advised to recognize that the absence of depth in the mathematics content knowledge backgrounds of the typical primary grade teacher will likely present an especially obstinate border to dismantle. As such, professional development focused on this goal should be paired with another critical issue that has potential to highlight for teachers the sheer necessity to shore up their mathematics. In the case of Johnetta, the "culture piece" of NMD was the portal through which she recognized that the lack of depth in her own mathematics content knowledge significantly compromised her ability to offer an equity pedagogy (Banks, as cited in Marshall, 2002) to her students. Through this case study, we demonstrated that Johnetta's content knowledge improved thus providing evidence that she had begun to "un-border" this aspect of her mathematics pedagogy. Nonetheless, it is unlikely this

would have occurred for Johnetta had the two issues not been presented in tandem. Johnetta's own words provide a poignant support for this conclusion. Reflecting on her first year experiences she noted they had been "[f]rustrating to the point that I really wanted to quit… because of the math. Not the culture piece, but the math." It was her ability to connect to the cultural focus of NMD, in part through the painful memory of racism in her adolescent schooling experience, that presented the critical opportunity for her to muster the courage to face a longstanding and previously impermeable border surrounding her personal and professional identity as a mathematics learner and teacher.

Finally, professional development interventions geared toward critical pedagogy must occur over multiple years if they are to have a chance of impacting teachers' professional identity and critical consciousness of sociopolitical aspects of their work and role as professional educators. Johnetta was one of a handful of teachers in the NMD project who demonstrated in multiple ways that she was fully engaged in, and had been substantively challenged by, the complex concept that is culturally relevant pedagogy. By Year II, we would learn that her keen interest in this aspect of the project was directly related to her lived reality of encounters with racism in the context of 1960s southern society in the U.S. and her experience as an adolescent student in a newly desegregated school system. Perhaps due to this (or in spite of it) Johnetta responded to the culture emphasis of NMD in a manner that differed strikingly from most of the other teachers who, in direct and indirect ways, exhibited various levels of resistance. Irvine (1991) referred to this latter reaction among teachers as "cultural aversion" noting its confluence with fear that acknowledging and addressing culture (and its related issues including race, ethnicity, values, diverse worldviews) will upset the harmony albeit precarious in school environments. Yet in the context of culturally diverse schools while this aversion may appear to maintain harmony, it also promotes creation of an ominous de-stabilizing border around the pedagogy of teachers who, in the context of contemporary classrooms, are confronted daily with the complexities of cultural diversity in all aspects of their work. Even so, the opportunity to explore and *re-visit* difficult issues over consecutive years, (and then to be charged to help facilitate others' understanding of those issues as was the case in Year III for Cohort I teachers) was a critical element of NMD that contributed to Johnetta's growth. Drawing again on her own words, we note how Johnetta described the significance of the multi-year time span by comparing NMD to her previous experiences with professional development.

> I guess the concern I have [about past professional development] is we try new things and before we get a good handle on it, we abandon it and we try something else. Therefore you never really get to perfect what may have been great for student achievement. Whereas with this project, having been in it for three years, you can see the foundation being built and it was something *you* could build upon and continue to build upon and then it also could reshape your thinking as an educator. To me it's one of the most important things. And as I change as an educator, you can give me all the stuff and I can sit through, like you said, hundreds of workshops. But until I make a shift in my thinking and my teaching that will

> impact students, I [will have] just sat through another session. [Focus Group Interview]

Whether it occurs at the K-2 level or beyond, we believe the un-bordering of pedagogy is a necessary aspect of critical pedagogy. Not all teachers will be ready (or willing) to face this challenge and muster the courage to seriously question both the substance and effectiveness of their practice. For those who do, a life without borders has the potential to be emancipating. Johnetta expressed it best when she noted, "…. then there was a freedom, [and I said to myself] … oh yes, I can do this."

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Erken Matematik Pedagojisinde Sınırların Kaldırılması: Eleştirel Mesleki Gelişimde Kültür, İçerik ve Kimlik

Özet

İlköğretim düzeyindeki öğretmenlerin genel olarak sınırlı alan bilgisi temeline sahip olmaları öğrencilerinde derin öğrenmeyi gerçekleştirmek amacıyla oluşturacakları öğrenme deneyimleri konusunda yeterince hazırlıklı olabilmelerini engellemektedir. Bu öğretmenlerin çoğu için matematik öğretiminde eşitlik çağrıları, günümüz şartlarında kültürel olarak çok çeşitlilik gösteren A.B.D okulları bağlamında gerek mesleki gerekse kişisel yönden çok zorlayıcı bir durum oluşturmaktadır. Diğerleri içinse yüksek nitelikli matematik öğretimini, kültürel çeşitlilik ve eşitlik konularıyla birlikte ele almak kişisel pedagojilerini sorgulamak ve geliştirmek için istendik bir istendik bir güdü olarak algılanabilir. Bu makale böyle bir öğretmenin mesleki gelişime yönelik birkaç yıllık bir araştırma projesindeki katılımı ile elde ettiği deneyimlerden nasıl etkilediğini anlatmaktadır.

Anahtar kelimeler: Erken matematik pedagojisi, eleştirel mesleki gelişi