

The Development of Secondary Mathematics Teachers' Pedagogical Identities in the Social Context of Classroom Interactions

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Research demonstrates a disjuncture between the practices encouraged by teacher education programs and what teachers actually do in the classroom. It also informs us that the cognitive and social characteristics of individual teachers such as their attitudes, beliefs and knowledge contribute to their classroom practices. This qualitative study investigates how the teacher identity of mathematics teachers – the person's sense of who he/she is as a mathematics teacher – is related to the disjuncture between encouraged and actual classroom practices. Specifically, the study looks into how mathematics teachers form their teaching practices in the social context of their classroom interactions, and tries to understand the nature of the discomfort that teachers sometimes experience in the process of shaping their classroom role and teaching practices. The study takes a dialogical approach to identity, seeing the self as something that an individual develops through interactions between his or her core "substantial self" and context-dependent "situational selves." The qualitative data were collected from four in-service high school teachers in the United States. The study sheds light on the variability of the process of shaping teaching practices; it discusses factors in this variability, and explores how teachers develop and settle into their practices through negotiation between the substantial self and situational selves in the classroom context.

Keywords: self, teacher identity, secondary mathematics, teaching practices, teacher characteristics, substantial self, situational selves

Introduction

Research Questions

According to Clift and Brady (2005) and Gainsburg (2012), there is a widening disjuncture between the practices promoted by teacher credential programs and what teachers actually do in their classrooms. Mathematics teachers' limited uptake of university-promoted practices may be attributed to: the difficulty of translating general conceptual tools learned at the university into specific classroom activities, the inconsistency between mathematics teachers' natural teaching inclinations and how they are expected to teach in the classroom, and conflict between teacher beliefs and recommended teaching practices. For example, the current recommendations of the National Council of Teachers of Mathematics (NCTM) support reform-oriented teaching approaches that emphasize open discussion between teachers and students and among students themselves (NCTM, 2000). Hence, contemporary mathematics teacher credentialing programs generally favor these teaching approaches, and a mathematics teacher thus educated might believe that reform-oriented teaching is the most effective teaching approach. But if such a teacher is naturally introverted and feels uncomfortable leading a discussion, she might struggle to implement student-teacher interactions. Or a mathematics teacher with certain learning experiences or beliefs may disagree with the reform-oriented teaching approach espoused by the credentialing programs. This teacher might experience a disjuncture between the kind of teaching that worked best for her/him as a student and the practices recommended by the

teacher education program from which she or he graduated. In order to unravel such problems, this study seeks to understand the process of how mathematics teachers shape their classroom role and teaching practices in view of teacher identity.

Grootenboer and Ballantyne (2010) defined teacher identity, in the context of teaching mathematics, as a teacher's own conception of who one is as a teacher. Such a conception includes beliefs, learning experiences and classroom behaviors among other elements. Their study emphasized the role a teacher's identity plays in determining pedagogical approaches and behaviors, which is in line with Grootenboer, Smith and Lowrie's (2006) claim that teacher identity is one of the major determinants of teaching effectiveness. Another definition of teacher identity in the same mathematics education context was given by Peressini et al. (2004). They considered teacher identity (or professional identity in their term) to have both cognitive aspects – goals, values, commitments, knowledge and beliefs – and sociocultural aspects – the ways in which teachers participate in the activities of their professional communities and present themselves to others in the context of professional relationships. The cognitive aspects and the sociocultural aspects of professional identities, which for brevity I refer to as the cognitive identity and the sociocultural identity, respectively, are different in nature. While cognitive identity describes a person's more intrinsic characteristics, sociocultural identity concerns the more outward characteristics that are revealed in social contexts. In this paper, I refer to the elements that constitute both cognitive and sociocultural aspects of teacher identity as pedagogical characteristics of a teacher. Further, I define the pedagogical identity of a teacher as the teacher's unifying and connective concept that brings these elements together in the classroom context. Understanding how a person puts these elements together to develop that unifying and connective concept of who one is as a teacher is the goal of this study. More specifically, the paper focuses on the development of teachers' sociocultural identity: how secondary math teachers present themselves to students in the classroom and the teaching approaches they take in the classroom.

This study follows previous research in viewing identity not as static, but as fluid and constantly changing (e.g., Peressini et al., 2004). From this perspective, identities evolve in response to social and cultural demands (Holland et al., 1998). Sociocultural identity, in particular, can be expected to change based on teachers' continuing experiences, continuing education, and new dilemmas as they progress in their teaching career (Grootenboer, Smith, & Lowrie, 2006; Schepens, Aelterman, & Vlerick, 2009). Hence, the sociocultural identity of mathematics teachers, particularly the ways in which they present themselves to their students in the classroom context, can change based on classroom demands in conjunction with an individual teacher's characteristics. Consequently, teachers can face dilemmas as they form their teaching practices. To try to understand the process in which mathematics teachers develop their sociocultural teacher identity and their teaching practices, this study takes a dialogical approach to identity (Akkerman & Meijer, 2011), which considers the self to comprise both a substantial self and situational selves (Ball, 1972; Nias, 1989). The substantial self is embodied by beliefs and values that are shaped in one's early years, and is relatively impervious to change. Situational selves incorporate such beliefs and values, but change over time and context. One's self thus emerges from ongoing negotiation between these two types of self, with the balance between them changing in different contexts and at different times. Using these terms, I state the research questions as follows:

- How do mathematics teachers' pedagogical identities develop in the social context of their classroom interactions?

- What factors (pedagogical characteristics) contribute to mathematics teachers' shaping of their teaching practices?
- How do mathematics teachers negotiate between their substantial self and situational selves in the classroom context?
- What challenges, if any, do mathematics teachers encounter in this negotiation process?

This study seeks to learn how the interaction between mathematics teachers' pedagogical characteristics and the social environment of the classroom affects the way they identify their role as a teacher and frame their mathematics classes. The exploration of these issues will help us understand what challenges mathematics teachers face in implementing teaching practices recommended by credential programs or shaped by their own beliefs. In order to better meet mathematics teachers' needs for more effective teaching methods, it is important to develop insights into the nature of teachers' difficulties, including where such difficulties originate and what efforts mathematics teachers make to overcome them. By exploring these questions, this study hopes to draw attention to the pedagogical impacts of the variable characteristics mathematics teachers bring to their classrooms. In the sections that follow, I discuss the dialogical approach to identity and professional identities of mathematics teachers.

A Dialogical Approach to Identity

The notion of *identity* has changed historically in accord with the social contexts of different eras, and the transition of the notion from one era to the next has reflected changing value systems (Akkerman & Meijer, 2011). In the modern era, identity was perceived as singular (not varied or dynamic within the individual), continuous (keeping the core identity consistent regardless of the social context) and individual (regardless of the social environment). In contrast, in the postmodern view of identity, identity is decentered into multiplicity in the sense that an individual has multiple identities, different ones of which come to the fore depending on the social setting; discontinuous in the sense that the multiple identities that emerge in different social settings are not necessarily interrelated; and social in the sense that identity is understood in a social context. The postmodern characterization of the self as multiple, discontinuous and social suggests that identity is *neither* an overarching and unified framework *nor* a fixed or stable entity. Rather, it is viewed as being fragmented along with the multiple social worlds that people engage in, and as shifting with time and the context of the society of which people are a part.

In their discussion of identity, Akkerman and Meijer (2011) typified teacher identity as both unitary and multiple, both continuous and discontinuous, and both individual and social, with the two opposing natures (unity-continuity-individuality and multiplicity-discontinuity-sociality) taking turns in a dialogical relationship of intersubjective exchange and temporary dominance. That is, one develops identity by engaging in dialogical relationships between opposing aspects of one's own nature. For example, an introverted math teacher could find it challenging to lead discussions in class, and feel more comfortable taking a lecture-based approach. Her social nature, which is her invariant self, corresponds to the aspect of unity-continuity-individuality in her teacher identity. She would resist deviating from this social nature if this aspect of her teacher identity is strong. However, if she acts like an extrovert, compromising her social nature to accommodate the needs of her students or to conform to the standards of the math teaching community, then she is manifesting the multiplicity-discontinuity-sociality side of her identity. Between adhering to her social nature and compromising it for student needs, a teacher may struggle to form her teaching strategies

and develop her teaching approach. In this dialogical relationship, one's self is further understood in terms of one's core substantial self (referred to as an *I*-position) and the context-dependent situational selves (referred to as a *me*-position). This relationship is the dialogical approach to identity (Ball, 1972; Nias, 1989; Rodgers & Scott, 2008) that provides the theoretical foundation of this study.

The aim of the study is to understand the nature of mathematics teachers' sociocultural identity development in the classroom context in connection with their pedagogical characteristics as formed by their teaching experiences and mathematics learning experiences, among other influences. The study draws upon the dialogical approach to identity formation to understand teachers' pedagogical identity development in terms of a dialogue between their core substantial self and their context-dependent situational selves. Some studies have discussed how the personal histories of teachers influence their teaching in the context of their workplaces. For example, Flores and Day (2006) studied how personal histories of teachers at the elementary school level interact with the contextual influences of the workplace in shaping and reshaping teachers' understanding of teaching and in constructing and reconstructing their professional identities. While such studies show the impact of the interaction between history and the context of a workplace on teachers' formation of identity in the general teaching context at the lower grade levels, little research has adopted a dialogical approach to understanding how *mathematics* teachers' pedagogical characteristics inform their identity as teachers. The nature of sociocultural identity formation as a negotiation process between substantial self and situational selves still remains unexplored in the academic context, especially in mathematics education.

Professional Identities of Mathematics Teachers

This study takes the view that identity formation is a process of the *self* constructing and being constructed (Akkerman & Meijer, 2011; Flores & Day, 2006; Rodgers & Scott, 2008), and explores the process of mathematics teachers' self-construction, focusing on sociocultural identity. Recently, several studies have explored teacher characteristics beyond content knowledge, looking into belief and affect in an attempt to identify certain characteristics' links with pedagogical effects. For example, Grootenboer, Smith and Lowrie (2006) considered the idea of teachers' sense of who they are as teachers as well as their knowledge, beliefs, values, emotions and practices, which, as a whole, they called *teacher identity*. They explored how teacher identity impacts both the teaching and the learning of mathematics. In a subsequent study, Grootenboer and Ballantyne (2010) suggested that a teacher's pedagogical choices are influenced, to an extent, by his or her teacher identity. According to Grootenboer, Smith and Lowrie (2006), there are three influential views on identity formation: (1) psychological, (2) sociocultural and (3) post-structural. The psychological perspective has its focus on the individual. Scholars within this tradition concentrate on *either* compartmentalizing and categorizing aspects of identity of individuals *or* creating models that connect the individual with contextual variables (Marsh, Graven, & Debus, 1991). The psychological perspective on identity suggests that the formation of pedagogical identity for mathematics teachers is, at least partly, predetermined by their experiences (pedagogical or non-pedagogical) prior to their teaching. The sociocultural perspective focuses on interactions between individuals. Scholars in this tradition assert that identity develops through social and cultural practices (Côte & Levine, 2002). The sociocultural perspective on identity formation suggests that teachers' pedagogical identities constantly develop in the social context of the classroom. On this view, mathematics teachers' pedagogical identities would develop through interaction with students in

discourse-based mathematics classrooms. The post-structural perspective is interested in the nature of identity formation rather than the question of whether it is the individual or the individual's interaction with others that contributes more to identity formation (Foucault, 1984). Scholars in this tradition see identity formation as a continuing process of becoming, and thus identity as capricious.

The author of this paper holds that the post-structural perspective on identity formation in conjunction with the dialogical approach suggests that pedagogical identity formation for mathematics teachers is a continuing process of becoming through their interactions with their students and their engagement in negotiations between their substantial and situational selves. This study, by remaining open to all three of these perspectives on identity formation, aims to learn the nature of mathematics teachers' sociocultural identity formation with respect to the negotiation between the substantial self and situational selves. That is, the study seeks to uncover how mathematics teachers negotiate between the broader context of the teaching environment and all the individual or cognitive dimensions of a teacher's self that are brought into the classroom.

Methods

Data Collection Site and Participants

The data for this study were collected from in-service mathematics teachers at two public high schools – School A and School B – from two different school districts of the same state in the United States. Students in both schools have the opportunity to complete Advanced Placement (AP) coursework and take AP exams. Student body enrollment for School A is 1,792 and the AP participation rate is 19 percent. Total enrollment for School B is 1,487 and the AP participation rate is 15 percent. *U.S. News and World Report* provides an index to measure how well high schools prepare students for college, which is called the College Readiness Index (CRI). The CRI is based on the school's AP or IB (International Baccalaureate) participation rate (for example, the number of 12th-grade students who took at least one AP or IB test before or during their senior year, divided by the number of 12th graders) and how well the participating students do. The CRI is 17.2 for School A and 13.3 for School B at the time of data collection. Conversations with some mathematics teachers in both schools indicated that the teachers were not given specific pedagogical guidelines to follow. However, teachers were expected to use textbooks provided by the school as a guide for the classes they taught and to teach certain content during a particular school year.

From the two school sites, data were collected from eight mathematics teachers who taught a range of courses and students. In this paper, I report the results from four – Mr. A, Mr. B, Ms. C and Mr. D – of the eight teachers. Table 1 summarizes the background of the participating teachers.

Table 1
Pedagogical Background of the Teacher Participants

Teacher	School	Experience	Classes observed	Grade levels taught	Pilot
Mr. A	A	3.5 years	Pre-Calculus	9–11	Yes
Mr. B	A	5 years	Algebra 2	9–11	Yes
Ms. C	B	4 years	Algebra 1	9	Yes
Mr. D	B	18 years	(Remedial) Algebra 1	9–12 & lower levels	No

Mr. E	A	14 years	Equivalent to Algebra I	N/A	Yes
Ms. F	B	2 years	Consumer Math	9–12	Yes
Ms. G	B	18 years	Calculus	9–12	No
Ms. H	B	8 years	Algebra 2	9–11	No

Data Collection

A pilot study was conducted with six teacher participants. To avoid an order effect, the pilot study included only observation, with no interviews or surveys. Five of the pilot study participants also took part in the main study, which three additional teachers joined, thus making a pool of eight participants. (The last column of Table 1 shows which individuals participated in the pilot study as well as the main study.) The data for the main study were collected through field observations, surveys and interviews.

Field Observation: The pilot and main studies both began with observation due to the lack of previous research on teachers' pedagogical characteristics. Field notes focused on how the teachers facilitated learning, the kinds of teacher-student interactions they allowed in class, any difficulties they had in classroom management and any efforts they made to overcome difficulties.

The pilot study observation was undertaken with few preconceived ideas. Over twenty class sessions with the six teachers at the same two schools where the main study was later conducted were observed. Field notes were used to document teachers' behaviors and student reactions to these behaviors. Casual conversation with the teachers outside of class about their daily challenges supplemented the classroom observation notes. Through the pilot study, I obtained preliminary and partial profiles of the teachers' pedagogical characteristics. The observation results of the pilot study supported the purpose of the main study and contributed to framing, modifying and refining the research questions and interview protocol, and developing the research design. To avoid potential bias in the development of survey items and interview questions relating to pedagogical characteristics of teachers, I paid no particular attention, in this process, to specific participants. Thus, the survey items and interview questions were deemed general and not "tailored" to the pilot study participants.

In the main study, each teacher's class was observed and audio-recorded two to nine times over six weeks. Only the parts of the recordings deemed significant for the study were transcribed, including participant comments that (1) revealed the teachers' pedagogical characteristics such as pedagogical beliefs, and (2) characterized their teaching styles. The field notes and transcripts provided a secondary data source to complement the survey and interview results. Speer (2005) described teachers' beliefs and practices as *professed* if stated by the teachers, and *attributed* if inferred based on observations. Data from the field observations allow the study to incorporate attributed practices, avoiding potential participant bias, in its depiction of the participants' behavioral patterns. The observations also informed the development of specific interview questions for each individual.

Survey: After field observations were completed, a 17-item survey was developed and administered to the eight participants. The survey items were informed by the pilot study results and two studies on teacher identity (Alsup, 2006; Gainsburg, 2012). The responses to the survey were used to develop the interview questions. The first eight items asked about participants' academic background. The other items sought the participants' perceptions of their value systems, such as the factors of their pedagogical knowledge they value most, their mathematics teaching philosophy, how their learning experiences influence their choices as

a teacher, and whether they experience conflicts caused by a disjuncture between their personal and pedagogical identities.

Interviews: While longitudinal research can observe the development of pedagogical identity over time, this short-term study used interviews with each participant to learn how they understood their long-term pedagogical identity development. Teachers may “profess,” in interviews, how their beliefs and practices have changed over time. The interviews were based on a protocol but included questions reflecting individual participants’ responses to the survey items. The primary focus was to find out why the teachers chose to employ certain pedagogical methods. Each interview lasted about one hour and was audio-recorded and later transcribed.

Data Analysis

All interviews were transcribed completely. The transcripts were then coded with the *line-by-line* and *focused* coding methods of grounded theory approaches (Charmaz, 2004).

Line-by-line coding: The lack of research concerning mathematics teachers’ professional identities demanded line-by-line coding, a method that examines each line of data and defines the actions or events that can be seen as occurring in it or as represented by it (Charmaz, 2004). This coding method helped to detect influences on the mathematics teachers’ pedagogical identity development, the routes of this development in response to classroom dynamics, and any previously unseen issues associated with teachers’ pedagogical characteristics. In this coding step, each utterance was assessed for information about pedagogical characteristics. The utterances in each transcript that were deemed informative for answering the research questions were then summarized. During this process, the transcripts were annotated with the researcher’s interpretation of responses that revealed the teachers’ pedagogical characteristics and their sources, how their pedagogical characteristics developed in response to student reactions, how such development impacts their class design, the struggles teachers have regarding their pedagogical identity development, and the ways they resolve their struggles. Through this line-by-line coding, rough preliminary hypotheses were generated and categorized.

Focused coding: In reviewing the preliminary hypotheses, four of the eight teachers – Mr. A, Mr. B, Ms. C and Mr. D – seemed more informative than the others. They were either more conscious of their pedagogical identity development or more open to sharing their thoughts. Therefore, the next step, focused coding, utilized only the data from these four participants. In this step, codes were created to categorize the data, re-organize it in a simpler format, and gain an overall sense of it (Charmaz, 2004). The codes were created with reference to the notes taken during the transcription process and the preliminary hypotheses generated by the line-by-line coding. Most of the codes were created immediately after the line-by-line coding, before proceeding to focused coding. However, the process of focused coding included re-reading the transcripts, and continually considering the data within and across categories. New codes were added and some initial codes were revised to embrace all significant aspects of the data. The codes are categorized into three groups: attribution (by teachers of the sources of their teaching style), pedagogical characteristics (revealed by teachers in the interviews) and phenomena (related to pedagogical identity development).

Developing Themes: The coding process helped determine which of the preliminary hypotheses were robust enough to help understand this study’s findings and which parts of the data were relevant to these hypotheses. This process led to preliminary conclusions regarding the four participants’ pedagogical characteristics, and the sources that contributed to the formation of these pedagogical characteristics. The next step of analysis used concept

maps to pick out valuable, overarching, emerging themes by comparing and contrasting the participants' different pedagogical characteristics and the ways in which the teachers developed their pedagogical identities. This process of finding emergent themes frequently returned to the coded and categorized interview data to determine how the individual participants' data related to the emerging understanding of the pedagogical identity development of math teachers, and to find excerpts that illustrated the emergent themes.

Validity

The generalizability of this study's results is limited by the short period of data collection and the small number of participants. However, the findings are validated by several features of the study design.

First, this study's use of data from three sources – field observation, surveys and interviews – increases its validity. The observations of the participants' classroom behaviours were used in preparing the survey and interview questions. The survey collected information about the teachers' academic backgrounds, value systems and conflicts. The interviews allowed the teachers to describe these value systems and conflicts in depth. In the data analysis, the three data types were not treated in a fully separate manner to yield separate findings. Rather, they were used to supplement one another in drawing conclusions in the sense that one source of data often provided information needed to better understand the findings of a different source of data. The validity of a study design and data analysis is increased by a methodological process of triangulation, in which findings are drawn separately from different data sources, and the inconsistencies of the preliminary findings obtained from different data sources are compared and resolved to form the study's conclusions (Patton, 2002). Although I did not seek such a methodological triangulation in this study in the sense that I did not draw separate findings from different data sources, I nevertheless did adopt the underlying strategy of methodological triangulation in the data analysis. That is, during the process of analysis, I immediately compared inconsistencies appearing in the different data sources, and resolved them by checking within and across data types, to draw out the common themes that led to the study's conclusions.

Second, although the study analyses the data of only four teachers, data were collected from eight participants in two sites (two different school districts). By collecting data in more than one site and including a greater number of participants in the initial stages, I sought environmental triangulation in the research design and data analysis.

Finally, this research has descriptive rather than prescriptive goals (Beyth-Marom, Fidler, & Cumming, 2008). The research questions are designed to describe how secondary math teachers' pedagogical identities develop in the social context of their classroom interactions, and as a result, how they present themselves to students and what teaching approaches they take in the classroom. Such goals can be met by qualitative approaches using a small sample. To ensure the validity of this process, the study began with observation. As mentioned, the observation was undertaken without preconceived ideas, and the research design was based on its findings. The grounded theory approaches of step-by-step and focused coding further increase the validity of the study's results.

Results

The results of the study largely rely on the teachers' written and verbal descriptions of the pedagogical characteristics they thought contributed to their current teaching practices. The direct use of the data from classroom observation is limited to describing the teaching

practices of the teachers and supplementing the discussion of the results of the written and verbal data. In this section, I address notable pedagogical characteristics for each of the four focus teacher participants, and discuss the process of how their pedagogical characteristics influence the development of their teaching practices in terms of their negotiating and balancing between the substantial self (referred to as an *I*-position) and the situational selves (referred to as a *me*-position).

Mr. A

Mr. A had three years of teaching experience at a public high school, after he had received a bachelor's degree in math education. The classes he taught included Algebra 1, Algebra 2 and Pre-Calculus. At the time he participated in the study, he was taking the year off from the school he had worked at for three years in order to prepare for a PhD program in math education, and he was working as a long-term substitute teacher at School A.

During the interview, Mr. A shared his teaching philosophy where he showed evidence of having an inclination toward autonomy in learning mathematics. In his comments on Survey Item 9, which asks what sources of pedagogical knowledge the teacher values most, Mr. A showed how he, as a student, perceived mathematics problems, as illustrated in Excerpt A.

Excerpt A: *I learned it [math] by trying different things¹, and seeing. [pause] For me, especially as I got into a higher level for math, yeah so for me, when I was learning math, [I was] trying, you know, "how do we figure this out?" For me, it was always a puzzle. That was what math was about. Doing things you didn't know how to do given certain relationships².*

Mr. A's claims in Excerpt A show how he connects his autonomous learning inclination toward mathematics (A¹) with his beliefs on the nature of doing mathematics (A²). This is further shown in his written (Excerpt B) and verbal (Excerpt C) responses to Survey Item 9, where he connects his teaching beliefs to his own autonomous learning inclination.

Excerpt B: *The way I try to teach it [autonomous learning], is that [pause] I learned it by trying different things¹, and seeing [pause] which I think actually doesn't work very well for teaching because I think a lot of kids aren't trying different things².*

Excerpt C: *... [autonomous learning] is only successful with some of the kids. For most of the kids, you still have to give them the information you wanted them to know in the end¹. I am not gonna say, "Hey, you gotta figure it out," "I am not gonna help you until you figure it out"².*

While (B¹) shows Mr. A's desire and efforts to implement autonomous learning in his classes by having students approach mathematics problems via discovery, (B²) and (C¹) indicate his frustration with his students when he tries to implement this approach. Further, (C²) shows how Mr. A's frustration impacts the ways he would talk to and behave around his students in the classroom. His comment here implies that he compromises his pedagogical belief in autonomous learning to meet the students' needs. That is, he is taking a *me*-position (one's context-dependent situational selves that change over time and context) as opposed to an *I*-position (one's core substantial self that is impervious to change) regarding his belief in autonomous learning.

Mr. A's pedagogical characteristic of viewing working on difficult problems as a valuable learning experience is further evidenced in his written (Excerpt D) and verbal (Excerpt E) responses to Survey Item 16, which asked about conflicts between the math teachers' own beliefs about what/how to teach and others' expectations of what/how one should teach.

Excerpt D: ... I think that mostly a sense of inadequacy arises at times about how I conduct my classroom and how well my students perform. *I think it is a valuable experience for kids to work with difficult math¹ ... sometimes I let them struggle rather than just hold their hand². I think it is valuable for them to have difficulty and learn how to handle it³.*

Excerpt E: *I would rather let kids fail than just be this constant coach. "Come on, you can do it, you can do it" like "let me help." If I have to push a kid every step of the way, I don't think they are learning. They may be learning some math, but in the end, they don't learn how to deal with difficult things in their life¹ ... I am trying to like [pause] I feel like I am standing at the goal line, encouraging, showing them the way rather than running right next to them, "You can do it, you can do it." So it's more like "Follow me," like, "Believe in yourself and go for it." If I try to help motivate kids, but if they just continually give up, then I let them give up ... If a kid puts his head down for whatever reason, day in and day out, I will try to make a real connection with them, and see how I can motivate them. But I am not gonna go every class like, "Take your head up." Like, I am not gonna force them to do it. I feel like they have other things to know besides math if that's where they are at².*

(D¹) and (D³) confirm that Mr. A values "learning by discovery," and (D²) and (E¹) indicate that he will let his students struggle in the hope that they will move forward in discovery-learning. But contrary to this characteristic of his, (E²) implies that he would rather give up on strongly unmotivated students if improving their learning requires intervening in their classroom behaviors frequently. The contrast between (D², E¹) and (E²) indicates the difficulties Mr. A faces in handling the conflict between what he believes is ideal (having students learn by discovery) and the reality of having unmotivated students in the classroom. His comments suggest that he compromises, taking both an *I*-position and a *me*-position in handling this conflict; by letting unmotivated students give up when he is faced with their classroom behaviors, he leaves his pedagogical beliefs about what he should do in the classroom only partly achieved.

Mr. B

At the time Mr. B participated in the study, he had five years of high school teaching experience, and had no other full-time jobs prior to becoming a mathematics teacher. He earned a bachelor's degree and a master's degree, both in mathematics education, and had taught Algebra 1, Algebra 2 and Geometry. Mr. B allowed me to observe his classes, but did not let me make audio-recordings.

During the interview, Mr. B explained various aspects of his pedagogical characteristics. Mr. B's interview showed his passion for teaching and inclination to associate with his students inside and outside the classroom. He also revealed pedagogical characteristics such as an inclination toward learning and teaching mathematics concepts by providing justifications for the methods employed for problem-solving, and an inclination toward using visualization in teaching mathematics. These points are shown in his remarks during the interview such as, "I really liked the idea that everything that we did was justified (in the classes I was taking as a student). That was really nice. Everything that we did related to stuff that we did before" and "I'm very visual, and a lot of kids see things visually, which helps in geometry."

During the interview, to my question, "What challenges do you face in interacting with your students and how do you manage the challenges?" Mr. B responded as follows:

Excerpt F: *One of the biggest challenges for me in high school is the unmotivated kids, you know, the kids that probably shouldn't be there ultimately. But they are required to be in class. The kids don't care¹. I can't say that I have a strategy. I personally think these kids are kids with needs that aren't being met, you know, they are way higher up than a math education². You know, like, "Where am I going to spend the night tonight, what am I going to eat when I get home," stuff like that. I don't*

know if high school has an answer for those [pause], those kids. You know I think there are other factors.

In (F¹), Mr. B describes his challenges in teaching unmotivated students. (F²) indicates that he is facing a challenge in motivating students, which has not been resolved (i.e., he has not found a way to deal with the learning of unmotivated students), and that he is viewing this matter from a *me*-position by considering the students' living conditions. To my follow-up question, "Do you have an answer [solution to this challenge]?" Mr. B responded as below.

Excerpt G: ... my job is to teach kids algebra, whatever their course is, but also to teach a lot of life skills there as well. I think they get a lot of that from me, you know, how to be respectful.

Mr. B's comments in Excerpt G imply that, having suffered a sense of powerlessness when facing unmotivated students (F²), he expanded the scope of his teacher role beyond teaching mathematics to "teach a lot of life skills." In his adaptive (and emotional) reactions, Mr. B's position contrasts somewhat with Mr. A's. They both face challenges with unmotivated students and have difficulty implementing their belief-led practices. Mr. A tries to implement his beliefs on "authentic teaching." Mr. A, who views the challenges of dealing with unmotivated students as caused by the school enrollment system, would give up, to a certain extent, on the unmotivated students' learning rather than taking actions to address the students' reality (E²). In contrast, Mr. B seems to accept reality – understanding the students' family background – and is willing to adapt his teaching to the context by expanding his teacher role to embrace the unmotivated students' classroom behaviors. This willingness to adapt is evidence that Mr. B is taking a strong *me*-position in his treatment of his students, adjusting to the real context of his classroom.

Another pedagogical characteristic of Mr. B is that he developed his teaching strategies from continuous trial and error. For Survey Item 9.A, which asks about the most significant sources of the teachers' pedagogical knowledge, he wrote, "Ongoing professional development, though I learned most from trial and error. I think I use my own (teaching) experience." He made the same claims in his oral response to the same survey question, as shown in Excerpt H.

Excerpt H: I think I learn best from the (teaching) experiences that I have in the classroom. And I guess I have tried a lot, you know, over, for the first five years. *And you find things that work and you find things that don't work. And you find ways that kids learn best and you know. Probably for your first, one or two, or even three years, you know you are not the best teacher that you can be, but you are finding it. You know you are making yourself, but you are also finding what works and what doesn't work*¹. And I think I found some good strategies. But, you know, every good strategy [pause], you find it from one or two strategies that didn't work that well. You know, so I think *I have refined my teaching and refined ... You know, when I get to a certain section in Advanced Algebra 2, I know the struggles they are going to have with it. And I know that I've tried one way and it probably didn't work as well. The new way I might have to teach it*².

In Excerpt H, Mr. B explains that he acquires his pedagogical knowledge by trial and error, and in particular, his comments in (H¹) and (H²) show that Mr. B's classroom teaching approach is shaped by continuous reflection on how well various methods work for him. It is evident that Mr. B is taking a *me*-position in shaping his own teaching strategies by reflecting on how different teaching approaches work with his students.

During my classroom observations, I found that Mr. B often facilitated student-teacher interactions by asking thought-provoking questions. Yet Mr. B's response to an interview question, "By having that kind of teaching approach – the approach that promotes

communication ... do you face any challenges in terms of class management?" shows that such an interactive learning environment caused a challenge for him (Excerpt I).

Excerpt I: ... it's not a typical room, in the sense that "you'll get in there and I'll be lecturing and everyone will be writing down what I am saying." They are freer to talk ... they care about what they are doing. They are pretty directed, but *there are times when you have to talk to kids and say, "Hey, you are not really doing what you need to be doing"*¹.

Excerpt I shows that Mr. B perceives student distraction as a disciplinary challenge. In particular, the comments in (I¹) imply that the implementation of interaction-based teaching gives rise to a situation where students do not focus and make noise, distracting the rest of the class. Mr. B's preference for allowing students the freedom to talk over upholding discipline is further shown in his oral response in Excerpt J.

Excerpt J: *The disciplinary thing is tough for me*¹, um because, you walk by some classrooms and you say, "Wow, look at all those kids just sitting there," you know. I don't think you see that in my room. So I think it's a weakness in some regard. But, like I said, *it's a sacrifice I make for good communication and all that*².

While Mr. B perceives student distraction as a disciplinary challenge, as shown in comments (I¹ and J¹), he engages in self-reflection to achieve a balance between upholding discipline and providing good communication as shown in Excerpt J. In particular, his comments in (J¹) and (J²) show that he leans toward compromising on discipline to attain student learning in his classes. This implies that Mr. B is balancing closer to his *me*-nature (substantial self) than his *I*-nature (situational selves).

Ms. C

Ms. C had four years of high school teaching experience at the time the data were collected. She had a bachelor's degree in math education with a specialty in secondary-level education. At the time she was interviewed, she had taught Algebra 1 and Geometry. Prior to becoming a math teacher, Ms. C had worked at a daycare and a summer camp.

When discussing Survey Item 9, Ms. C revealed evidence of a strong inclination for modifying her teaching strategies and methods in response to her classroom context. This is shown in Excerpt K.

Excerpt K: *I think throughout the college classes they weren't very good about preparing you for the real-life situations and right when I went in the classroom as a teacher, you know*¹. It was kind of like a big shock, *every child had a different need, every year there were different kids, a different chemistry in the classroom, a different dynamic*², so *I had all these modified myself, and you know the lessons, to try to reach out to more and more students*³ ... I don't think you can learn that without the experience.

Ms. C's comments in (K³) show her inclination to modify her teaching strategies to accommodate student needs. Such modification was sparked by her acknowledgement that every class has different needs (K²) and her belief that college classes do not prepare mathematics teachers for real-life situations (K¹). Ms. C's modification-based practices come from her inclination to make constant improvements, as demonstrated in her response (Excerpt L) to my question, "How do you think the teacher, the preparation, the class notes should change [that teachers make to prepare the classes] um, with the change of students?"

Excerpt L: I think maybe the setup, the dynamics. If I have students who are slow readers, I'm not going to have a whole bunch of word problems. I'm going to space them out, put some pictures in, have lots of space, big, big font, easy wording. *You have to kind of modify. Teaching's all about modifying and it depends on the teacher if they want to keep growing and changing or not*¹.

The comment in (L¹) indicates that Ms. C regards the need to modify as an essential component of the force that determines her teacher practices. Excerpts K and L provide evidence that Ms. C adapts herself to the context of each classroom. This implies that the multiple, discontinuous and social sides are dominant in Ms. C's teacher identity. In other words, Ms. C takes a strong *me*-position in her teaching. An example of Ms. C's inclination for modification is further shown in Excerpt M, in which she describes the challenges that lead to her continuous modification.

Excerpt M: Well, *a teacher education [program] may really emphasize the set-up of lesson plans ... but I learned every day isn't predictable, and you have to kind of ... some days you may have to throw your lesson out the window and say, "You know what? This kid had a bad day. I'm not going to be able to teach as much as I wanted to, the kids are rowdy" and you have to keep molding it*¹. So, *my belief has changed in terms of preparation. You have to be prepared to be unprepared*².

Ms. C's comment in (M¹) explains how her beliefs differ from what teacher education programs suggest and how she came to these beliefs. Her comments in (M²) again imply that she takes a *me*-position in adapting her teaching methods to fit her class's nature.

Ms. C claimed during the interview to have learned, through her teaching experience, that student learning and performance are not always ideal. This is shown in the following conversation (Excerpt N).

Excerpt N: *I learned the hard way that those types of kids won't do homework. So, I don't assign homework anymore*¹ ... I used to give homework to everyone, and I was like, their grades were dropping, not college prep kids, we are talking about [pause] *I'm like well they are only here for the 90 minutes legally, so make them do work during the time that they have to*².

Ms. C's comments in (N¹-) and (N²-) show the compromise she made in her pedagogical approach between what she had believed her students should do to learn and what they really turned out to do. These comments provide further evidence of her taking a *me*-position in developing her teaching practices.

Ms. C's tendency to take a *me*-position is further evidenced in regard to her social nature of being an introvert. During the interview, she claimed, "I am shy, and self-conscious in a crowd. *And I'm not one to speak up*, but in the classroom you are the center stage, so it kind of forces you to become an extrovert whether you are or not" and "I may be, um, a little too friendly with [pause] you know the atmosphere, I try to make it light and airy, and I try to make sure the kids are joking, I want it to be a positive experience." These comments show Ms. C taking a *me*-position in that she describes herself as an introvert who tries to act like an extrovert to bring energy to her classes.

In response to my interview question, "Do you face any ... new challenges ...?" Ms. C's explanation again suggested her strong *me*-position in her teaching, as shown in Excerpt O.

Excerpt O: I do, well, every year I make rules. Then half way through the year, I'm like, "Oh I should have made this a rule, no, no um, drinks in the classroom," you know, because kids spill throughout the year and if you start the rule halfway through the year they are like, "Why is Ms. C being mean all of a sudden?" So they say to start the rule at the beginning and then get rid of them, so that's something I should have done, but halfway through the year you don't know these kids yet, so there's different rules.

This comment shows that she faces challenges in preparing her classes even when she takes a strong *me*-position.

Mr. D

The class I observed Mr. D teaching was Remedial Algebra 1. At the time he was interviewed, Mr. D had two previous work experiences: teaching at elementary and middle

school levels and working as a lawyer. His teaching career started at the elementary level, and he had fifteen years of teaching experience at the elementary and middle school levels. While working as a teacher, he completed his law degree. After fifteen years of teaching, he worked as a lawyer for six years. He then came to the high school where he was working as both a mathematics teacher and a baseball coach. He earned a bachelor's degree and an M.Ed., both in education, and a J.D. in juvenile law.

Mr. D claimed, during the interview, that he was trying to emulate the interaction strategies employed by baseball coaches within his classroom, as shown in Excerpt P.⊖

Excerpt P:

I: Is there a teacher that you learned mathematics from when you were in high school that you tried to emulate?

Mr. D: No, I just, *I would say that I would emulate myself after coaches that I played for, I played baseball in college, so coaches that I've had, have far more effect on who I am as a teacher*¹.

I: What, what do you try to emulate from them?

Mr. D: *The ability to get people to perform at a high level, working together, but it's still you as an individual doing your job, um, through practices which are like our regular classroom games or like a test where you got to show how good you are. Maybe you're good one day and maybe you're not. Um, but coaches, they have an ability to take groups and like I said work with them as individuals in smaller groups to get them to perform at a higher level*².

I: You have this strong idea of teaching, um, ... individual relationship with the students is an important thing ... where do you think this idea came from?

Mr. D: *I think it might have been from coaches who, who you know, would put an arm around me ... it was my coaches who said, you know, "What did you have for dinner last night, what movie did you see over the weekend, what did you do on vacation last week?"*³

In Excerpt P, Mr. D explains that he favors coaches' individual-based training approaches and their efforts to forge a bond with the players (P¹ and P³). The comment in (P²), in particular, explains that he values the role of student affect in learning. To encourage the students' positive affect, he attempts to establish a strong bond with students in his math courses. My observations in his algebra class showed that Mr. D's teaching was not class-centered at all: he did not spend any time explaining mathematics to the whole class. The whole class time, he sat at his desk and had each individual student come and sit next to him to spend five to fifteen minutes working one-on-one. This teaching approach allowed him to interact with students on an individual basis. During this time, he had the student work on only one question and then discussed any issues that the student might have outside the math content. The one-on-one nature of his teaching strategy reflects his consideration of the individual students' needs for their learning (beyond mathematics), implying that Mr. D is taking a strong *me*-position in determining his teaching strategies, based on his beliefs that a classwide discussion or lecture would not work well with the particular students he had in his Remedial Algebra I class.

During the interview, Mr. D explained that he deeply understands the challenges faced by his struggling students. Excerpt Q is from his answer to my question, "Having that experience working as a lawyer, does that make you a different teacher?"

Excerpt Q: When you are a lawyer, everything's a conflict situation, and you can't react emotionally in a conflict situation. You saw me how many times in class, where some things happened ... they might start yelling ... When you are a lawyer, conflict is part of the job ... you have to be able to communicate in a way where you can get your point across without creating conflict or getting all emotional ... *I did represent a lot of kids in court. And I represented parents who had their children removed by the state because they were being [inaudible] by their parents. And any of these situations*

*create, um, conflict at home, and negative situations at home. So I've been in there and I understand what, when they leave school and go back home, I know what they go to*¹.

Excerpt Q, in particular the comments in (Q¹), explains how Mr. D's work experience as a lawyer helped him understand the family background of the students in his classes. In particular, his conflict-handling experience as a lawyer seems to have helped him learn how to diffuse tense situations with his students. To my follow-up question, "How does it [the career as a lawyer] help (your teaching) though?" he responded:

Excerpt R: I think I know where kids are from, I mean I know what they are living ... treating someone as an individual and trying to know what makes them tick, to get them to perform clearly is from coaching. And those were the people that influenced me the most.

Excerpt R, like Excerpt P, suggests Mr. D's belief in treating students in need the way a sports coach treats players. It is evident that this belief has been the driving force of the formation of his one-on-one teaching practices. His view that values treating students in ways that work for them and his one-on-one teaching practices further show Mr. D's *me*-position in how he deals with his students.

In addition to his non-academic work experience, Mr. D's fifteen years of teaching experience at the K–8 level seem to have played a role in forming his pedagogical beliefs and further influencing his classroom practices. This is demonstrated in the following excerpt, which is his oral response to Survey Question 9.

Excerpt S: *My general view towards, um, the pedagogy would be probably from teaching elementary school and middle school*¹. Uh, I did my student teaching at third grade. Third grade teachers don't teach ... lecture. So having spent my internship there and then working in elementary and middle schools for the next fifteen years, I learned that *standing and lecturing the students tends not to be the primary way that they learn*². So that was probably the primary way that I, um, based my teaching style on³ as I go into class thinking that every child's a little different⁴. And we want to give them kind of the same general experience. You can't make them all fit the same rule.

Excerpt **R-S** shows that Mr. D's teaching experience at the K–8 grade level contributed to his understanding of struggling students and his negative views of lecturing (S²). That is, his understanding and belief that every child is a bit different (S⁴) led him to believe that "standing and lecturing the students tends not to be the primary way that they learn" (S²). Together, Excerpts R and S indicate that Mr. D's understanding of his struggling students – where they come from and what needs they have – came from his K–8 teaching experience (S¹ and S³), and that this understanding seems to have served as a grounding view that formed his one-on-one pedagogical practices, leading Mr. D to take a *me*-position in his teaching approach. Both his interview and survey responses show that Mr. D identified his students' needs and formed his teaching strategies accordingly. However, unlike the other teachers, Mr. D did not make any comments that identified current or on-going challenges in his teaching in his interview or survey responses.

Discussion

The goal of this study is to understand how mathematics teachers' pedagogical identities develop in the social context of their classroom interactions. In particular, the study considers what factors (pedagogical characteristics) contribute to mathematics teachers' shaping of their teaching practices; how the teachers engage in negotiation between their substantial self and situational selves in the classroom context; and what challenges the teachers encounter in this negotiation process.

Regarding what contributes to mathematics teachers' shaping of their teaching practices, the results showed a variety of factors among the four teachers. Some driving factors were, for example, beliefs on the nature of doing mathematics (Mr. A), certain inclinations toward learning and teaching mathematics concepts (Mr. B), an inclination to modify teaching strategies to accommodate student needs (Ms. C) and working experience (Mr. D). These factors created different negotiation dynamics for each of the four teachers between their substantial self (*I*-position) and situational selves (*me*-positions), which shaped the development of their teaching strategies. The different dynamics are explained by the varying degrees to which the individual teachers accommodate student needs and the challenges they recognize around the negotiation process, which we discuss next.

Regarding the negotiation process between substantial self and situational selves (between *I*- and *me*-positions) and the challenges the teachers face in the negotiation process, the results show that the teachers commonly encounter challenges in dealing with unmotivated students and classroom management, and, by leading math teachers to engage in negotiation processes, such challenges play a role in shaping their teaching practices. While classroom interactions determined all four teachers' teaching practices to a certain extent, they had each formed different teaching practices and took varying routes to do so, displaying differences in their sociocultural identities. For example, Mr. A struggled between implementing autonomous learning and the reality of teaching unmotivated students. Having identified his teacher role as "standing at the goal line" (Excerpt E), he would give up on strongly unmotivated students. While Mr. A's adherence to autonomous learning may be viewed as taking an *I*-position, it is evident that he has not found a solution for teaching the unmotivated students (Excerpts B, C, D and E). In the language of *self*, he has not found a balance between his substantial self and situational selves that would help him achieve student learning with a teaching approach he believes in. Regarding Mr. B, Excerpts F and G show that he prioritized meeting the unmotivated students' needs over teaching them mathematics, and he adapted to the context of his classroom by expanding the scope of his teacher role to go beyond teaching the subject. Although he has not found a solution to the challenge of unmotivated students (Excerpt F), his view of the matter is evidently formed by his situational selves (Excerpts F and G), and thus he is closer to a *me*-position than an *I*-position in this case. Ms. C constantly modified her teaching practices and strategies to accommodate the needs of students, including unmotivated students; in fact, her inclination toward constant modification of her teaching strategies was identified as her main pedagogical characteristic. In particular, she claimed that she was an introvert, but that she acted as an extrovert to bring energy to her classes. Unlike Mr. A and Mr. B, she was deeply engaged in a struggle that she clearly perceived as arising from the discrepancy between the teaching practices recommended by her teacher credential program and the actual practices she needed to meet various student needs. In this struggle, she took a strong *me*-position by modifying her teaching strategies in response to classroom interactions. Finally, Mr. D had developed his understanding of the life conditions of the students in his remedial class through his working experiences – both academic (teaching at the elementary school level) and non-academic (working as a lawyer). He developed his one-on-one teaching approach on the basis of this understanding, taking a strong *me*-position by responding to the needs of each student as an individual. Mr. D, unlike the others, did not show evidence of struggling to form his own strategies. As an experienced teacher who had also worked outside academia, he may have had such struggles early on but resolved them over time. In any case, his current teaching practices suggest that he uses his situational selves to anchor him as he

takes a *me*-position in teaching unmotivated students or students with disadvantaged family backgrounds.

According to Flores and Day (2006), teachers' efforts to cope with the demands of the teaching environment and its inherent tasks inevitably entail a continuing process of shaping their understanding of teaching and forming their teaching practices. Flores and Day's characterization of this process is supported by this study's finding that teachers take different routes to form their teaching strategies, which develop into their teaching practices. In particular, the findings indicate that different teacher characteristics come into play to engage teachers in the various negotiation dynamics between taking *I*- and *me*-positions, and that the negotiation processes of the mathematics teachers are closely associated with the shaping of the teachers' sociocultural identities (the social aspect of teachers' pedagogical identities). This study contributes to the mathematics education community by casting light on how mathematics teachers are immersed in negotiation between the reality of their teaching environment and the cognitive dimensions of the teachers' self.

In addition, this study casts light on an aspect of the nature of the challenges mathematics teachers encounter in forming their teaching practices. The challenges stem from the disparity between teachers' pedagogical characteristics and student needs. Such challenges develop into struggles between the *me*-position – accommodating student needs – and the *I*-position – implementing their pedagogical beliefs (Mr. A) and upholding curricular discipline (Mr. B), for example. These struggles may be ongoing or resolved, depending in part on the degree to which teachers inhabit their situational selves (that is, take a *me*-position). According to Maclure (1993), creating and maintaining identity itself entails a continuing struggle. The study provides a conforming explanation for how mathematics teachers develop their pedagogical identities – in particular the sociocultural identity – from the struggles caused by the disparity between teachers' pedagogical characteristics and student needs, and thus explains the disjuncture between mathematics teachers' actual practices in the classroom and the practices they believe are ideal for mathematics teaching or the practices that external forces expect them to implement.

The study suggests that such disjuncture may be inevitable for teachers of mathematics: they are very likely to be engaged in struggles that emerge from conflicts between their beliefs or desire to uphold certain principles, and their need to interact comfortably with their students, address student lack of motivation and manage their classrooms. It is important that both education programs for math teachers and pre- and in-service mathematics teachers understand the nature of such struggles and the need to make efforts to achieve a reasonable balance between an *I*-position and a *me*-position to reconcile their beliefs or natural inclinations with their teaching context. To this end, mathematics teacher education guidelines must consider addressing such issues along with articulating pedagogical principles and standards for teaching mathematics. Professional development programs for mathematics teachers need, in addition, to incorporate discussion of how a teacher develops his or her identity as a teacher and what kinds of struggle the development necessarily entails.

This study's conclusions are largely based on the participants' professed beliefs and practices (Speer, 2005), which may lack accuracy: a teacher may not be aware of or may not be frank with a researcher regarding his or her own pedagogical identity development. These limitations constrain the extent to which the findings can be generalized. Larger-scale research that depends less on self-report and more on observed data would provide firmer and more generalizable findings. Further research is needed to better understand the dilemmas mathematics teachers face in developing their pedagogical identities (or in

balancing between substantial and situational selves) and how they overcome such dilemmas.

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