

Dimensions of Mathematics Graduate Students' Professional Identities as Prospective Faculty

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Graduate education in mathematics is instrumental to the socialization of prospective mathematics faculty, however, our understanding of how graduate students develop their professional identities is still limited. This preliminary study examines and compares how two doctoral students at different stages of their graduate programs reflect on and understand their professional identities. I highlight qualitative similarities and differences in how each participant identified as a teacher, as a researcher, and as a mathematician. The structure of the program and progression through degree milestones reflected how strongly participants were anchored onto dimensions of their professional identities. Both students strongly identified as teachers and both described how their gender identity as women negatively impacted dimensions of their professional identities, especially their mathematics identities.

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Introduction

Many mathematics graduate students pursue faculty positions, however, our understanding of how they are socialized into the profession (Tierney & Rhoads, 1993) and develop their professional identities as faculty is still limited (Clarke et al., 2013), likely contributing to the minimal professional development opportunities that aim to develop strong professional identities (Austin & McDaniels, 2006; Jensen, 2011). I draw on Beijgaard et al.'s (2000) conception of teachers' professional identity as "how they perceive themselves as teachers and what factors contribute to these perceptions" (p.751). Although there are similarities between K-12 teachers and higher education faculty, the differences in the preparation, institutional contexts, societal pressures, roles and expectations, and the discipline-specific cultures constitute a starkly different backdrop through which professional identities are developed (Nyquist, 1999; Van Lankveld et al. 2016). The experiences in graduate education are instrumental to students' professional identity development as future mathematics professors, and it is imperative that we understand how they make sense of their professional identities and identify the experiences that are formative or destructive to their sense of selves as faculty.

Additionally, it is important to examine the professional identities of prospective mathematics faculty as unique cases because the mathematics discipline has norms, beliefs, and values that set it apart from other disciplines. Clarke et al. (2013) noted:

Discipline-based cultures are the primary source of faculty members' identity and expertise and include assumptions about what is to be known and how tasks [are] to be performed, standards for effective performance, patterns of publication, professional interaction and social and political status (p.7).

Examining the professional identity development of mathematics graduate students affords insight into the experiences and features of mathematics graduate education that prepare students for faculty positions. For this preliminary study, I examined the professional identities of two graduate students at different stages of their doctoral programs. The research questions that guided this study were: (1) How did mathematics graduate students reflect on their professional identity development as prospective faculty? (2) What experiences were formative to their professional identity development?

Framing

I drew on a sociocultural perspective of professional identity development (Solari & Ortega, 2020) to frame this study. Specifically, I consider the process of socialization into the profession (Tierney & Rhoads, 1993; Weidman et al., 2001) to be a mechanism of professional identity development. This view on identity development recognizes the weight and consequences of the context and the social interactions with others (Gee, 1996), and posits that the transmission of culture and the acquisition of the knowledge, dispositions, and skills necessary to perform in a profession are the product of the everyday social interactions that an individual has with others in a situated context (Clarke et al., 2013; Solari & Ortega, 2020). This can involve observing more expert others, learning by doing, interacting with others, and reconciling personal ideologies and beliefs about the profession with the everyday realities (Pillen et al., 2013; Tateo, 2012).

Within mathematics graduate education, I consider experiences such as serving as teaching assistants, engaging in research, attending conferences, receiving mentorship, and interacting with others can shape and inform graduate students' professional identities. Additionally, members of their profession and the mathematics community attach and attribute meanings to graduate students, prompting them to reconcile these various meanings and discourses (Gee, 1996; Sachs, 2001) to construct their professional identities. Lastly, I acknowledge that mathematics graduate students are embedded within institutional contexts, power structures, societal and political perspectives, and mathematics-specific cultures, values, beliefs, and norms. These factors, along with graduate students' individual social and cultural identities (Hayley et al., 2014; Trepte, 2013) interact to uniquely inform their professional identities as prospective faculty.

Method

This study is part of a larger dissertation project focused on the pathways to the mathematics professoriate and was conducted at a Minority-Serving Institution in California. Purposeful sampling (Miles et al., 2020) was used to recruit mathematics doctoral students pursuing faculty positions. They participated in 90-minute interviews over Zoom that included responding to a semi-structured interview protocol (Rubin & Rubin, 2011), writing a letter to the mathematics discipline, and graphing a visual representation of their graduate education experiences. For this preliminary study, I focus on two graduate students, Kayla and Morgan (pseudonyms), because they were revelatory (Yin, 2016) about the dimensions of their professional identities and the disparity in the time spent in graduate school afforded a comparison of the experiences that seemed to most impact their professional identity development. At the time of the data collection, Kayla had completed the first year of the doctoral program and Morgan had completed the fourth year (after being previously enrolled in a PhD program at another institution). Both graduate students self-identified as White/Caucasian, straight or heterosexual, female/feminine, and reported that they are actively pursuing careers as mathematics faculty.

The data for this study were the participants' responses to the semi-structured interview protocol centered around their experiences in graduate school and perceptions of the mathematics professoriate. I open coded (Miles et al., 2020) each response to make sense of how participants described themselves as future mathematics faculty, their understanding of the profession, and how they hope to be recognized as such by their prospective professional community. The initial codes that I conceptualized as dimensions of professional identity, included: (1) teacher identity, (2) researcher identity, and (3) mathematics identity. I analyzed themes across their responses and made sense of how these dimensions reflected similarities and differences in Kayla's and Morgan's identities and graduate education experiences.

Findings

I highlight the dimensions of participants' professional identities that most emerged when they reflected on their experiences and considered the ways they have seen themselves as faculty and how they hope to be recognized as such in the future. For this preliminary analysis, I focus on how Kayla's and Morgan's developing professional identities as faculty encompassed their teacher identities, researcher identities, and mathematics identities.

Teacher Identity

Kayla's and Morgan's professional identities as mathematics faculty were primarily anchored onto their identities as teachers (Berger & Lê Van, 2019; Mockler, 2011). They both described how an early passion for teaching, experiences with tutoring and helping others, and serving as teaching assistants or instructors of record during graduate school were formative and positively contributed to their professional identities. However, there were also differences in how each student recognized themselves as faculty or described what they would emphasize as a teacher or instructor.

Kayla said, "I've always known I wanted to teach." and mentioned that her decision to pursue a career as a mathematics faculty was primarily motivated by her desire to teach. She considers herself as an educator who is uniquely positioned to teach and support students in a variety of ways. As she reflected on her identity as a teacher, Kayla emphasized dimensions of teaching that went beyond subject matter expertise and the mathematics content. She expressed that getting to know students on a more personal level, connecting with them, and sharing about her own experiences are practices that she hopes to engage in. This was most influenced by her own experiences as a student when she learned the most from faculty who were more personable – explicitly articulating how she does not want to be like the professors she did not enjoy. An important aspect of Kayla's professional identity was that she saw herself as someone who can reframe dominant discourses and narratives around mathematics through teaching. She hopes to "reconfigure the narrative that mathematicians are these godlike people you can't talk to" and just make mathematics "more human" to the students. To Kayla, the experience that most formed her identity as a teacher was serving as an instructor of record, when she was afforded more ownership over the courses she was teaching, rather than just taking up a more supportive role as a teaching assistant to a faculty member.

Morgan shared a similar passion and early desire to teach students, however, given her more extensive experiences in graduate school, she recognized herself more jointly as a teacher and researcher in more evident ways than Kayla. To describe what being a mathematics faculty meant to her, she said "It means you get to teach students during the whole school year... You get to contribute to the field by research and publishing papers." Like Kayla, Morgan most recognized herself as a teacher when she was serving as an instructor of record during the summer terms – again emphasizing that employment positions that provide more ownership and agency of a course significantly contributes to professional socialization. Additionally, Morgan saw her identity as a teacher connected to her desire to mentor students and "foster collaborative environments" in mathematics. As she reflected on her future students and colleagues, she said, "I would like to be seen as someone that students want as a professor." We can see how Kayla and Morgan described their professional identities as teachers with direct consideration of how they would like to engage with and be perceived by students. Their teacher identities are consistent with literature on women faculty in STEM and how they tend to describe needing to be more caring and approachable (e.g., Guarino & Borden, 2017; Hart, 2016) and exhibit more student-centered pedagogies (e.g., McMinn et al., 2022).

Researcher Identity

Although both students acknowledged their identities as researchers (Castelló et al., 2020), Morgan identified more strongly as a researcher than Kayla, likely due to her more extensive research experiences, professional experiences (e.g., presenting conferences), mentorship from her advisor, and more time spent in graduate school. In the structure of the focal PhD program, students are not assigned an advisor until they pass their qualifying exams (i.e., advance to candidacy), and spend time reading scholarly works assigned by a potential research advisor. The mathematics department's norms with progressing through the degree milestones reflected the extent to which Kayla and Morgan disparately recognized themselves as researchers.

At the time of data collection, Kayla had not yet passed all her qualifying exams nor was in a position to complete readings and prepare for research with an advisor. Thus, Kayla seemed to identify less as a researcher when prompted to describe how she saw herself as a prospective mathematics faculty. She said, "I do think I'll probably end up doing research." which reveals an early understanding of what the profession may entail. Prior to graduate school, Kayla originally thought that mathematics faculty were solely focused on teaching. She said that the research aspect of the profession is something that she is still getting accustomed to.

On the other hand, Morgan explicitly said, "There's two aspects of being a math professor." – referring to her understanding of the mathematics professoriate as encompassing both teaching and researching responsibilities. She saw herself as someone who can contribute to the field by researching and publishing works, in addition to teaching mathematics to students. Morgan expressed that she wanted to be recognized as "someone who is known to be good at teaching but at the same time produces high quality mathematics." which reveals how her professional identity as a mathematics professor deeply intertwines her sense of self as a teacher and as a researcher. Morgan described that working with her advisor and completing her thesis were the most formative experiences to her identity and preparation as a researcher. Morgan more strongly identified as a researcher because she was in the latter stages of her program, whereas Kayla had only completed her first year. Within this particular institutional context, this revealed that graduate students are socialized as researchers later in the doctoral program.

Mathematics Identity

Lastly, Kayla and Morgan revealed that their mathematics identities (Cribbs et al., 2015; Voigt, 2020) were important dimensions of their professional identities as faculty. Despite recognizing themselves as math persons and being positioned as competent from an early age, graduate school marked a time when their mathematics identities were negatively affected. For Kayla and Morgan, adverse interactions and interpersonal relationships with members of the mathematics community damaged their self-concepts and identities. Kayla said, "I'm not *the* math person, I'm *a* math person." to describe how arriving in graduate school and seeing herself in relation to other students caused her to feel "less special" and made her question her place in mathematics. Additionally, Kayla articulated how her qualifying exams experience – particularly how she perceived the exams to be unnecessarily difficult and how she felt unsupported by faculty – caused her to doubt her career pursuits and sense of self as a mathematician.

It is important to note that Kayla and Morgan explicitly connected their mathematics identities with their gender identity and highlighted how navigating graduate school as women involved facing gender-based bias and microaggressions (Wilkins-Yel et al., 2019). Morgan was previously enrolled in another PhD program prior to her current program, and the experiences at that prior institution caused her to leave academia for a few years. She cited challenges such as the low salary to have contributed to her exiting this program, however, her identity as a

mathematician and a prospective faculty was most negatively affected by how she was treated as a woman. She described the culture at the previous institution as “sexist” and said, “I felt like I had to work twice as hard to be taken seriously.” To illustrate an instance of some of the microaggressions she experienced, she described an encounter with another graduate student:

My first year, I won an award for best incoming, or best first year [student]. And then another grad student was like, “Oh, you just won that because you’re a woman,” or something like that. I felt like I wasn’t really listened to as much and there, wasn’t really supported.

Unfortunately, this is consistent with our contemporary understanding of the experiences of women-identifying graduate students or faculty in STEM (e.g., Herzig, 2004). The patriarchal and masculine discourses that have historically dominated the field (Leyva, 2021) fostered a climate where Morgan felt like her successes do not belong or are simply handed to her because of her gender identity, which in turn challenged her mathematics identity. After leaving that program, she spent a few years in industry before deciding to pursue a doctorate at the current institution. She has described feeling a sense of belonging in the current program and has more strongly identified as a mathematician because of the support she has received.

Discussion and Conclusion

The professional identity development of mathematics graduate students has been an often-overlooked dimension of the pathways to becoming mathematics faculty. The present work is aligned with scholars who have studied the socialization of graduate students (e.g., Clarke et al., 2013; Solari & Ortega, 2020), and have illustrated the complexity and multidimensionality of professional identities (e.g., Trede et al., 2011). I extend that work and highlight how dimensions of participants’ professional identities (i.e., identities as teachers, as researchers, and as mathematicians) developed within higher education mathematics contexts. Kayla’s and Morgan’s professional identities reveal how formative the experiences of graduate education can be, and how students are more strongly anchored onto certain dimensions of their professional identities at different stages of their doctoral programs. Using professional identities as a lens also afforded insight into the experiences that seemed to drive or hinder professional identity development. For example, serving as instructors of record, where graduate students are given more agency and ownership, most developed their identities as teachers. Also, graduate students may identify more strongly as researchers later in their graduate education, which reflects the structure of the degree milestones. This suggests that mathematics departments can better support students’ development as researchers at earlier stages of their graduate education or provide them more opportunities to serve as instructors of record.

Moreover, this preliminary study briefly illustrated how graduate students’ professional identities, especially their mathematics identities, are influenced by their social and cultural identities. The tensions between participants’ gender identities and their sense of selves as mathematics faculty demonstrates how mathematics can still be a patriarchal and masculine space (Herzig, 2004; Leyva, 2021). This suggests that for women-identifying graduate students, the self-recognition as mathematics faculty may be more difficult and challenging. Future research can more closely examine the gendered experiences of mathematics graduate students pursuing faculty positions and continue to make sense of how students’ intersectional identities (e.g., race, sexual orientation, etc.) inform their professional identity development. In all, a more nuanced understanding of these dimensions of their identities allows higher education institutions and mathematics departments to broaden the access and reimagine systems of support that can better prepare graduate students to enter the mathematics professoriate.

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