# COUNTERSTORIES OF PRESERVICE ELEMENTARY TEACHERS: STRATEGIES FOR SUCCESSFUL COMPLETION OF THEIR MATH CONTENT SEQUENCE

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*Master narratives exist in many forms within mathematics education. Preservice elementary teachers often are seen as having high levels of math anxiety while students in developmental mathematics are seen as being deficit in their mathematical understanding. This study uses counterstories to understand the experiences of two women of color, who are enrolled in math content courses for preservice elementary teachers. Students share strategies that they learned from one math content course in order to succeed in their math course sequence.*

Keywords: Instructional Activities and Practices; Affect, Emotion, Beliefs, and Attitudes; Equity and Diversity

Master narratives about preservice elementary teachers' (hereon labeled as PSTs) relationship with mathematics often paints a story that PSTs have high levels of math anxiety both during their teacher preparation program and also beyond as in-service teachers (Gresham, 2007). In particular, of all college majors, female elementary PSTs show the highest levels of mathematics anxiety (Beilock et al., 2010). Math anxiety can often be debilitating, leading to feelings of helplessness, tension, or panic, and can affect PSTs' experiences and success in their math content courses. "Mathematics anxiety affects learning and causes individuals to perform at lower levels than their capabilities" (Brown, Westenskow, & Moyer-Packenham, 2012, p. 366). It has been recommended that mathematics teacher educators incorporate strategies in the PSTs' math content classes that can help students alleviate their anxieties and to help PSTs succeed in their future courses and ultimately in their careers (Vinson, 2001). In fact, Johnson & vanderSandt (2011) showed that taking a math content course in the freshman year of college can contribute to reducing math anxiety in PSTs.

Another master narrative that can apply to PSTs is the deficit perspective that often comes with being required to complete developmental math courses. Developmental mathematics courses "target underprepared students with the purpose of improving their abilities to handle college-level material and succeed in college" (Bettinger, Boatman, & Long, 2013, p. 94). Oftentimes these courses focus on what students *do not* know and attempt to remediate topics in arithmetic and algebra. According to Sitomer (2014), a deficit view of students in such courses is problematic because it does not distinguish between different ways of knowing mathematics, seeks to blame instead of finding solutions, and does not acknowledge that the mathematical experiences of students might differ in significant ways from the mathematical experience of those who "define" the content of mathematics courses. Valencia (2015) argues that many remedial programs fail because they are quick fixes based on a deficit view, placing the burden of acquiring the needed knowledge on marginalized students and their families without much support for accomplishing learning. Oftentimes the coursework does not align with future courses that specific majors, like liberal studies majors, will need to take. Gutiérrez (2008) contends that in order to move away from the negative view of student achievement gap, more research should be done to investigate effective teaching and learning environments for marginalized students.

These master narratives are important to dismantle. Larnell (2011) defines *identity infiltration* where students who often continue to hear the master narrative can begin to replace their experience with that of the master narrative. This can be troublesome for PSTs. If a PST believes that math anxiety is a fixed feature of being an elementary teacher or believes that they are deficit in their

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mathematical knowledge, this can be transferred onto their future students (Vinson, 2001). Therefore, we need to understand strategies that help students to succeed. The research questions that this paper addresses are: 1) What are the counterstories of two PSTs who enrolled in a support course? 2) What strategies do PSTs utilize to succeed in their math content course sequence? 3) How does a mathematics support course support students to forge new mathematical identities?

## Theoretical Framework

This study uses a Critical Race methodology (Solórzano & Yosso, 2002) to understand the ways that two students experienced their math content courses as part of their teacher preparation. We chose this methodology because it focuses on the stories and experiences of marginalized students, viewing these experiences as sources of strength. Solórzano and Villalpando (1988) define those who are marginalized as having "less access to opportunities and resources [and] experience different barriers, obstacles or other forms of individual and societal oppression than those at the center" (p. 212).

PSTs who are also placed into developmental mathematics face more obstacles than those students who are placed in a traditional, introductory mathematics course. First, PSTs are expected to deeply understand, engage with, and convey deeper conceptual understandings of mathematics than a student taking, say, a pre-calculus course. Elementary teachers must balance the challenges of not only understanding mathematical content, but they must have a level of specialized content knowledge (mathematical knowledge that may not be familiar to mathematicians), paired with pedagogical content knowledge (knowledge of how the content interacts with students and within teaching) (Ball, Thames & Phelps, 2008). Second, more underrepresented minority students are placed in developmental mathematics courses (Bahr, 2010) which is problematic because such remediation often places barriers to access to higher levels of education (e.g., receipt of financial aid, extended time to degree), which effectively places many underrepresented students on the periphery of educational opportunities and advancement (Valencia, 2015).

In this study we specifically focus on counternarratives of the second and third authors. *Counterstories* "serve as a method of telling the stories of those people whose experiences are not often told" (Solórzano & Yosso, 2002, p. 32) and can be seen as a tool to challenge the dominant stories of marginalization. "Storytelling has been used to provide a venue for the marginalized to voice their knowledge and lived experiences" (Rodriguez, 2010, p. 493). Solórzano and Yosso (2002) argue that stories can build a sense of community among marginalized populations, giving voices to those who may be overshadowed by the dominant stories within education. Because schooling privileges some students and not others, understanding a student's narrative can aid in understanding the way that those students who are under-supported within our educational system experience mathematics and also find ways to support their learning and success. As scholars, we need to understand how students who may be marginalized in our educational system "make sense of their own experiences and how they feel empowered to act to learn mathematics" (Zavala, 2014, p. 62).

## Methods

This study took place at California State Polytechnic University, Pomona, a large public university on the West Coast of the United States. The second (Hazar) and third (Samantha) authors enrolled as freshmen in Math 1900 (described in the next section) at the university Fall 2018. Both students enrolled as Liberal Studies majors, preparing themselves to complete a Bachelor's degree supporting elementary school teaching. Hazar is in the fourth and final course of the mathematics content sequence while Samantha is enrolled the third course. Students who are deemed as needing extra support enroll in Math 1900 and then move onto the three-course math sequence. Students that do not

need extra support enroll directly into the three-course math sequence which covers numbers and operations, algebra, statistics, and geometry. Hazar identifies as a first-generation, Lebanese-American woman. She is the first in her family to attend public schooling in the United States. She is 20 years old and plans to finish her multiple subject credential with the goal to ultimately get a masters degree. Samantha is a 19-year-old woman who identifies as a Hispanic woman with Native American heritage, focusing on early childhood education. She would like to one day open a pre-school.

## The Quantitative Reasoning Course

Based on a statewide change in the California State University (CSU) system in Fall 2018, developmental mathematics coursework could no longer be offered, and instead general education courses needed to be modified to provide support for students who would have been placed in developmental mathematics courses. Because research has shown developmental mathematics courses hinder student graduation, this change was implemented to help students complete general education mathematics in their first year, shortening their time to degree completion and to lower dropout rates. When a student enrolls at a CSU, they are suggested to take specific courses that provide the right level of support. Through an algorithm that utilizes multiple measures, such as high school GPA, cumulative high school math GPA, SAT score, and whether or not students took math their senior year, students are placed into their math courses.

Math 1900 was a newly designed course, developed by author one, to fulfill the CSU mandate. As a credit-bearing course, the quantitative reasoning course was specifically designed to support students who are enrolled in the liberal studies sequence aiming to become elementary teachers. Previously, these students would have been asked to enroll in two developmental mathematics courses focusing on algebraic skills before starting the liberal studies course sequence. The course was structured around three factors designed to: 1) help students alleviate their mathematics anxiety by focusing on course reflections, strategies, and growth mindset, 2) provide students with opportunities to have authority in their learning and self-regulation of their ideas, and 3) engage students in the eight standards for mathematical practice.

## Analysis

This study focuses on the storytelling of these two students during their fourth semester in the liberal studies program. Both students responded to reflection questions asking them to relate their experiences in the math content courses they have taken. In particular, they were asked to reflect on their relationship with math coming in as a freshmen, their perspectives on teaching mathematics, how they attempt new problems or content areas, strategies they have developed along the way to support their success, and their sense of belonging in the liberal studies program. Through constant comparative methods, we pulled the following themes from the narratives: minoritized experiences in mathematics, change in relationship with math, relying on peers for deeper learning, and looking to oneself for validation.

This study, like all, has its limitations. First, the second and third authors, the participants of this study, were students in the first author's course. This may lead to some bias in the responses of the students. However, these students discuss their experiences after taking several math courses in the liberal studies math sequence, reflecting back on their overall experience. Second, the course has only run for two years, and therefore, much is to be learned, yet about its long-term implications for other students. However, it is worthwhile to gain an understanding of how it is addressing PSTs' needs in the moment.

## Findings

Through their reflections, Hazar and Samantha related their experiences in the content sequence for liberal studies. In particular, the two students described how being in Math 1900, specifically, helped them to feel confident in their math abilities and to persevere in the subsequent course sequence. Both students indicated that their peers who did not start in Math 1900 struggled in their coursework when placed in the next class. From their narratives, both students discussed how they felt minoritized in previous math experiences, strategies that they have used to be successful, which include discussing their past and current relationship with mathematics and teaching mathematics, relying on peers for deeper learning opportunities, and relying on themselves to validate their work.

### Minoritized Experiences in Math

Both women described being minoritized racially or because of their gender in their high school educational experiences, while Hazar also felt minoritized because of her learning disabilities. Both Hazar and Samantha went to schools that had a high proportion of Asian students. Samantha indicated that she was a Hispanic female attending school with a predominantly Korean population of students. She felt that because she was Hispanic, her peers automatically thought that she would not perform well in mathematics. Hazar attended nine different elementary schools, and felt that this caused gaps in her education. When she attended high school, she had a similar experience to Samantha:

> As a middle eastern woman I had less in common with my peers. Our school had a reputation of being academically advanced…Students felt the need to be competitive, and outperform one another instead of lift each other. I felt a need to prove my abilities, not only to my peers, but also my teachers. I did not feel as comfortable raising my hand, and asking questions. I had the fear of being thought of as stupid, or unintelligent. I wouldn't have the confidence to raise my hand or ask the teacher to slow down. On the first day of classes, I felt the need to stay after class and explain I had ADHD, and admitting that I may need extra guidance to perform at the same levels of my peers.

Hazar felt the pressure to perform at her high school, and felt that her lack of consistent learning in elementary school paired with her learning disability contributed to how people thought of her. Samantha described how in high school, she was told that because she was female, she was not good at mathematics. "I had always been told that my brain simply did not function in a mathematical standpoint…I was told that because I am a woman, I would not be as good at math as a male. I noticed that many times, the teachers would pair us with a male partner."

In contrast, both students described how they did not feel this way in their Math 1900 course. For example, Hazar reflected on how she felt when she walked into the class for the first time.

> When I walked into Math 1900, I was taken back to how female dominant the class was. I was heard, and felt that people cared about what I had to say…I was surrounded by a group of diverse and powerful women (and men) who had similar high school experiences to me. I thrived in Math 1900. It was the first time I felt my mental disability was not a crutch. I was able to embrace my differences, and got to be up and moving, and talking. I was no longer subjected to sitting down and lectured at. I am the first generation within my family to be born and raised in the United States. I have had to navigate the education system, which is very different than education in Lebanon. When coming to Cal Poly, specifically Math 1900, I was surrounded by a group that shared the same experiences I have had.

Samantha also indicated that her experience in college was different than in high school, "we were embraced for our differences and told that we were capable regardless of race or ethnicity."

## Changes in Relationship with Math

Hazar and Samantha had relationships with math prior to starting college. Samantha particularly had a high level of anxiety when it came to her relationship with math.

> I did not believe that I would be able to pass a college level math class nor understand it. I was most likely one of the most pessimistic human beings ever when it revolved around math. Throughout my pre-college years, math was truly one of my biggest struggles…although I was excited to finally learn math in which I would be passionate about, I could feel my heart beating out of my chest as I entered into my first ever college class.

Samantha was very insecure about her ability to perform in the set of courses she was expected to pursue as a liberal studies major. She realized that her biggest fear was that she felt that if she could not comprehend the basics of mathematics, how would she be able to teach children? Before college, Hazar felt that mathematics gave her "a lot of anxiety and stress". While she enjoyed math in her early years, she felt that she started to fall behind in high school because she lacked the basic understanding of concepts. She feels that mathematics is important and is something that is used regularly in everyday life, however, she felt a lot of pressure to perform prior to starting college.

Both students described ways that their relationship with math changed after starting the liberal studies program. Samantha described learning about growth mindset in Math 1900 and decided that it might be worth it to change her perspective of mathematics and her ability to learn.

> I began to learn and grow faster than I could have ever imagined. Astonishingly, I finally understood math to the point where I could educate my peers during study review. Never have I walked out of a class with such confidence…Now, I am able to use critical thinking to attempt to comprehend [math] rather than [searching] the internet immediately…[the class] offered me multiple strategies of comprehending different forms of math.

Her relationship with mathematics started to change and her confidence grew. Hazar also indicated seeing similar changes.

> I relearned foundations of math that helped me to understand it better. I was no longer blindly doing problems and hoping I was doing it right. I understand what I am doing, and why I am doing math the way I am. And the moment I don't understand a topic, I've gained the confidence to raise my hand and ask for clarification. I had many misconceptions about math, I thought it was independent, and all memorization…I genuinely want to know and learn more. It has increased my appreciation for teaching…As cliché as it sounds, math is really fun and I want my students to get the appreciation of it earlier than I did.

Both women found a way to relate to mathematics again. Samantha found that changing her mindset provided her the opportunity to engage in mathematics more than she did in high school. She recognized that now she was learning mathematics in order to teach, and therefore found joy when she was able to explain to others. Hazar recognized that with support to understand basic foundations of mathematics, she was able to understand and gain more confidence. She reflected on a moment when she was selected to present her explanation for how to add two fractions:

## Peer Interactions

Samantha and Hazar distinguished that interacting with peers was an essential strategy that they learned from Math 1900 that helped them succeed and persevere in the subsequent math sequence. As noted above, Hazar had always been in classes where she sat in rows, faced forward, and was lectured at. Both students indicated that because group work was a daily routine in Math 1900 and that they were expected to change group members regularly, they were able to create a bond with their peers. Samantha and Hazar found it extremely rewarding to be able to help their peers. Hazar stated

> More than anything, I learned how to think critically, which is very important as a Liberal Studies major. I even took a different approach to how I help my peers. I wanted to create an encouraging and positive setting, but I couldn't do that by saying "no that's wrong". Just changing my verbiage ended up being a learning curve, and I have gone a long way. I now see dozens of students and tutor them at my school's Learning Resource Center…It gave me confidence I didn't know I had.

At the end of her first year, Hazar had gained so much confidence through working with others, that she decided to apply for a position as a tutor for the first two math courses in the sequence. She has now been tutoring for almost a year, and finds the experience very rewarding.

Both Hazar and Samantha started group study sessions outside of class. They found that by being able to practice teaching concepts in front of one another, they were able to clarify their language and understanding of the material. For example, Samantha indicated that by becoming close with her classmates through groupwork in class, she was able to develop closer bonds with her peers and feel comfortable meeting outside of class to study and develop their mathematical understanding. "We were able to…develop the proper communication skills and be able to know the process to overall work through problems with one another…[which I used] not only my math courses, but my other courses in general."

In particular, Hazar indicated that because of her widespread interactions with peers in Math 1900, she felt she finally found her calling.

> I knew I was meant to be a teacher because I have never bonded so instantly with any group in my life. We are like-minded and have similar goals. I've met some of the most encouraging and uplifting people I will ever meet. I made a mistake on a worksheet and I said "I'm stupid" and the whole table responded "No you're not" so instantly. Teaching is exactly what I want to do, and I've never been so excited to start my future.

While both students indicated that the type of group work they experienced in Math 1900 was not the same in the subsequent math courses, they decided to carry on the tradition. For both students, their interactions with peers was a strategy that they took into their future math classes. For example, Hazar mentioned how she volunteers and shares her work with her peers, even though her instructor had not expected her to, because she understood the value of learning from peers. Samantha continues to meet with peers outside of class, even if they are not in the same course section, "with the community [from Math 1900], we still have study sessions, coffee dates, a hand to hold onto, and overall encouragement when we are feeling down."

### Validating their Own Work

Hazar and Samantha both indicated the value of struggle in their Math 1900 course. Hazar described scenarios when in Math 1900, the instructor never explicitly answered her questions and instead would ask her to think through her reasoning.

> I found it important to have a professor that allows you to struggle and make mistakes. [My professor] was patient, she didn't give us all the answers right away. She gave a lot of time to communicate and troubleshoot within our groups. If I asked for help she would ask me to go through the work I had out loud, and upon doing so I would naturally answer my own question.

Hazar indicated that this strategy of asking "why?", "what?", or "how?" helped her immensely in her subsequent math courses. She does so for questions like: "Why did I convert fractions to decimal in this word problem? Why are we using base 5? In ⅝ why, is 5 part of the 6? What does the 3 represent in 532, and what is its relation to the other numbers?

Samantha described a similar takeaway from that course. She recalled that for the first time she was genuinely asked to explain her reasoning behind how she did specific problems.

> [My professor] instigated the challenge of questions such as "*why* do we do this that way?" or "*how* did you get that outcome?" This ultimately helped me to find the deeper meaning to why or how I got an answer which is an important aspect to becoming an educator.

Samantha recalled a moment when she was presenting at the board and when she was asked by her professor how she arrived at her answer, she "[stared] at the numbers scribbled all over the board for what seemed to be hours, I finally…said 'I do not know.' This taught me that children will ask why and how, and an answer is a necessity." Samantha understood that in future courses and her transition to becoming a teacher, she needed to rely on herself to validate her own work.

## Discussion

In this study, we discussed the counterstories of two women enrolled in their math sequence for future elementary teachers. Both women described how their previous high school experiences positioned them as inferior to their peers in their mathematics courses. Their experience in Math 1900 was transformational to these experiences; they were able to create and utilize strategies in their subsequent math courses that promoted their success while also creating more positive mathematical identities. The master narratives that PSTs struggle with high anxiety and also that developmental math students are deficient in math understanding are being challenged through their experiences. An essential take-away from the findings is that the two students felt a sense of community in their Math 1900 class (e.g., did not feel minoritized, felt like they were part of a team). On the first day of class, all students in the course contributed towards a classroom set of norms, which were followed all semester. Part of the list was that students were expected to hold authority of their learning, to give respect to others, and to provide positive feedback to others. This could also contribute to why both women experienced a change in their relationship with mathematics and the joy they found working with others. Students were expected to be creative and to work on problems together, requiring them to only ask questions once the entire group needed help. Positive experiences for PSTs can contribute to positive attitudes towards mathematics (Kalder & Lesik, 2011). Part of the design of the course was to be transparent in the rationale for why the instructor did what she did, revealing underlying reasons to classroom decision making of the content and the mathematical practices.

Hazar and Samantha may have found purpose and utility in the mathematics they were learning because it was the first time they saw how it could be connected to their field. Anderson (2007) argues that an important feature of mathematics identity is to be able to *imagine* how mathematics fits into a student's broader life. Students in developmental mathematics courses often find that the math they learn is not connected to their career goals or futures and therefore do not feel motivated to learn the material (Cawley, 2018). Hazar and Samantha found a transformative change to enjoying mathematics and wanted to better understand it once they saw its purpose: to teach future children. Because the class was built around the standards for mathematical practice, students were constantly asked to make sense of problems and persevere in solving them while also constructing viable arguments for the conclusions they reached in problems and to critique the reasoning of others in their group. Both women found the strategy of asking themselves *how* and *why* they chose certain ways to work on problems to be a positive learning strategy that they carried forward. They also found that asking for help from others supported their learning. These strategies appeared to increase their confidence to engage with and present their mathematical work.

It is important to provide the supports early on for students in order to help them succeed. Different from developmental math, this course was grounded in math content that was purposeful for future teachers, intentional in the design, provided an early intervention for students to build confidence, connected to mathematical practices, and created positive learning experiences for students to have continued success.

## References

Anderson, R. (2007). Being a Mathematics Learner: Four Faces of Identity. Mathematics Educator, 17(1), 7-14.

Ball, D. L., Thames, M. H., Phelps, G. (2008). Content knowledge for teaching: What makes it special. *Journal of Teacher Education, 59*(5), (pp. 389 – 407).

Bahr, P. R. (2010). Preparing the underprepared: An analysis of racial disparities in postsecondary mathematics remediation. The Journal of Higher Education, 81(2), 209-237.

Beilock, S. L., Gunderson, E. A., Ramirez, G., & Levine, S. C. (2010). Female teachers' math anxiety affects girls' math achievement. *Proceedings of the National Academy of Sciences*, *107*(5), 1860-1863.

Bettinger, E. P., Boatman, A., & Long, B. T. (2013). Student supports: Developmental education and other academic programs. *The Future of Children*, *23*(1), 93-115.

Brown, A., Westenskow, A., & Moyer-Packenham, P. (2012). Teaching anxieties revealed: pre-service elementary teachers' reflections on their mathematics teaching experiences. *Teaching Education, 23*(4), 365-385.

Cawley, A. (2018). The instructional experiences of Latinx community college students in a developmental mathematics course taught by an adjunct faculty at a Hispanic-serving institution, (Doctoral dissertation). University of Michigan, Ann Arbor, MI.

Gresham, G. (2007). A study of mathematics anxiety in pre-service teachers. *Early Childhood Education Journal*, *35*(2), 181–188.

Gutiérrez, R. (2008). A" gap-gazing" fetish in mathematics education? Problematizing research on the achievement gap. *Journal for Research in Mathematics Education*, 357-364.

Johnson, B., & vanderSandt, S. (2011). "Math Makes Me Sweat" The Impact of Pre-Service Courses on Mathematics Anxiety. *Issues in the Undergraduate Mathematics Preparation of School Teachers*, *5*.

Kalder, R. S., & Lesik, S. A. (2011). A Classification of Attitudes and Beliefs towards Mathematics for Secondary Mathematics Pre-Service Teachers and Elementary Pre-Service Teachers: An Exploratory Study Using Latent Class Analysis. *Issues in the Undergraduate Mathematics Preparation of School Teachers*, *5*.

Larnell, G. V. (2011). More than just skill: Mathematics identities, socialization, and remediation among African American undergraduates. Michigan State University. Mathematics Education.

Sitomer, A. (2014). Adult returning students and proportional reasoning: Rich experience and emerging mathematical proficiency. Unpublished Doctoral dissertation, Portland State University, Portland, OR.

Solórzano, D. G., & Villalpando, O. (1998). Critical race theory, marginality, and the experience of students of color in higher education. *Sociology of education: Emerging perspectives*, *21*, 211-222.

Solórzano, D. G., & Yosso, T. J. (2002). Critical race methodology: Counter-storytelling as an analytical framework for education research. *Qualitative inquiry*, *8*(1), 23-44.

Valencia, R. R. (2015). Students of color and the achievement gap: Systemic challenges, systemic transformations. Routledge.

Vinson, B.M. (2001). A comparison of preservice teachers' mathematics anxiety before and after a methods class emphasizing manipulatives. Early Childhood Education Journal, 29(2), 89–94.

Zavala, M. D. R. (2014). Latina/o Youth's Perspectives on Race, Language, and Learning Mathematics. *Journal of Urban Mathematics Education, 7*(1), 55-87.