# TEACHERS CANDIDATES' IMPLEMENTATIONS OF EQUITABLE MATHEMATICS TEACHING PRACTICES: AN EXAMINATION OF DIVERGENT PATHS

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*In this multiple-case study, we track the diverging paths of two teacher candidates enrolled in an undergraduate elementary mathematics methods course as they developed their understanding of equitable teaching practices that were central to their course learning objectives. The cases were purposefully selected based upon our previous finding that, by the end of the course, Mary and Rose were extreme opposites in terms of their implementation of equitable mathematics teaching practices they attributed to the course. Teacher preparation programs are designed to help beginning teachers develop the skills to teach content equitably to diverse learners. Thus, methods instructors must consider the ways that teacher candidates use their knowledge and skills in their teaching.*

Keywords: Instructional activities/practices, equity and diversity, teacher education, pre-service teachers, mathematics education

Amid the complex debates about the nature and purposes of teacher preparation, a critical question pervades: How do we prepare mathematics teachers to enact equitable teaching practices? The authors seek to understand their elementary mathematics methods teacher candidates' understanding and implementation of equitable mathematics teaching practices that are centered in their elementary mathematics methods course by looking deeply at two cases over the course of the semester. One teacher candidate, Mary (pseudonym), implemented equitable mathematics teaching practices that she attributed to learning in the course (via her end of course survey) with 100% fidelity for extended periods of time in her final project video. Another teacher candidate, Rose (pseudonym), implemented a few of the practices. The differences observed in Mary and Rose's final course project videos led us to wonder how two students in the same course and section could finish with such dramatic differences in their level of understanding and implementation of equitable teaching practices.

## Related Literature and Framework

This study is rooted in socio-cultural theories that argue that: knowledge is developed and transmitted through social contexts, culture plays a fundamental role in cognition, and knowledge is dependent upon human interactions with each other and the world around us (Crotty, 1998).

Individuals bring their culture to the learning environment, and their culture and knowledge are constructed and reconstructed in the moment-to-moment interactions in the learning environment. With this perspective, classroom contexts provide a space where culture is produced and possibly changed (Nasir & Hand, 2006).

Although our definition of equity and equitable mathematics teaching continues to evolve, in principle it focuses on deliberate efforts to interrupt systems of oppression, harm, racism, and violence as they show up in schools, classrooms, and teaching practices particularly in ways that

In: Sacristán, A.I., Cortés-Zavala, J.C. & Ruiz-Arias, P.M. (Eds.). (2020). *Mathematics Education Across Cultures: Proceedings of the 42nd Meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education*, Mexico. Cinvestav / AMIUTEM / PME-NA. https:/doi.org/10.51272/pmena.42.2020

ensure students have access to learning ambitious mathematics content and learn mathematics in empowering environments that support their development of a positive mathematics identity.

## Course Description and Design[1]

The mathematics methods course which catalyzed this study is designed to equip teacher candidates with the instructional skills to develop classroom cultures that enable students from diverse backgrounds to fully participate and learn using a practice-based model[2]. Course resources, targeted reading assignments, and focused class sessions exposed teacher candidates (TCs) to issues of status, equity issues that arise in mathematics classrooms, and effective teaching practices that help mitigate them for diverse learners, including Native American, Latinx and, Black boys.

To understand equity issues affecting Native American, Latinx and, Black boys in mathematics classrooms, our teacher candidates reviewed frameworks and publications by the Smithsonian National Museum (2019) and the National Indian Education Association (2019) to explore local Native American communities, artifacts, and curricular resources; they learned about emergent bilingual Latinx (EBL) supports including allowing students to use their first language, incorporating sentence starters and sentence frames within anchor documents, and attending to the language demands of mathematics lessons (Aguirre et al., 2012; Ahn et al., 2011; Bresser, 2003; Khisty, 2002; Torres-Velasquez & Lobo, 2005, & the Board of Regents of the University of Wisconsin System's WIDA English Development Standards, 2020); and they incorporated supports for mathematics learning and identity development for Black boys (Berry, 2004; Jett et al., 2015).

# Methods

This multiple case, follow up study is designed to expand our knowledge of factors that might have influenced Mary and Rose's alignment to and/or divergence from the equitable mathematics teaching practices centrally featured in our elementary mathematics methods course (Seawright & Gerring, 2008). The following research questions guided our study:

1. In what ways do Mary and Rose's elementary mathematics coursework demonstrate their alignment with or divergence from the equitable mathematics teaching practices that were explicitly taught in their elementary mathematics methods course?
2. How does the work produced by Mary and Rose compare to each other, as students enrolled in the same course section who were both placed in internship classrooms with culturally and linguistically diverse students?
3. What might explain this alignment and/or divergence?

## Study Participants

This study took place at a large, predominantly white, research-intensive, 4-year university. The two cases were a subset from teacher candidates enrolled in one of three elementary mathematics methods courses during the fall semester of their senior year ($n=55$). Our prior study incorporated a funneling sampling sequence (Erikson, 1986) where nine cases (two of which were Mary and Rose, who are both white and female) were selected for further examination of equitable teaching practices. In that study, Mary had the highest degree of implementation fidelity over an extended period of time, and Rose had the lowest. Thus, we selected these two divergent cases for our current study.

[1] Some of the work and ideas represented in this course, including the title and structure of the major projects are drawn from Math Methods Planning Group at the University of Michigan (under the direction of Dr. Deborah Ball (https://deborahloewenbergball.com).

[2] This course was developed by Dr. Imani Goffney as a part of her NSF grant, Mathematical Knowledge for Equitable Teaching, Award No. 1725551.

## Data Sources and Equitable Mathematics Practices

Written materials submitted by Mary and Rose for 3 course projects, assigned at the beginning, middle, and end of the course, provided opportunities to demonstrate their understanding of equitable mathematics teaching practices in their internships and are the primary data sources for this study. The first project was the Student Thinking Project (STP). TCs prepared 2- 3 grade appropriate mathematics tasks and a series of probing questions to elicit student thinking with 2 students selected from their internship. TCs analyzed their own video recordings to explain student selection, and useful strategies in raising and equalizing their students' status. The second project was the Circulating and End of Class Check Project (EOCC). TCs video recorded themselves circulating while students worked independently. They practiced observing, responding to questions, and probing and intervening when appropriate. The final project was Leading a Whole Class Discussion Project (WCD). For this project, TCs video-recorded themselves teaching a mathematics lesson that incorporated a whole class discussion and an end of class check. For their analysis, they identified a 3-5-minute video segment highlighting one equitable mathematics practice covered in the course. They explained their practice selection and identified areas for improvement.

## Analytical Techniques

Our qualitative data analysis (Saldaña, 2015) began with deductive coding of Mary and Rose's written projects to identify evidence of equitable teaching practices that were the central focus of the course. Two members of the research team independently coded each of the participants' written submissions for all three projects. Codes were labeled and mapped to the course. Then, the five members of the research team met to review initial codes for each case to ensure inter-rater reliability and to confer on preliminary findings. Next, we drafted analytical memos for each participant. In the second phase of analysis, we independently examined our coded data to identify evidence of each participant's alignment with, or divergence from, the equitable mathematics teaching practices that were the focus of the course. We also examined the relationship between the participants' degree of alignment with course goals across the term. Coded phrases, such as "repositioning a low status student," were secondarily assigned one of two codes: "aligned," as in this teaching practice or description was similar to the equitable teaching practices featured in the course, or "divergent," not aligned with the equitable teaching practices featured in the course. Secondary codes were examined by two members of the research team to ensure at least 80% inter-rater reliability. Once at least 80% inter-rater reliability was confirmed, secondary codes were integrated with our analytical memos to develop the participants' case narratives. Our findings are described in the following section.

# Findings and Summary

Mary and Rose began the course with differing levels of understanding of equitable mathematics teaching. Both Rose and Mary's STPs incorporated asset-based language to describe their students and both cases discussed their desire to learn more about their students' thinking through this project. However, 95% of Mary's STP was aligned with the equitable teaching practices taught in the course, while only 61% of Rose's STP was aligned, indicating that she grappled with implementing equitable teaching practices. The most compelling data was the EOCC data. Mary's EOCC and WCD data was 100% aligned with equitable teaching course goals. Rose's EOCC data showed a decrease in alignment with course goals (50%) and a movement toward procedural mathematics instruction. Rose's divergent trend increased on her WCD. She described supporting her students' "math smarts" by acknowledging their correct solutions. Differences in their understanding and implementation of equitable teaching were evident from the first project (STP) to the EOCC.

**Tables 1-3: Percentage of Alignment with Course Goals by Participant and Course Project**

| | **Table 1: Student Thinking Project** |
|---|---|
| Rose: 61% aligned | *I think that in order to equalize status issues in the classroom, it is important that students work in a variety of groups. It is important that students are in groups with students as the same abilities as them, but it also equally as important that they work with a variety of students. This way, students are learning from their peers and they are all seen as equals. If students are always in the same group they may realize they are grouped by ability. However, if every once in a while students are working and sharing with a variety of people in the classroom, they will also benefit from others that are on a different level.* |
| Mary 95% aligned | *To neutralize the status of the groups, I would ask the children to stay within their table groups when discussing answers so one child doesn't always go up to the same person for discussions. Additionally, I would ask students to help their peers by teaching them a skill, not doing it for them. I would want to emphasize group success and the idea that unless everyone is successful, then no one in the group is fully successful. I would set roles within the group so that the children could each have a task to perform.* |
| | **Table 2: Circulating & EOCC Project** |
| Rose: 50% aligned | Exit ticket: Does the problem 6789+987 require regrouping? How do you know? *I hope to learn if students know when it is appropriate to regroup, and if they can explain what regrouping is.* |
| Mary: 100% aligned | Exit ticket: Miss Smith is preparing materials for the table groups. She puts 4 worksheets in each table group bin. There are 5 table groups. Write an equation or draw a picture to illustrate this problem. *By giving this prompt, I hope to develop a deeper understanding of the students' skills at drawing arrays. The children have been working on this skill for 2 days. However, through completing this project, I noticed that the children still have some confusion about arrays and while they may get the problems correct, they might not always be confident about their answers. This leads me to believe that there could be some confusion about the concept, and I would like to learn more about where this confusion comes from so that I can re-teach the confusing parts.* |
| | **Table 3: Leading a Whole Class Discussion** |
| Rose: 6% aligned | *I chose the first aspect, purposefully using questions to elicit, probe, and connect students' mathematical ideas. I did this during the lesson when I was doing the first problem with my class. After they decided what the single digit number was, and they decided what number was in the ones place, they knew they had to multiply. The numbers were 5 times 2, and with the traditional algorithm this requires regrouping. However, I asked the students "If I wrote the number 10 down instead of regrouping, what method would I be doing?" Students responded by saying that that method is partial products. In this lesson, I also addressed students' math smarts by reaffirming them when they solved problems correctly* |
| Mary: 100% aligned | *The reason why I chose this skill is because it is important for students to be able to participate in whole class discussions. First, it minimizes status issues because if all students are able to participate in a respectful class discussion, each child's affective filter will naturally be lowered to (hopefully) a level where they are able to participate in the class activity since there will be an environment of respect in the classroom. I chose to practice this skill on this particular day because money is something that almost every child has seen before, but many children don't understand the value of it. So, everyone will be able to contribute to the conversation and it will be engaging because it is a topic that they are probably curious about.* |

## Discussion and Conclusion

How can two teacher candidates who receive the same content in the same class, with the same instructor, have dramatically different outcomes? One explanation may be mentoring. In her final course project, Mary describes classroom norms like using a positive behavior intervention system, and she reflects on failing to implement two talk moves due to minimal modeling from her mentor. However, Rose does not reflect on existing classroom norms or practices. Therefore, we wonder whether her mentor modeled equitable mathematics instruction and whether Rose may have been

constrained by structures in her internship. Another possible explanation is that Rose's personal experiences or beliefs may have prevented her from implementing equitable teaching strategies. We know that our experiences shape our beliefs, biases, and identities. It is possible that Rose's personal beliefs and identities did not align with our course teachings. We know that changes in beliefs occur if equity is deliberately and explicitly implemented throughout teacher preparation. These cases suggest that teacher preparation programs should develop interventions to help TCs demonstrate proficiency for teaching mathematics in equitable ways. Finally, this tells us that novice teachers, even graduates from the same program, will have a wide range of understanding and skills relating to equitable mathematics teaching, so it is essential for school districts to provide induction support.

## References

Aguirre, J. (2018). Math Strong: Actualizing our commitment to a more just and humanizing mathematics education [Powerpoint slides]. Invited keynote at the Teachers Development Group Leadership Conference: Portland, OR.

Aguirre, J. M., Zavala, M. D. R., & Katanyoutanant, T. (2012). Developing Robust Forms of Pre-Service Teachers' Pedagogical Content Knowledge through Culturally Responsive Mathematics Teaching Analysis. Mathematics Teacher Education and Development, 14(2), 113-136.

Ahn, R., I, J., & Wilson, R. T. (2011). Teaching mathematics to English language learners using Moses' Five-Step Approach. Teaching for Excellence and Equity in Mathematics, 3(1), 20-28.

Berry, III, R. Q. (2004). The Equity Principle through the voices of African American males. Mathematics Teaching in the Middle School 10(2), 100-103.

Board of Regents of the University of Wisconsin System's 2012 WIDA English Development Standards. (2020) Retrieved from https://wida.wisc.edu/sites/default/files/resource/2012-ELD-Standards.pdf

Bresser, R. (2003). Helping English-language learners develop computational fluency. Teaching Children Mathematics, 9(6), 294-300.

Chapin, S., O'Conner, C.,& Anderson, N. (2009). Classroom discussions: Using math talk to help students learn, Grades K-6 (2nd ed.). Sausalito, CA: Math Solutions Publications.

Crotty, M. (1998). The foundations of social research: Meaning and perspective in the research process. London: Sage Publications.

Dixson, A. (Ed.), Rousseau Anderson, C. (Ed.), Donnor, J. (Ed.). (2017). Critical Race Theory in Education. New York: Routledge, https://doi.org/10.4324/9781315709796

Featherstone, H., Crespo, S., Jilk, L. M., Oslund, J. A., Parks, A. N., & Wood, M. B. (2011). Smarter together! Collaboration and equity in the elementary math classroom. Reston, VA: National Council of Teachers of Mathematics.

Gay, G. (2002). Preparing for culturally responsive teaching. Journal of teacher education, 53(2), 106-116.

Ivy, K., Stoltz, A., Buli, T., Goffney, I., & Terrell Shockley, E. (2019, November). Teacher candidates' understanding of equitable mathematics teaching [Paper Presentation]. In Otten, S., Candela, A. G., de Araujo, Z., Haines, C., & Munter, C. (2019). Proceedings of the forty-first annual meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education (pp. 1335-1339). St Louis, MO: University of Missouri. Available at: https://www.pmena.org/pmenaproceedings/PMENA%2041%202019%20Proceedings.pdf

Jett, C. C., Stinson, D. W., & Williams, B. A. (2015). Communities for and with Black male students: Four strategies can be effective in creating supportive learning environments. Mathematics Teacher, 109(4), 284–289.

Kazemi, E., & Hintz, A. (2014). Intentional talk: How to structure and lead mathematical discussions. Portland, ME: Stenhouse.

Khisty, L. L. (2002). Mathematics learning and the Latino student: suggestions from research for classroom practice. (Research, Reflection, Practice). *Teaching children mathematics*, *9*(1), 32-36.

Ladson-Billings, G. (1995). Toward a theory of culturally relevant pedagogy. American educational research journal, 32(3), 465-491.

Martin, D. B. (2012). Learning Mathematics While Black. The Journal of Educational Foundations, 26(1/2), 47.

Milner IV, H. R., Cunningham, H. B., Delale-O'Connor, L., & Kestenberg, E. G. (2018). "These Kids Are Out of Control": Why We Must Reimagine" Classroom Management" for Equity. Corwin Press.

Nasir, N. I. S., & Hand, V. M. (2006). Exploring sociocultural perspectives on race, culture, and learning. Review of educational research, 76(4), 449-475.

National Indian Education Association. (2019). *Native Education 101*. Retrieved from http://www.niea.org/our-story/history/native-101/

Saldaña, J. (2015). The coding manual for qualitative researchers. Sage.

Seawright, J., & Gerring, J. (2008). Case Selection Techniques in Case Study Research: A Menu of Qualitative and Quantitative Options. Political Research Quarterly, 61(2), 294–308. https://doi.org/10.1177/1065912907313077

Smithsonian National Museum of the American Indian. (2019) *Framework for Essential Understandings About Native Americans*. Retrieved from https://americanindian.si.edu/nk360/pdf/NMAI-Essential-Understandings.pdf

Teaching Works. (2018). Retrieved from http://www.teachingworks.org/

Torres-Velasquez, D., & Lobo, G. (2004). Culturally Responsive Mathematics Teaching and English Language Learners. *Teaching Children Mathematics*, *11*(5), 249.

Yeh, Cathery & Ellis, Mark & Hurtado, Carolee. (2017). Reimagining the mathematics classroom: Creating and sustaining productive learning environments, K–6.