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UNIVERSITY OF CALIFORNIA,
IRVINE

Broadening Participation in Mathematics: A Study of Secondary Mathematics Teachers and
Noticing for Equity

DISSERTATION

Submitted in partial satisfaction of the requirements
for the degree of

DOCTOR OF PHILOSOPHY

in Education

By

Janet Mercado

Dissertation Committee:
Associate Professor Rossella Santagata, Co-chair
Associate Professor Elizabeth van Es, Co-chair
Associate Dean & Associate Professor Joi Spencer

2017

DEDICATION

To my husband, Abraham, for his endless support and enthusiasm. Thank you for making me smile every single day. Siempre.

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Elizabeth van Es, I appreciate not only your feedback on this dissertation, but also the opportunity you gave me to be part of this study. It was wonderful to have had such a prominent role as your GSR on this project. I enjoyed collaborating with you on data collection. Thank you for encouraging and guiding me through the analysis of this data. Additionally, I would like to thank Vicki Hand, Beth's collaborator on this project, for including me in the analysis and the presentation of findings related to this project. I admire you both as scholars and look forward to hearing about the future directions of this valuable work. Also, I want to share my appreciation to the teachers that participated in this study. I enjoyed observing your teaching. Finally, thank you to the Spencer Foundation for providing the grants for this study to be possible.

Additionally, I would like to thank Joi Spencer and Tesha Sengupta-Irving for their feedback on the development of this dissertation. Thank you for your thoughtful comments and for pushing me to think critically about this work. I would also like to thank my colleagues in Rossella and Beth's research groups (Carlos, Cathery, Doron, Jennifer, Jiwon, Karen, and Priyanka) for listening to my ideas, questioning me, and giving me a space to think through my research. Also, I want to thank my research assistants (Nini and Jacklyn) for their help on the analysis.

To my past mentors, Michael Martinez, Gaithri Fernando, and the CSULA MORE program directors, thank you for pushing me to pursue a doctorate degree and for believing in me. I never would have dreamed that this accomplishment was possible without you all.

Thank you to my wonderful family and friends for their love and support over the years. I am most grateful to my parents, Ramon y Rosa Garcia, who have always supported my educational goals. Both, immigrants from humble backgrounds, inspired me to work hard and push through the difficulties that life has thrown at us. Your perseverance is inspiring. Papa, doy las gracias que estás aquí para celebrar conmigo. Gracias por tu apoyo. Te quiero mucho!

Finally, this accomplishment is dedicated to my husband, Abraham, who has been my motivation through this long journey. Since the moment that I decided to pursue my doctorate, you inspired me to follow through with my ambitions. It is because of you that so many of my dreams have come true. I am grateful for the strength and comfort you have given me during difficult moments and appreciate all you do to make me smile. I treasure your love, support, and encouragement. Coming home to you, Maximus and Lola is always the best part of my day.

CURRICULUM VITAE

Janet Garcia-Mercado

Education

Doctorate of Philosophy, Education, University of California, Irvine (UCI), August 2017

Bachelor of Arts, Psychology, California State University, Los Angeles (CSULA), March 2008

Specialization

Learning, Cognition, and Development

Awards & Honors

2016, UCI School of Education Keith Curry Scholarship founded to honor a doctoral student who has demonstrated significant growth in academic achievement and unusual perseverance

2015, UCI School of Education Award of Appreciation awarded as recognition for participating in diversity efforts (e.g. CSU Diversity Forum)

2009, UCI Summer Undergraduate Research Program provides funding for UCI undergraduates from all disciplines who are conducting summer research projects or creative activities under the guidance of UCI faculty members

2008-2009, Sally Casanova California Pre-Doctoral Fellowship a competitive fellowship designed to enable current CSU students to explore and prepare to succeed in doctoral programs

2008-2009, CSULA Graduate Student Recognition Reception honors to all outstanding graduate student honorees for their academic and professional achievements

2007-2009, CSULA Minority Access to Research Careers - Undergraduate Student Training in Academic Research Program (MARC-U*STAR) Fellowship awarded to provide support for undergraduate students who are underrepresented in the sciences to improve their preparation for rigorous graduate training at the doctorate level.

2006, CSULA Dean's List

Research Interests

Secondary education, equitable teaching practices, adolescent learners, teacher noticing, broadening participation in mathematics, learner identity, culturally relevant pedagogy, multicultural education

Research Projects

Dr. Elizabeth van Es (UCI), January 2013- Present. *Understanding Noticing in Equitable Teaching.* The goal of this study is to investigate equitable mathematics teaching by examining practices of teaching and learning enacted in a classroom. Specifically, we were seeking to know more about what equitable mathematics teachers attend to in moments of classroom activity and how they interpret what they see. My role in this lab involved data collection, data analysis, conference presentations and collaborating for publications. I also worked with and trained undergraduate research assistants in data analysis.

Dr. Rossella Santagata (UCI), September 2011- Summer 2015. *Learning to Learn from Teaching.* This study examines the characteristics (knowledge and beliefs) of prospective elementary mathematics teachers. My role in this lab involved data collection, data analysis, conference presentations and collaborating for publications. I also worked with and trained undergraduate research assistants in data analysis.

Dr. Tesha Sengupta-Irving (UCI), January 2013- April 2015. *The Engineering & Education Collaborative- Teacher Professional Development.* Our two-phase study focused on creating an engineering professional development for secondary math and science teachers. My role in this lab involved workshop development, data collection, data analysis, conference presentations and collaborating for publications.

Dr. Jeannette Mancilla-Martinez (UCI), September 2013-June 2014. *Preschool Literacy Development.* This study focuses on the language development of pre-school aged children, specifically focused on English Language Learners. My role in this lab involved participant recruitment, research assistant training and data collection through observations and student assessment.

Dr. Michael Martinez (UCI), June 2009 - June 2010. *Spatial Temporal Math.* This study examined the implementation of spatial temporal software used as an added representation to teach elementary mathematics. My role in this lab involved data collection through assessing elementary students.

Dr. Gaithri Fernando (CSULA), Fall 2006 - Spring 2009. *Studies of Traumatic Stressors.* This research examined the effects of traumatic stressors on psychosocial functioning in the form of civil war, natural disaster, abuse and violence. My role in this lab involved participant recruitment, data collection, focus group interviews, data analysis, conference presentations and collaborating for publications.

Publications

Book Chapter

van Es, E., Hand, V., **Mercado, J.** (2017). Making Visible the Relationship between Teachers' Noticing for Equity and Equitable Teaching Practice in Teacher Noticing: Bridging and Broadening Perspectives, Contexts, and Frameworks. Springer

Peer-reviewed articles

Sengupta-Irving, T. and **Mercado, J.** (2017) "Anticipating Change: An Exploratory Analysis of Teachers' Conceptions of Engineering in an Era of Science Education Reform," *Journal of Pre-College Engineering Education Research*. 7(1), 108-122.

<https://doi.org/10.7771/2157-9288.1138>

Hand, V., Freeman, Q. **Mercado, J.**, van Es. (2017). International Mathematics Education and Society Conference. Volos, Greece.

Publications in progress

Santagata, R., Yeh, C., **Mercado, J.** (revision submitted). Preparing Elementary School Teachers to Learn from Practice: A Comparison of Two Approaches to Mathematics Methods Instruction. *Journal of the Learning Sciences*.

Santagata, R. & **Mercado, J.** (in progress). Characterizing Pre-Service Teacher Knowledge and Beliefs about Mathematics Teaching and Learning at the Beginning of Reform-Oriented, Practice-Based Teacher Preparation.

Mercado, J., (in progress) Broadening Mathematics Participation through Teacher Noticing.

Selected Conference Presentations

Mercado, J., van Es, E., Broadening Participation through Teacher Noticing. American Educational Research in Education Conference. San Antonio, TX, April, 2017.

Mercado, J., van Es, E., Noticing for Equitable Mathematics Teaching. Association of Mathematics Teacher Educators Conference. Irvine, CA, February, 2016.

Sengupta-Irvine, T. & **Mercado, J.** Anticipating Change: Secondary Teachers' Beliefs About Engineering, Students, and Science Reforms. American Educational Research in Education Conference. Chicago, IL, April, 2015.

Mercado, J., van Es, E., Hand, V. Noticing for Equitable Mathematics Teaching. National Council of Mathematics Teachers Research Conference. Boston, MA, April, 2015.

van Es, E. A., Hand, V., **Mercado, J.** Using Video to Collaboratively Examine Equitable Secondary Mathematics Teaching. In I. Horn (Chair), Teachers' Learning about Equitable Practice through Talk with Colleagues. Symposium presentation at the International Conference of the Learning Sciences, Boulder, CO June, 2014.

Hand, V., Bibilos, C., van Es, E., & **Mercado, J.** Teacher Dispositions, Classroom Noticing, and Equitable Mathematics Instruction. American Educational Research Association Conference. Philadelphia, PA, April, 2014.

Van Es, E., **Mercado, J.**, Hand, V., C'de Baca, C., Ormseth, T., & Quiroz, R. Noticing for Equitable Mathematics Teaching. Presentation at the annual meeting of the Association for

Mathematics Teacher Educators, Irvine, CA. Noticing for Equitable Mathematics Teaching. Association of Mathematics Teacher Educators. Irvine, CA, April, 2014.

Mercado, J., Mohr, S., Santagata, R., Elementary Pre-Service Teachers' Knowledge and Beliefs about Mathematics. National Council of Teachers of Mathematics Conference. Denver, CO, April 2013.

Mercado, J., Mohr, S., Santagata, R., Elementary Pre-Service Teachers' Knowledge and Beliefs about Mathematics. European Association for Research & Instruction. Munich, Germany August. 2013.

Santagata R., Mohr, S. **Mercado, J.** (The relationships among) knowledge, beliefs, self-efficacy, and career aspirations and satisfaction of U.S. elementary pre-service teachers. European Association for Research & Instruction. Munich, Germany. August 2013.

Garcia, J. & Martinez, M. *Approaching Mathematics Through Spatial Temporal Learning*. The University of California, Irvine 2009 Research Symposium. Irvine, August 2009.

Garcia, J., Fernando, G., Chan, S., Miller, K. *Emotional and Psychosocial Functioning of Sri Lanka Youth Exposed to Traumatic and Daily Stressors*. International Society for Traumatic Stress Studies Chicago, IL, November 2008.

Fernando, G., Miller, K. **Garcia, J.**, Chan, S. *Incidence of Traumatic Exposure and their Impact on Emotional and Psychosocial Functioning Among Children in Sri Lanka*. American Psychological Association Convention Boston, MA, August 2008.

Teaching Experience

Adjunct Lecturer

Department of Secondary Education
California State University, Fullerton

Adolescent Development

Fall 2015; Spring 2017

Teaching Assistant

School of Education
University of California, Irvine

Multicultural Education

Fall 2014; Fall 2016

The Policy Environment of Teaching

Summer 2016

Outcomes of Schooling and Assessment

Summer 2014; 2015; 2016

Critical Assessment of Practice & Learning

Summer 2016

<i>Theories of Development and Learning</i>	Winter 2016
<i>Science and Mathematics Teaching</i>	Fall 2015
<i>Origins, Purposes, and Central Issues in K-12 Ed</i>	Winter 2015
<i>Special Populations in Education</i>	Fall 2013

University Service/Diversity Efforts

Member of the UC Irvine Education Center for Research on Teacher Development and Professional Practice 2011-Present.

This group fosters collaborations among faculty, students, and practitioners on projects focused on a variety of aspects of teacher development and learning and on the study of teaching and teacher professional practice. As a participant in this group, I share my own work and provide feedback on various projects to my colleagues. I was the student coordinator between Fall 2012 to Summer 2015.

Equity and Diversity/ Learning, Cognition and Development Student Representative for the UC Irvine School of Education PhD Admissions Committee 2016 and 2015.

While serving on this committee, I was asked to represent the School of Education's emphasis on Learning Cognition and Development, but was also a representative for equity to assure that our school was considering students from diverse backgrounds and experiences. I also helped coordinate candidates' information to be accessible to interested faculty.

**UCI School of Education Recruiter at the CSU Diversity Forum 2014 and 2013
For two consecutive years in a row I was asked to represent UC Irvine's School of Education**

This event is held yearly to encourage and recruit a diverse group of outstanding CSU undergraduates in research to pursue doctoral degrees. Since I experienced this event as an undergraduate, I was asked by UC Irvine School of Education to recruit current undergraduate students attending this event. While at the event, I was asked to network with these students, share my own experiences and incite their interests in UC Irvine.

Invited Guest Lectures

Guest Lecturer

Exploring Equitable Practices through teacher noticing. Outcomes of Schooling and Assessment course. Summer 2016.

Understanding Equitable Teaching Practices. Origins, Purposes, and Central Issues in K-12 Ed. Winter 2015.

Noticing Equity in Secondary Education. California State University, Los Angeles - Minority Opportunities in Research (MORE) Programs, Summer Retreat 2014.

Panelist

Graduate School Experiences. California State University, Los Angeles - Minority Opportunities in Research (MORE) Programs, Summer Retreat 2014.

Applying to Graduate Programs. California State University, Los Angeles - Minority Opportunities in Research (MORE) Programs, 2013

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Journal of Teacher Education

Professional Associations

American Educational Research Association (AERA)

National Council of Teachers of Mathematics (NCTM)

Association of Mathematics Teacher Educators (AMTE)

Statistical Programs/Analytical Tools
--

STATA, SPSS, Amos, Transana, HyperResearch, HyperTranscribe, ATLAS.ti, and Dedoose

ABSTRACT OF THE DISSERTATION

Broadening Participation in Mathematics: A Study of Secondary Mathematics Teachers and

Their Noticing for Equity

By

Janet Mercado

Doctor of Philosophy in Education

University of California, Irvine, 2017

Associate Professor Rossella Santagata, Co-Chair

Associate Professor Elizabeth van Es, Co-Chair

Equity in mathematics teaching has gained increased attention in the last few decades. A growing field of research has provided various definitions of equity, outlined standards, and identified practices that lead to equitable learning opportunities for all students, particularly for students from non-dominant backgrounds. However, few studies have examined how teachers engage in this complicated work. Recently, a limited number of researchers have highlighted the possible connection between teacher noticing and equitable practices. Existing studies on teacher noticing in mathematics have primarily focused on teachers' attention to student thinking. Noticing for equity expands on the idea of attending to students to explore what teachers attend to in terms of participation, access and power. This dissertation consists of two studies that examined secondary mathematics teachers' noticing, practices and pedagogical commitments. The first paper examined the noticing, instructional practices and pedagogical commitments of three secondary mathematics teachers who were identified as being committed to equity. Data were drawn from three case studies and included videotaped observations, field notes and interviews. Specifically, this study examined what teachers noticed in the moment of teaching

and the relationship between teachers' in-the-moment noticing, practices, and pedagogical commitments. The study findings highlight the complexity of engaging in equitable practices, associated noticing and the crucial role of teachers' pedagogical commitments to students and equity. The second paper examined how teachers reasoned about videos of instruction and the influence of teachers' pedagogical commitments on their interpretations. This study conceptualized noticing as not just related to what teachers see, but how they also reason about what they see. Teacher noticing is also conceptualized as being tied to broader constructs of instruction that shape what one finds to be noteworthy. In other words, teacher noticing is informed by the expectations teachers have of teaching and learning, what some researchers describe as framing. Findings from this study highlight the interpretive frameworks that teachers use when watching videos of teacher practices and the role of teachers' pedagogical commitments in framing their interpretations. Drawing from both study findings, recommendations for professional development are provided.

Chapter 1: Introduction

Mathematics is a critical subject matter for all students, serving as a foundational element to future learning and employment opportunities. Accordingly, helping students from non-dominant¹ backgrounds gain access to equitable learning opportunities and resources has been deemed a civil right (Moses, 1995; Moses & Cobb, 2001). Achieving equity is a complex task that requires considering the interplay between academic and social factors that influence student learning. In the context of education, numerous scholars have presented the inequities that persists in our educational system. Equity continues to be a concern because, despite recent reform efforts, there continues to be an unmistakable achievement gap between students from dominant and non-dominant backgrounds (Ladson-Billings, 1997; Lubienski, 2002; Martin, Gholson, & Leonard, 2010; Secada, 1992; Tate, 1997). Various assessments have demonstrated the inequities among groups of students in mathematics achievement related to class, gender, race, and ethnicity (Hiebert, et al., 2007; Strutchens & Silver, 2000). While these assessments have demonstrated an evident gap in the achievement of different groups of students, Gutierrez (2008) argues that focusing on the achievement gap promotes “deficit thinking and negative narratives about students of color and working-class students” (p. 4).

Excessive emphasis has been placed on these gaps to underscore student deficit, rather than confronting the sources of inequities. Educators often use the achievement gap to blame the students and the contexts of their lives for their lower achievement levels (Valencia, 2012). Some

¹ The terms “dominant” and “non-dominant” groups are used with reference to student diversity (Gutiérrez & Rogoff, 2003). The dominant group does not refer to numerical majority, but rather to social prestige and institutionalized privilege. While student diversity is increasing in the nation’s classrooms, non-dominant groups continue to be underserved by the education system. Thus, the term “non-dominant” highlights a call to action that the education system meets the learning needs of the nation’s increasingly diverse student population.

argue that these gaps can be explained by looking at linguistic complexity and cultural biases within the tests (Abedi, 2006; Martin, 2006; 2007; Solano-Flores & Li, 2006). Furthermore, research has strongly suggested that these gaps can be due to disparities in school resources, access to higher-level courses, rigorous curriculum, teacher quality, and teachers' expectations (Bol & Berry, 2005; Horn, 2007; Lee, 2004; Ladson-Billings, 1997; Lubienski, 2002; Martin, 2003; Meece & Eccles, 2010; Oakes, 1990; Lee & Orfield, 2006; Spencer, Santagata, & Park, 2010).

Earlier conceptions of equity equated it to equality. However, Secada argued that these traditional notions of equity were a quantitative construct heavily focused on educational outcomes through standardized test scores (1992). While providing all students with similar resources and assessments may appear fair, it does not consider students' diverse backgrounds and previous learning experiences. Thus, distinguishing between equity and equality is essential since equity requires particular learning opportunities for students' diverse experiences (Secada 1992). Broadly, Secada defined equity as "justice" or "fairness" in mathematics, which does not assume the same instructional approach towards all students, but rather opportunities for all students to learn.

This conception of equity was communicated in documents that have previously addressed equity in mathematics learning (NCTM, 2000; Rand, 2003). For example, the National Council for Teachers in Mathematics (NCTM) acknowledged that opportunities to learn have been largely unfair for certain groups of students (2000) and include an "equity principle" to guide equitable instruction:

"All students regardless of their personal characteristics, backgrounds, or physical challenges, must have opportunities to study-and support to learn- mathematics. Equity does not mean that every student should receive identical instruction;

instead, it demands that reasonable and appropriate accommodations be made as needed to promote access and attainment for all students” (NCTM, 2000).

With regards to instructional practice, this definition was also articulated through Gutierrez’ work (2007; 2012). While Gutierrez argued for the necessity of equity in mathematics learning, she further pushed for students’ statuses and cultural resources to be recognized in learning. Gutierrez identifies four dimensions that characterize equitable opportunities to learn mathematics: access (available learning resources), achievement (visible results), identity (linguistic, personal, or cultural aptitudes), and power (addresses issues related to social change). Gutierrez acknowledged the dimensions may not all be present at one given time in instruction, but should underlay instructional practices (2012).

Others have conceptualized equity in terms of addressing student status within the classroom and society (Alrø & Skovsmose, 2002; Boaler, 2008; Hand, 2012). For example, Boaler (2008) developed the idea of relational equity. Relational equity highlights the mathematical contributions of students, but does so in a way that identifies contributions from diverse cultural and academic backgrounds. Hand (2012) also addressed the importance of being inclusive of students from diverse backgrounds. Specifically, Hand (2012) described the case of a teacher that oriented her instruction at a “human level” by helping students “take up space” in a classroom and society (p. 238). Her work described instruction that helps students “take up space” to include the following features: supporting dialogic space, blurring distinctions between cultural and mathematical activity, and reframing the system of mathematics.

These conceptualizations of equity suggest that the goal of equity in the context of mathematics includes a full examination of instructional practices. In this dissertation, I focus specifically on the instructional practices in mathematics classroom that promotes what Esmonde (2009) described as “fair distribution of opportunities to learn in the mathematics classroom” (p.

1008). I chose to use this definition of equity because it allows for the exploration of the decisions teachers make about instructional practices that fairly distribute opportunities to learn and engage all students within a classroom setting. This definition will help describe the instructional practices that help teachers achieve equitable conditions within their classrooms.

While the field has identified a set of instructional practices that promote equitable mathematics learning, less is known about how teachers come to engage in this complicated work while teaching. Teacher noticing has been shown to be an effective approach for investigating how teachers attend to student thinking (Jacobs, Lamb, Philipp, 2010; Sherin & van Es, 2009; van Es & Sherin, 2002). In terms of equity, this can be leveraged to focus on what teachers notice about students to broaden participation in classrooms. In this dissertation, I use the lens of teacher noticing to understand equity in mathematics. Specifically, I explore how teachers attend to and make sense of videos of instructional practice. I also examine the relationship between teachers' noticing, pedagogical commitments and practice. Below, I describe the three broad goals of this dissertation.

Relationships between Teacher Noticing, Practices, and Pedagogical Commitments

First, I investigate the relationship between noticing, practices and pedagogical commitments. Recent work has suggested the possible associations between teacher noticing, practice and pedagogical commitments (Hand, 2012). Research shows that expert teachers have ways of parsing out teaching, and this is informed by their commitments to instruction (Lampert, 2001; Leinhardt & Steele, 2005; Mason, 2011). Further, during classroom interactions, what teachers choose to focus on and how they make sense of what they see is guided by their commitments to teaching. This dissertation describes the relationship between the noticing, instructional practices, and commitments of three teachers that were identified as being

committed to broadening participation in mathematics learning. This study will add to the literature by identifying what these teachers attend to and how what they attend to is related to their instructional practices and pedagogical commitments. The study also examined the possible directions of the relationships between the three constructs.

Selective Attention & Knowledge-based Reasoning

Second, I examine what teachers look at and how they interpret what they see in relation to equity. Sherin (2007) identified teacher noticing as involving selective attention and knowledge-based reasoning. These two components of noticing are not distinct but rather they are tightly connected (Sherin, 2007). Furthermore, teacher noticing extends beyond simply discerning classroom features. Rather, it is characterized as being “active” (Erickson, 2011, p. 17) and ingrained in teachers’ knowledge and positioning (Schoenfeld, 2011). Thus, seeing similar phenomena may elicit different responses among different individuals. That’s because what people see is informed by what they are looking for, or some expectations they have about the phenomena (Hammer, Elby, Scherr, & Redish, 2005; Hand, Penuel, & Gutierrez, 2013). We know a lot about what teachers attend to related to student thinking, however we know less about what teachers attend to in terms of equity. Second, there are few studies that describe how teachers make sense of observed phenomena. Paper two contributes to this limited research by focusing on how teachers make sense of equitable instructional practices.

Viewing of One’s Own Practices versus the Practices of Others

Third, I explore the differences in looking at videos of one’s own instructional practice versus looking at the practice of other teachers. This highlights the selection of video clips in helping teachers reflect on equity. Videos of their own teaching provided teachers with a replay of their practices. This replay provided the teachers with reminders of why they may have made

an instructional move, which promoted the development of “critical reflection” (Gaudin & Chalies, 2015, p. 51). On the other hand, viewing others’ instructional practices provides examples of varying forms of instruction for teachers to reflect on. Research has demonstrated that when watching videos of others’ instructional practices, teachers draw on strategies (Colestock & Sherin, 2009; Sherin & Russ, 2015) or frameworks (Hammer et al., 2009; Hand, Penuel, & Gutierrez, 2013) to make sense of observed phenomena. Both types of videos give us insight into the teachers’ philosophy of practice (Erickson, 2011). This dissertation provides further insight into the benefits of using videos of teachers’ own teaching and videos of the practices of others.

This dissertation is organized as follows. Chapter 2 describes the first research study, which focuses on what teachers attend to in the moment of teaching and how their noticing is related to their pedagogical commitments and instructional practices. In Chapter 3, the second study paper relates the teachers’ pedagogical commitments to discuss how teachers use interpretive frameworks to reason about what they noticed in videos of instruction. Both papers draw from similar data sources, but are analyzed using different methods and analytical perspectives. Thus, the reader will notice some overlap in the description of the participants and some of the data sources. Chapter 4 serves as the conclusion to the dissertation, highlighting the broad implications for future research and for teacher professional development. This dissertation addresses the following research questions:

Paper 1

RQ1: What do teachers who have been identified to as being committed to broadening participation in classrooms attend to in the moment of teaching?

RQ2: In what ways is noticing for equity related to teachers’ pedagogical commitments and instructional practices?

Paper 2

RQ1: What interpretive frameworks do teachers committed to equity draw on as they observe and make sense of classroom interactions?

RQ2: What is the relationship between teachers’ interpretive frameworks and their pedagogical commitments?

The two papers analyze data collected from three secondary mathematics teachers who were identified as being equitable. By equitable, it is meant that they create opportunities for students learning and they were recognized for broadening participation for students from non-dominant backgrounds. To answer the research questions, I analyzed these teachers’ noticing interviews, observation field notes, and pedagogical commitments interviews. Table 1.1 describes the data that were included in each paper. In the chapters that follow, I present cases for each teacher and describe the findings in further details.

Table 1.1 *Dissertation Data Sources by Paper*

Data Source per Teacher	Paper 1	Paper 2
Practice (3 videos & 7-10 field notes)	x	
Pedagogical Commitments Interview	x	x
Noticing of Own Teaching Interviews (3)	x	x
Professional Noticing Interview	x	x

Chapter 2: Relationship Between Teacher Noticing, Teacher Practices and Pedagogical Commitments

Abstract

Broadening participation in mathematics continues to be a concern for educational researchers and teacher educators. Inequities persist despite the important progress made in setting standards and identifying instructional approaches that promote equity. While equitable instructional practices have been identified, less is known about how teachers come to engage in this complicated work while teaching. This study examines equity by investigating what teachers committed to equity notice in the moment of teaching and the relationship between their noticing, instructional practices and pedagogical commitments. Three cases were examined through the analysis of interviews and classroom observations. The analyses revealed that teachers committed to equity attend to students' mathematical understanding, participation, individual identities, and positioning within the classroom. In addition, themes related to equity across the three constructs surfaced from the data. While similarities were found among the three teachers, there were notable nuances in their noticing and instructional practices. These distinctions were found to be shaped by their varying pedagogical commitments. Implications for professional development are discussed.

Keywords: secondary mathematics, teacher noticing, pedagogical commitments, non-dominant students, instructional practices

Introduction

Knowing the impact that mathematics has on future participation in college, employment and society (NCTM, 2000), many scholars have explored and conceptualized equity in mathematics. Often, these scholars have drawn attention to achievement gaps or gaps in the opportunities afforded to students by the educational system (Berry, 2004; Ladson-Billings, 1997; Lubienski, 2002; 2003; Martin, 2006; 2007; Moses & Cobb, 2001; Oakes, 1985). As a result, the mathematics research community has developed a robust knowledge base of practices and standards for ambitious, high-quality mathematics instruction that is more inclusive of students from non-dominant linguistic, ethnic, racial, and socioeconomic backgrounds (Berry 2004; Civil, 2007; Hiebert & Grouws, 2007; Kilpatrick, Martin, & Schifter, 2003; Lampert, Beasley, Ghouseini, Kazemi, & Franke, 2010; Moschkovich, 2007; Leonard & Guha, 2002; Malloy & Malloy, 1998; NCTM, 2000). Such practices support student agency, promote kinship among students and encourage students to negotiate their own mathematics learning (Gresalfi, 2009; Nasir, Hand & Taylor, 2008). These practices also highlight the individual knowledge bases and strengths students bring to learning (Boaler, 2002; Boaler & Staples, 2008; Cohen & Lotan, 1997; Civil, 2007). While there is evidence that equitable practices lead to better learning outcomes, it is unclear how teachers engage in this work.

Recently, researchers have highlighted the importance of teacher noticing for understanding equitable practices (Aguirre, Turner, Bartell, Kalinec-Craid, Foote, McDuffie & Drake, 2012; Hand, 2012; Jilk, 2016; Roth-McDuffie, Foote, Bolson, Turner, Aguirre, Bartell & Drake; Turner, Drake Roth-McDuffie; Aguirre, Bartell and Foote, 2012; Wager, 2014). Teacher noticing has been shown to be an effective approach for investigating how teachers attend to student thinking (Jacobs, Lamb, Philipp, 2010; Sherin & van Es, 2009; van Es & Sherin, 2002).

In terms of equity, this can be leveraged to focus on what teachers notice about students to broaden participation in classrooms. Hand (2012), a leading scholar in equity, was among the first to theorize that teacher noticing may deepen our understanding of equitable practices.

This study draws on the literature on teacher noticing and equitable practices, to expand on the research on noticing for equity. Specifically, I examine what teachers attend to and how their noticing is associated to their practices and pedagogical commitments. Three teachers were identified by a teacher educator who studies equity in mathematics as being committed to equity in mathematics. They do this by implementing instructional practices that are inclusive of all students and they tend to pay specific attention to students that are not normally considered to have high participation statuses within their classrooms. Further, students in their classrooms are placed at the center of instruction to foster a sense of meaningfulness, belonging, and agency for each student. Through the analysis of interviews and observations, I address the following questions:

RQ1: What do teachers who have been identified to as being committed to broadening participation in classrooms attend to in the moment of teaching?

RQ2: In what ways is noticing for equity related to teachers' pedagogical commitments and instructional practices?

Analytical Framework

This study expands on current research that examines how teachers engage in instructional practices that broaden participation in mathematics. To do so, I examined the associations between instructional practices, teacher noticing and pedagogical commitments. The sections that follow review the literature on equitable instructional practices, teacher noticing and pedagogical commitments. First, I provide the definition of equity that will be used for this study

and discuss practices that have been shown to lead to equitable learning outcomes for students. Second, I define and review the literature on teacher noticing and the limited research on noticing for equity. Finally, I discuss the role of teachers' pedagogical commitments in influencing what teachers attend to and do in the classroom.

Equitable Instructional Practices

Before discussing the instructional practices that have been identified to increase participation in mathematics, I provide a definition of equity to frame the literature and analysis of this study. Among the several definitions available (Boaler, 2008; Gutierrez, 2002; Gutierrez, 2012; NCTM, 2000; NCLB, 2001; Secada, 1986), this paper incorporates Esmonde's definition of equity as "fair distribution of opportunities to learn for all students" (2009b, p. 1008). This conceptualization assumes that all students can participate in mathematics and contribute an assortment of ideas to problem solving (Cohen & Lotan, 1997; Dunleavy, 2015; Esmonde, 2009b; NCTM, 2000). Essentially these environments support student agency, influencing students to make contributions and holding them responsible for their peers' learning (Engle & Conant, 2002; Gresalfi et al., 2009; Gresalfi & Cobb, 2006; Nasir & Hand, 2008). With teachers elucidating expected forms of discourse and student actions around mathematics, students eventually adopt these practices without explicit direction (Engle & Conant, 2002; Esmonde, 2009; Schoenfeld, 2002). To promote student agency and participation, these instructional practices must encompass the "tangible resources that students have available to them to participate in mathematics" (Gutierrez, 2012 p. 2). In other words, teachers must consider the identities of individual students and the resources they bring into the classroom. To better understand this conceptualization of equity, I provide examples from empirical studies that have identified key features of equitable instructional practices.

One influential set of practices was identified in Cohen and Lotan's (1997) work on "complex instruction". Complex instruction attempts to equalize academic status within working groups to increase student participation by encouraging mixed-ability² grouping, which requires the use of many cognitive abilities for a group of students to complete a given group task. Another element involves assigning competence to students, where the teacher verbally points out the usefulness of a student's response in completing the task.

In a later study, Boaler (2002) implemented complex instruction and extended this work by creating a framework for "relational equity". Like complex instruction, relational equity encourages students to raise questions and work collaboratively. Additionally, these practices honor the influences from diverse cultural and academic backgrounds. (Boaler, 2008; Moschkovich, 2000; Silver, Smith, & Nelson, 1995). This feature of relational equity is important to note since much of the research on practices has tended to "characterize practices in broad strokes" (Gresalfi, 2009 p. 328) and this does not always account for students' individual connectedness and visibility in mathematics. For instructional practices to be equitable, students' lives at the center of instruction by identifying students' varying mathematical knowledge bases and providing experiences that foster a sense of belonging (Boaler, 2002; Gresalfi, 2009; Gutierrez, 2012; Hand, 2012; Moschkovich, 2002). Placing students' lives at the center of instruction helps them develop "positive positional identities" that engender competency and authority in the mathematics classroom community (Esmonde, 2009, p. 251).

Consequently, other research has emphasized the importance of making connections to and building off the experiences and knowledge that students bring into the classroom (Gutierrez & Rogoff, 2003; Ladson-Billings, 1995; Leonard & Guba, 2002; Rogoff, 2003). For example,

² Mixed-ability may also refer to a group in which children of varied abilities are taught together rather than being set apart in groups according to level of learning.

Ladson-Billings (1995) argued that culturally relevant pedagogy is essential for students that have been historically underserved by the schooling system. She further stated that students must maintain “some cultural integrity, as well as, academic excellence” (p. 160) since it implements students’ individual experiences and cultures as an instrument for learning mathematics. Similarly, “third space” veers away from traditional, formal classroom structures to incorporate more students’ ideas and interests. For example, instead of dismissing ideas that may be off topic, teachers using these instructional practices build on students’ ideas to influence lesson design (Gutierrez, 1995; Gutierrez, Larson, & Kreuter, 1995). Finally, Gutierrez and Rogoff (2003) highlighted the affordances of the use of “repertoires of practice”, which involves “engaging in activities stemming from observing and otherwise participating in cultural practices” (p.22). They explain that individuals’ experiences and interests prepare students for knowing how to engage in certain tasks (e.g. test taking, language usage, and interpersonal situations) (Gutierrez & Rogoff, 2003; Rogoff, 2003). In terms of mathematics instruction, a teacher may be aware of students’ cultural practices or languages used within their homes and may support students in implementing into classroom practices. For example, knowing a student is stronger in the Spanish language, a teacher may encourage that student to explain their thinking in Spanish through discussions or through written work.

The instructional practices described above are highly influential on broadening opportunities to learn. While examples of such instructional practices are invaluable, more research is needed to understand how teachers engage in this complicated work *while* teaching. Recently, teacher noticing and pedagogical commitments have been suggested to be useful constructs in examining how teachers engage in equitable instructional practices. For example, Hand (2012) conceptualized the possible associations between teacher noticing, classroom

practices and dispositions. In the section that follows, I describe the existing literature on teacher noticing and the developing work on noticing for equity.

Teacher Noticing

Teachers constantly face ongoing information and varied phenomena about student learning (Sherin, Jacobs, & Philipp, 2011p. 4; Sherin & Star, 2011). Lessons provide teachers with continual “blooming, buzzing confusion of sensory data” (Sherin & Star, 2011) that they must take in and make sense of. Furthermore, teachers are not merely observers of these data, they must also act on what they are observing (Sherin, Jacobs, & Philipp, 2011). Thus, many researchers have highlighted the importance of teacher noticing in understanding how teachers make instructional decisions in the moment of teaching (Jacobs, Lamb, & Philipp, 2010; Sherin, 2007; Sherin, Jacobs, & Philipp, 2011; van Es & Sherin, 2002, 2008). Teacher noticing has been found to be an important skill that needs to be developed for teaching mathematics (van Es & Sherin, 2008) and is particularly useful for reform mathematics since it requires teachers to be flexible in altering their instruction to align it with student understanding (Lampert et al., 2013; McDonald, Kazemi, & Kavanagh, 2013; Sherin, Jacobs, & Philipp, 2011). Having access to evaluating student thinking through these resources can serve as an ongoing source of professional development for teachers within their own classrooms (Jacobs, et al., 2011).

Selective Attention. Much of the work on teacher noticing focuses on what teachers attend to and where they direct their attention (Sherin, Jacobs, & Philipp, 2011; Star et al., 2011). Thus, many researchers assert that the leading process of noticing is selective attention (Kersting, 2008; Miller & Zhou, 2007; Sherin & van Es, 2009), which has also been referred as “call outs” (Frederickson, 1992) or “check points” (Leinhardt, Putnam, Stein, & Baxter, 1991). Despite the complexity of a setting, selective attention has been associated to individuals being able to focus

their attention on certain classroom objects or features. However, individuals do not see everything that occurs in a single situation and are unable to capture every detail (Simons & Chabris, 1999). In fact, teachers seamlessly choose to attend to noteworthy features during classroom interactions and “hone in on what is important in a very complex situation” (van Es & Sherin, 2008, p. 245), while overlooking others (Miller, 2011).

Teachers’ level of experience has been shown to influence what teachers notice when shown videos of classroom lessons. For instance, without guidance, some teachers may not be likely to identify relevant classroom events and instead attend to teachers’ instructional moves, students’ behavior, and classroom organization and management (Blomber, Stürmer, & Seidel, 2001; Castro, Clarke, Jacobs & Givin, 2005; Star & Strickland, 2008; van Es & Sherin, 2008). When asked about what they notice, many teachers provide oversimplified, generalized inferences about what they observe and make quick judgments about what they have seen (van Es, 2011). Alternatively, experienced teachers have been shown to draw on pedagogical strategies or students’ mathematical thinking (van Es, 2011). For example, some teachers attend to students’ participation, communication, and questioning (Carpenter, Fennema, Peterson, Chiang, & Loef, 1989; Franke, Carpenter, Levi, & Fennema, 2001; Franke, Webb, Chan, Ing, Freund, & Battey, 2009). Other teachers have been shown to focus on students’ understandings, misconceptions, and strategies. This is important because attention to students’ mathematical thinking has been documented as being associated with effective instruction (Carpenter, Franke, Jacobs, Fennema, & Empson, 1998; Hiebert, Morris, Berk, & Jansen, 2007; Lampert, 2009; Stein, Smith, Henningsen, & Silver, 2000; Walkoe, 2013).

Knowledge-Based Reasoning. When describing their noticing, teachers do not simply list what they see or describe what they see as an isolated event (Collins, 1999; Sherin, 2007; van

Es & Sherin, 2002). Aside from attending to specific features, teachers also use knowledge-based reasoning to interpret and reason about what they see (Sherin, 2007). In other words, teachers gather specific details about a context and recognize that an event might be an example of a broader issue (van Es & Sherin, 2002). In a way, teachers are categorizing what they notice, and use this knowledge to respond to isolated events. This part of noticing is more developed in expert teachers who tend to describe events “in terms of issues related to teaching and learning” (Collins, 1999, p. 574). In other words, teachers connect a specific event to something they already understand about teaching and learning. For example, Jacobs and colleagues (2011) studied the noticing of expert and prospective teachers and found that only the expert teachers reasoned about evidence of student understanding by considering integrating knowledge that they had of their students’ previous understanding of problems.

While much of the existing research on noticing has focused on teachers’ attention to students’ mathematical thinking, concerns for equity call for broadening this lens to consider other aspects about students that might be important to notice. Few studies have examined what teachers who are committed towards broadening participation attend to while teaching. For example, instead of simply attending to mathematical ideas, a teacher may attend to students’ engagement in the classroom, personal attributes, or collaborations. Recent studies have focused on understanding equity by targeting how teachers attend to participation, access and identity (Dominguez & Adams, 2013; Hand, 2012; Jilk, 2016; Roth-McDuffie et al., 2014; Turner et al., 2012; Wager, 2014).

Noticing for Equity. Erickson (2011) theorized that *noticing for equity* involves the role of teacher noticing on whether certain groups of students feel empowered to participate in mathematics and the narratives teachers create about these students. Influenced by this idea of

noticing for equity, Hand (2012) sought to understand the relationship between noticing for equity, instructional practices and teacher dispositions by examining teachers with a disposition for equitable instruction³. She theorized that teachers who notice equitably attend to ways students develop in mathematics, make connections to students' experiences and foster solidarity among students. Hand developed the term "taking up space" to describe teachers' goals of students literally taking up space, or being engaged, "in and beyond the mathematics classroom". For students to take up space, teachers actively attend to student experiences, validate the range of participation and promote dialogic spaces where socio-historical topics are critiqued.

Similarly, Wager (2014) examined how pedagogy was informed by teachers' positionality and what they noticed about student participation. In her study, teachers with varying experiences in professional development focused on equity attended to issues of inequities in their classrooms and considered how they might change those inequities. Wager found that teachers tended to describe students' engagement generally and in relation to the effectiveness of instructional moves. For example, teachers described how an activity allowed all students to share their ideas, or how another activity may have elicited ideas from a broad range of students. Wager concluded that what teachers noticed was shaped by their positional identities. Specifically, the teachers that were positioned as thinking deeply about equity viewed participation as related to agency and power.

Turner and colleagues (2012) argued that teachers need to attend to more than student thinking for instruction to be equitable. They suggested that teachers should attend to aspects of students in relation to their homes, communities and culturally-based knowledge. The teachers

³ Hand (2012, p. 234) operationalized equity using the following criteria: (1) engages a broad range of learners from dominant and non-dominant ethnic, racial, and linguistic backgrounds in rigorous mathematics, (2) achieves measurable success with non-dominant learners (3) promotes competence, ownership, and belonging in the classroom among a broad range of learners, and (4) invites few incidents of classroom opposition.

did this by visiting and gathering information about their students' home communities. However, their findings demonstrated that beginning teachers were not able to integrate what they noticed about their students into the context of mathematics learning. While they attended to mathematical thinking and forms of knowing related to student identity, they had difficulty understanding how to make connections between them.

Other studies have focused on helping teachers shift away from deficit views to focusing on noticing students' strengths (Jilk, 2016; Roth-McDuffie et al., 2014). For example, language was used as a resource to learning in Dominguez and Adam's (2013) study. The teachers in this study attended to the words bilingual students chose to use in discussing mathematical ideas. This study is an example of teachers being supported to attend to important interactions during lessons and the language resources students bring to learning. The studies described previously suggest that noticing for equity involves focusing on and attending to students' participation, access, power and strengths. Hand (2012) and Wager's (2014) studies also suggest that teachers' positionalities seem to influence noticing for equity.

Pedagogical Commitments. Through personal and professional experiences, teachers develop dispositions that influence their commitments, perspectives and instructional decisions (Gresalfi, 2009; Hand, 2012; Lampert, 1985; Wager & Foote, 2013). The narratives teachers create about certain groups of students and learning are tied to their pedagogical commitments (i.e., dispositions) towards learners (Hand, 2010). Specifically, Erickson characterized these commitments in terms of the teacher's tacit and explicit "philosophy of practice" concerning teaching and learning (Erickson, 2011, p. 28). In other words, teachers make connections between things they see in the classroom, such as student engagement or understanding, and this informs how they make sense of what they see and how they respond.

In mathematics learning, generalized assumptions about groups of students' learning may influence how a teacher reacts to members of those groups. For example, a teacher may generalize students from Latino backgrounds as being unmotivated to learn, or they may generalize students from Caucasian backgrounds as being more driven. Taking these assumptions into consideration is important when discussing the learning of non-dominant students, which have traditionally been portrayed as being unproductive mathematics learners. Negative portrayals of students have persisted despite the implementation of standards and practices focused on broadening participation in mathematics.

The literature has given us ample examples of how teachers' unfavorable portrayals of non-dominant students can have detrimental outcomes for participation (Hand, 2010; Horn, 2007; Martin, 2003; Spencer, Santagata & Park, 2010). These studies have demonstrated that some teachers hold deficit views associated with students of non-dominant backgrounds and perceive these groups of students to be incapable of learning difficult curricula. For instance, Solorzano and Yasso (2001) found that students of color are often negatively stereotyped by their teachers. Some teachers referred to their students as being "dumb", "slow" or "lazy" (p.4), and these stereotypes have been used to justify their teaching practices (i.e., low expectations or "dumbing down" curriculum). Similarly, after examining mathematics teachers' group conversations regarding the implementation of reform curriculum, Horn (2007) found that the teachers believed that there was a mismatch between their students' ability in mathematics and the new challenging curriculum given to the teachers in the study. Like Solorzano and Yasso (2001) found, the teachers' in Horn's study referred to some of their students as "lazy" or "slow learners." Both examples demonstrate teachers taking on a deficit perspective in describing their students' and their abilities.

Teachers committed to broadening participation will have developed constructive portrayals of non-dominant students, which may promote student participation. For instance, if a teacher is committed to helping students build conceptual understanding, that teacher will abstain from generalizing students' learning as low- or high- achieving. Instead, they will focus on attending to student ideas and look for ways to build off those ideas. In terms of equity, the teacher may be committed to disrupting classroom hierarchies between the teacher and students. Thus, the teacher will encourage students to struggle through problems by way of collaboration with classmates with little help from the teacher. In this situation, the teacher would be disposed to notice group dynamics and kinship among students. In this study, I use evidence of three teachers' pedagogical commitments to make connections to their dispositions to notice students' involvement in mathematics learning and its influence on practice.

I draw on the construct of teacher noticing to examine how teachers attend to classroom features that influence equitable learning opportunities for non-dominant groups. Few studies have focused on understanding noticing for equity (Hand, 2012; Turner et. al., 2013; Wager, 2014). For instance, Hand (2012) and Wager (2014) suggested that noticing for equity may be associated with teachers' dispositions. As of now, few others have explored this association. Through the presentation of case studies, this study considers how teachers' commitments influence what teachers attend to and what they do in their classrooms. Specifically, this study also expands the research on equity by examining the associations between teacher practice, noticing, and pedagogical commitments. In the sections that follow, I describe the participants and how they were selected for the study. Through the analysis of each teacher's video observations and interviews, I answer the following two research questions stated above.

Methods

Study Participants

This study examines data that are part of a larger project that investigates noticing for equity. In this study, I investigate the practice, noticing and pedagogical commitments of three secondary mathematics teachers (Carter, Raymond, and Tim⁴) from three school sites across Southern California. A local teacher educator⁵ was solicited and presented with criteria informed by the literature on equitable instructional practices (Boaler & Staples, 2008; Cohen & Lotan, 1997; Moschkovich, 2002; Nasir et al., 2008). The following criteria were used to identify teachers:

1. addresses the needs of emerging bilingual students
2. looks for meaning making and engagement in students' everyday talk
3. engages students in deep reasoning
4. engages students rather than controls
5. holds students accountable for their classmates' learning
6. assigns competence to students' efforts

Broadly, the teachers were identified because of their commitment to broaden participation for students from non-dominant backgrounds. Most of the teachers' students were from Latino, lower-SES backgrounds, which are groups that have been traditionally underserved. There was also discernable diversity within the individual teaching contexts. The schools varied in rankings in terms of standardized test scores. For instance, the average SAT mathematics score from

⁴ The teacher names used in this document are pseudonyms.

⁵ This teacher educator's research focuses on mathematics teaching and equity. The teachers that he recommended were teachers that he had worked with through the teaching credential program at his university. Thus, he was familiar with their teaching practice and commitments to broadening participation.

Carter's school was 476, while the average SAT mathematics score from Raymond's school was 500⁶. In terms of California State testing, percent of students proficient in mathematics from Carter's school was 44.2%, while the percent of students proficient in mathematics from Raymond's school was 25.1% and the percent of students proficient in mathematics from Tim's school was 40%⁷.

Within the schools, the course levels varied in status. Status has implications for how teachers perceive, interact with, and teach students. For example, students taking algebra in 8th grade may be perceived as advanced, while those taking it as sophomores in high school may be regarded as remedial. For example, Carter's course was considered appropriate to the students' grade level. Tim's course was considered higher-status, while Raymond's course was considered lower-status in terms of grade level. Finally, within the individual classrooms, the students varied in positioning when compared to their own classmates. The students vary in terms of achievement on classroom assessments. Others were identified as having learning, behavior, and/or language difficulties. These variations will be discussed in further detail below. Despite the variations found within each teaching context, the teachers were committed to having all students actively participate in their learning and encouraged all students to share their ideas. The teachers empowered students by attending to individual student aspects and making instructional decisions based on what they noticed about individual students.

Before recruiting teachers into the study, the project's primary investigator and I visited the classroom of five teachers between three to five times. Through the observations, the three teachers were selected based on their alignment with the criteria listed above. The project's

⁶ Tim's students are in middle school and are not required to take the SAT.

⁷ Raymond are based on STAR test results. Tim's are based on CAASPP test results.

primary investigator and I visited each teacher’s classroom, observed and filmed lessons, hand wrote field notes, and conducted interviews. Before any data were collected, all teachers provided consent and expressed willingness to be part of the study. The participants were compensated with gift certificates for their involvement. General information about each participant is listed in Table 2.1. The teachers’ courses varied in mathematical subject, grade level and curriculum that they had access to. Below, I also provide further details about each teacher.

Table 2.1. *Teacher Information*

Name	Ethnicity	Gender	Course & Grade Level Observed	Curriculum
Carter	Caucasian American	Male	10 th Geometry	IMP
Raymond	Mexican, Japanese American	Male	9-12 th Core Concepts	Traditional with additional outside resources
Tim	Caucasian American	Male	8 th Algebra	CMP

Carter. Carter is a Caucasian male who has taught mathematics for over 10 years, coaches multiple sports teams, and leads the character development program in his high school. He left a career in business to pursue his teaching aspirations. While his school is a public high school, it provides a college preparatory program where parents are required to submit applications for their children to be considered for admission and admitted students are asked to sign contracts. The contracts provide clear consistent expectations and high academic standards. The school serves a student population that is predominantly composed of students from Latino (97%) and lower-socioeconomic backgrounds (91% eligible for free/reduced price lunch). Nineteen percent of students are considered English learners.

At the time that we collected data, Carter taught three geometry classes. One of Carter's 10th grade geometry classes was observed for this study. In Carter's school, most 10th grade students take geometry at this grade. So, this seemed to be a typical classroom for his school and appropriate for the course for the students' grade level. Seeing as this school is characterized as being demanding, these students were positioned as having higher-status mathematics learning. Further, Carter identified the class as being "high-achievers" on their testing (in-class and standardized proficiency exams). While the class was generally described as high-achieving, he also stated that there were students that he identified as being "lower-end" when compared to their classmates. He identified that some of these students may have lower self-esteem, or they may have tested lower when compared to their peers. Carter didn't describe his students as demonstrating opposition to learning.

In this class, he implemented the Interactive Mathematics Program (IMP), an integrated problem based curriculum that provides students with challenging content and emphasizes mathematical reasoning. This curriculum lends itself to teamwork, which is a fundamental aspect of how Carter organized his classroom. For example, the desks in his room were arranged in groups of four. At the center of each table, students were provided with toolboxes with manipulatives and tools to solve multi-step and multi-strategy problems. He described placing students in groups that he felt would be most helpful. For example, there were a few Spanish speaking students. He would group those students with bilingual students so that they would be able to contribute to the class.

Raymond. The second teacher, Raymond, teaches in the same community where he attended elementary and secondary school and has taught in the classroom for over 15 years. Raymond is often chosen as a teacher mentor to pre-service teachers from a local credential

program. The school serves a student population that is predominantly composed of students from Latino (76%) backgrounds. There are also students from Caucasian (9%), Asian (10%), and African American (2%) ethnic backgrounds. Most students are eligible for free/reduced price lunch (74%). Twenty-seven percent of students are considered English learners. His class is particularly diverse. While most of students come from Latino backgrounds, there are also two African American students, and three Caucasian students.

At the time of this study, Raymond taught four high-level mathematics courses (trigonometry and algebra) and a “core concepts course”. For this study, we observed his core concepts course, which focused on teaching pre-algebraic concepts to students of various grade levels (9th-12th). In Raymond’s school, this course was the lowest mathematics course available. Most of the students at this school begin with algebra in 9th grade and progress towards pre-calculus or calculus by the time they are in 12th grade. The core concepts course seemed unsuitable for the students’ grade level, especially for those in higher grades. Raymond shared that some of these students had taken and failed the course in the past. Raymond also shared that many of his students did not have success in their measured achievement. Since there were many students that had retaken the course, Raymond had reached out to their former teachers to gather information about their past achievement. The teachers shared that some of the students had behavioral issues in the past and demonstrated opposition to learn (by not coming to class, not completing work, or being disengaged during lessons). While the students were generally positioned lower than their peers within the high school, there were also some students within the classroom positioned lower than their classmates. For instance, about 15% of his students were identified as having learning disabilities or special needs. These students had individualized education plans (I.E.P.s) and were provided with two additional teaching aids during the class

period. Aside from these students, Raymond also shared that there were a few students with behavior and/or attention issues. Finally, Raymond also described that a few students were perceived as having lower-status compared to their classmates because that had not successfully performed on past assessments.

The school's mandated curriculum was a traditional mathematics textbook⁸ heavily focused on procedures. However, when Raymond was observed, he sought out additional resources to teach his students based on their needs. For example, he often looked for multi-step or real-world problems online. He would provide additional resources to try to get his students interested in the material or to provide support to those who were behind their classmates. While the curriculum itself did not lend itself to collaboration, he encouraged students to work in small groups. Raymond only did this for his core concepts course. When the team initially visited his other courses, his lessons were more teacher-centered and mostly based on the course textbook.

Tim. The third teacher, Tim, has over 25 years of teaching experience. After taking a seven-year break from classroom teaching to be a district mathematics coach, he returned to teach middle school mathematics. At the start of our observations, Tim was in his second year of teaching since his return. Aside from his work in the district and the classroom, Tim also worked as a teacher educator in a local university's teacher credential program where he taught a mathematics methods course for pre-service teachers.

At the time he was observed, Tim was teaching in a middle school that serves a student population that was predominantly composed of students from Latino (97%) and

⁸ After the completion of data collection, the teacher informed me that the school switched to a curriculum that is more student-centered and problem based.

lower-socioeconomic backgrounds (70% eligible for free/reduced price lunch). Eleven percent of students were considered English learners.⁹ During the year we observed him, Tim taught five mathematics courses (algebra and pre-algebra) and a history class. The research team observed and collected data from an eighth-grade algebra course. For this class, Tim used College Preparatory Mathematics (CPM), a curriculum focused on engaging all students in learning mathematics through problem solving, reasoning, and communication.

In Tim's school, few 8th grade students take algebra at this grade. This course was thus considered an advanced course for the students' grade level. Thus, these students were positioned as having higher-status mathematics learning. Further, Tim identified the class as being "high- to average-achievers" on their testing (in-class and standardized proficiency exams). Tim also stated that there were students that he identified as having difficulties in their mathematics achievement when compared to the rest of the class. He identified that some of these students as being "passive learners". These passive students had difficulties in providing responses or questions when called upon. When we observed his class, Tim would not let these students just be passive. He would give these students time to think and would continue returning to students until they provide their thinking.

Analytical Approach

The data were analyzed by research question. First, I examined what the teachers attended to in the moment of teaching. Second, I investigated how their noticing was related to their teaching practices and pedagogical commitments. To answer the research questions, this study adopted a case study approach. Case study research is a "qualitative approach in which the

⁹ Recently, the school transitioned from being a basic public middle school to becoming a magnet school focused on STEAM (science, technology, engineering, art, and math), claiming to offer students an engaging learning process that helps develop necessary skills for the future.

investigator explores a bounded system (a case) or multiple bounded systems (cases) over time, through detailed, in-depth data collection involving multiple sources of information (e.g., observations, interviews, audiovisual material, and documents), and reports of case description and case-based themes.” (Creswell, 2007, p. 73). A collective case study, where the researcher “focuses on an issue or concern, and then selects multiple case studies to illustrate this issue” (Creswell, [6] 2007, p. 74), is appropriate because of the issue that is being studied. Equity is a “value-laden term and requires human judgment” (Gutierrez, 2002 p. 148), and case studies can help provide examples of what equity might mean empirically.

Another reason for using this approach is that it allowed me to use extensive, multiple sources of information to provide an in-depth understanding about equity. It is important to note that while the participants were selected from a purposeful sample of secondary mathematics teachers that may have some similarities, the teachers provide varying perspectives through their experiences and teaching contexts. Though the findings may not be generalizable, the empirical evidence gathered, along with detailed analysis, can help build on existing theories and generate new hypotheses that may have gone unnoticed in previous studies (Yin, 2003).

Data Sources

To prepare for data collection, protocols for all observations and interviews were developed by the lead researcher and her collaborator. In the months leading to data collection, the primary researcher shared these protocols and highlighted relevant literature related to equitable practices (Boaler & Staples, 2008; Cohen & Lotan, 1997; Moschkovich, 2002; Nasir et al., 2008), and teacher noticing (Jacobs, Lamb, & Philipp, 2010; Sherin, 2007; Sherin, Jacobs, & Philipp, 2011; van Es & Sherin, 2002, 2008). This literature provided examples of what was to be captured across the observations and interviews.

Data collection took place in several phases and across a three-month span per teacher. Within each three-month span, the research team took hand-written field notes, videotaped three lessons and conducted various interviews. Initially, both the project's primary investigator and I collected data together and later compared notes to assure that both researchers were following the same protocol in capturing certain classroom features related to equitable mathematics instruction. Once it was assured that we were both following the appropriate protocol and capturing similar features related to teaching, we collected data individually when scheduling did not permit for both researchers to visit the research sites. Regardless of individual or paired data collection, the lead researcher and I met after each classroom visit to discuss the data collected. We discussed moments where the teachers seemed to engage a broad range of learners, or moments when the teacher had individual interactions with students that seemed to create opportunities for the student to participate.

In the first phase, the teachers were observed for about seven to ten days. During these observations, only hand-written notes were taken. In the second phase, three mathematics lessons were videotaped. Field notes were also taken during this phase. All field notes sought to capture the mathematical concepts taught, equitable instructional practices and moments when the teachers interacted with their students. The scheduling for videotaping was always discussed with the teacher. While the observations were generally random, we tried not to schedule during student testing or minimized classroom periods. After the videotaped observations, the teachers were interviewed about what they were attending to in the moment of teaching and how the teachers made decisions based on what they noticed. Finally, the teachers were interviewed about their pedagogical commitments. A list of the data for each teacher is available in Table 2.2. Specific details about each data source is described below.

Table 2.2. *Data Sources*

5-10 initial handwritten field notes observations
1 videotaped pedagogical commitments interview
3 videotaped lesson observations
3 sets of field notes to accompany videotaped observations
3 post lesson interviews-noticing of own teaching

Classroom Observation Field Notes. As described in the participant section, the teachers each taught multiple courses at the time we collected data. To get a sense of their instructional practices and to determine which class period was best to observe for this study based on the criteria for selecting the teachers described above, we visited several of the teachers' class periods to pick one to observe for the study. In the second phase of data collection, the research team continued to collect field notes alongside of the videotaped observations (described below). These field notes also provided further detailed documentation of the teachers' instructional practices.

When collecting field notes, the primary investigator and I positioned ourselves on the side or back of the classroom to not be intrusive and took note of many aspects of the lesson for an entire class period. We noted the physical positioning of the teacher. For instance, we noted the teacher walking around, listening to students' conversations, standing in the front of the class, or kneeling to speak to sitting students. We also noted students sitting at their desks or standing in front of the board. The physical classroom seating arrangements (facing towards the front or arranged in groups) and classroom visuals (charts, posters, and agendas) were noted. Notes were also taken on the mathematical objectives and tasks being completed by the students.

Problems and solutions written on the board were copied onto the field notes. We also noted the time spent on tasks and resources provided by the teacher to complete those tasks. At times the teachers would share handouts with us. These were also added to the field notes. Finally, we noted interactions between the teacher and students and among the students. Specifically, we attended to the teachers' conversations with students related to mathematical tasks and conversations that seemed off topic. While most of the notes were taken within a classroom period, sometimes the research team would capture moments right after the class period ended or before the period began.

Videotaped Lesson Observations. Three lessons were videotaped per teacher. The researchers placed themselves on the side or back of the room when videotaping. The video was focused on the teacher. If the teacher was in the front of the room and then circulated, the researchers would adjust the camera to follow the teacher's movements. The camera would also capture students that the teacher was interacting with. A microphone was placed on the teacher that would capture their voice, along with the voices of others in proximity to the teacher. A second microphone was placed at the center of the room to capture more students' responses and discussions. Each video captured an entire class period (approximately 50 min. per lesson) and focused on the teachers' interactions with their students around mathematics. The lessons were reviewed to identify shorter segments (about 4-7 minutes in length) to be shown to the teacher during the noticing interviews. Specifically, the selection of these shorter segments was based on the teachers' orientation towards equity and centered on issues related to student agency, students owning mathematical ideas and teachers' support of those emerging ideas.

Videotaped Noticing Interviews of Own Teaching. Within one week of each observation, a semi-structured, post-lesson interview (approximately 45 min.) was conducted.

The teachers were shown the selected segments described above and were then asked to discuss their noticing about the interactions chosen by the research team. Specifically, they were asked to recall their mindset during the interaction. Generally, teachers were prompted with the following questions, “what were you noticing in the moment of teaching?” or “what were you paying attention to?”. The teachers were also asked to describe their thought process and decision making. For example, they were asked, “what led you to pursue this student’s response?” The teachers were also invited to discuss and think-aloud about anything else that they wanted to share regarding the observed lesson. For example, sometimes the teachers wanted to share extra information about previous interactions with certain students or the class’ understanding of a previous mathematical concept. Thus, the teachers were often asked, “is there anything else that you wanted us to know about the clip?”. The teachers were typically pressed on their responses and asked to provide specific details. The specific questions asked in the interviews are available in Appendix A.

Pedagogical Commitments Interview. The teachers were interviewed once about their pedagogical commitments (approximately 20-45 minutes). To get a sense of their pedagogical commitments, the teachers were asked about their goals for their teaching for the rest of the school year, and were asked about what they hoped to achieve with their students. They were also asked to discuss their expectations for their students and what they thought it took for students to be successful at mathematics in their classrooms. The teachers were typically pressed on their responses and asked to provide specific details about how they would be able to achieve their goals. The specific questions asked in the interviews are available in Appendix B.

Data Analysis

Analysis of the data was holistic and provided detailed descriptions of individual cases and themes found across cases. All observation videos, field notes, and interviews were analyzed. While the data were collected alongside the primary researcher, the analysis was completed by me. The primary researcher, research colleagues and research assistants were solicited for help in refining codes and theme definitions. In the section that follows, I discuss the analysis of the teachers' noticing, practice and pedagogical commitments.

In the Moment Noticing. The first part of the analysis was centered on understanding what the teachers attend to in the moment of teaching. First, the interview videos were transcribed for analysis. I began the analysis by reading through the sets of transcripts to get a sense of the types of things that the teachers were noticing. Notes were taken about my overall impressions of the interview. This analysis was informed by prior research on teacher noticing (Star et al., 2011; Turner et al., 2012; van Es & Sherin, 2002; Wager, 2014; Walkoe, 2015) and noticing for equity (Aguirre et al., 2014; Hand, 2012; Jilk, 2016; Turner et. al., 2012; Wager, 2014). I began by coding the noticing interview transcript of one teacher, then followed the same procedure with the other two.

Microsoft Word was used for the open-coding. To know what they were attending to in the moment, I looked for phrases that included, "I noticed", "I saw" or "the student did". Specifically, I concentrated on comments that were relevant to themes found in the literature on equitable instructional practices. For example, a teacher could have noticed and described a student struggling to provide a response during a whole class discussion. I highlighted and tagged items in the margins of the Word document that seemed relevant to noticing for equity. For example, within a transcript, I highlighted the text, "it's the height, the body language, [that]

made it seem like he wasn't engaged". I initially tagged this excerpt as "student's body language". Excerpts like the one above seemed relevant to student engagement. I read through these data several times, refining my descriptions and identifying keywords or phrases based on themes that began to emerge.

In discussing their noticing, the teachers would also demonstrate knowledge-based reasoning and describe how what they saw influenced their decisions. The teacher gave meaning to why something occurred. This was evident when they used phrases like, "to me that meant" or "I think". For example, a teacher could have noticed the student being unable to provide a response and hypothesized that the student needed extra time grappling with the idea. The teacher could have expanded to describe how the student had struggled in the past or how they decided to provide the student with support with their struggles.

I used the same coding method for all noticing interviews and continued to refine my codes by writing analytic memos and discussing the analysis with others (primary investigator, research assistants and colleagues). I completed the same process for the remaining teachers. The goal was to identify patterns of noticing for equity, which I categorized into the broader topics that the teachers were focusing on with regards to broadening student participation (*mathematical understanding, participation in mathematics, individuals and positioning*).

I conducted the second phase of analysis to explore how teacher noticing was tied to the teachers' instructional practices and pedagogical commitments to equity. This analysis included the coding of observation videos and field notes, noticing interviews, and pedagogical commitment interviews. This phase of the analysis helped answer the second research question.

Teacher Practice. Data that captured instructional practices was gathered from the videotaped observations and were triangulated with the field notes. Video content logs were

created for each video observation to capture equitable instructional practices (e.g., teacher and student discourse, positioning, mathematical tasks, who did the math work, resources provided, and physical classroom arrangement). The videos and content logs provided concrete examples of these practices. The video content logs and field notes were combined for analysis.

My approach to coding the instructional practices was an iterative process. I implemented both top-down and bottom-up coding¹⁰ in tandem to capture equitable instructional practices. To begin this process, I implemented open-coding, which is described as line-by-line coding that considers “all analytic possibilities” and attempts to “capture as many ideas and themes” as possible (Emerson, Fretz, & Shaw, 1995 p. 151) on the field notes and video content logs. Keywords were highlighted within the field notes and tagged along the margin of the paper. I wrote memos describing my initial impressions and broader themes found within each teacher’s instructional practices.

Keeping Esmonde’s definition of “fair distribution of opportunities to learn for all students” (2009b, p. 1008) in mind, I looked for themes specifically focused on equitable instructional practices. Thus, I focused on moments where the teacher was creating opportunities for students to learn and participate meaningfully in mathematics. For example, I looked for moments when the teachers invited an array of ideas to problem solving or supported student agency. The coding was reviewed to create and refine a code list for focused coding. An initial set of tentative codes was generated to look for themes that emerged from the data. Through an iterative process involving analytic memos and discussions with the study’s primary researcher, we reached a consensus on specific themes and categories. While coding, I implemented a

¹⁰ Bottom-up coding begins with no predetermined codes and requires working closely with data to determine codes, while top-down coding begins with a set of pre-determined codes and the use of a coding frame to match parts of the data to the frame.

constant comparison process to continuously analyze the data and check for consistency (Glaser & Strauss, 1967). Records were kept to manage the analysis and descriptions of categories as they were developed and changed (Miles, Huberman, & Saldana, 2013). Specific themes were found among the instructional practice data (*building conceptual mathematical understanding, active engagement in mathematics, resources and strengths honored, language resources, kinship through collaboration, positioning students as competent, and building rapport*). These themes will be discussed in more detail in the findings. Like the noticing topics described above, these were centrally focused on broader categories related to *understanding mathematics, participation in mathematics, individuals, and positioning*. The emerging themes were used to analyze the noticing and pedagogical commitments data to capture the association between these two constructs and practices.

Associated Noticing. The analysis of the noticing interviews was also used to answer the second research question. The topics that emerged to answer the first research question were coded in further detail to align with the themes found in the instructional practice data. Each set of transcripts was analyzed across teachers. Analytic memos were generated (Miles, Huberman, & Saldana, 2013) that captured the nature of the teachers' noticing of classroom activity and how they reasoned about it. The codes that were developed from the analysis of instructional practices were applied to better understand the associations between teachers' noticing, instructional practices, and pedagogical commitments. For example, a practice focused on making connections between student experiences and mathematics would be associated with noticing students' conversations, unique student qualities, or indicators of students' interests outside of school.

Pedagogical Commitments. Like the noticing interview transcripts, the pedagogical commitment transcripts coded through various cycles. These interviews directly asked the teachers about their goals and commitments. Aside from these interviews, the noticing interviews were also used to triangulate the findings. Often, the teachers noticed something in the videos that prompted them to express a pedagogical commitment. For example, a teacher may have noticed a detail about a student's response, which led to the teacher to explain that he finds it important to help students see connections among the concepts they learn throughout the unit. This occurred without teachers being explicitly asked about their commitments.

To code these data, I read through the interviews a few times to get a sense of each teacher's stated commitments. I initially implemented a bottom-up coding strategy, without predetermined codes. Like in the coding of the previous data, I used Word to record keywords on the side or margin of the transcript. I generated analytic memos (Miles, Huberman, & Saldana, 2013) that captured the nature of the teachers' pedagogical commitments. The codes that were developed from the analysis of practices were applied to better understand the associations between teachers' pedagogical commitments, noticing, and instructional practices. For example, I looked for instances where the teachers explicitly stated wanting to students to be able to reason about concepts, wanting students to be actively engaged in their learning, or wanting to empower students. Finally, I conducted a cross-case analysis to compare the teachers to look for similarities and differences among the participants.

Findings

Specifically, I sought to identify the possible connections between teachers' noticing for equity, instructional practice, and pedagogical commitments. I begin the findings section by presenting the topics that the teachers expressed attending to while teaching and how they

reasoned about what they noticed. Second, I provide an overview of findings about the associations between the teachers' noticing and instructional practice. Third, I present teacher case studies to describe the influence of the individual pedagogical commitments on instructional practices and noticing.

Noticing Students

The teachers in this study viewed video segments of their own classroom instruction and were explicitly asked what they noticed in the moment of teaching after viewing those segments. The analysis revealed that there were four main topics that the teachers discussed that were related to equity: *mathematical understanding*, *participation in mathematics*, *individuals*, and *positioning*. The four topics are further elaborated below with examples from the data.

Attending to Mathematical Understanding. In attending to students' mathematical understanding, the teachers described attending to students' verbal responses, written work, or handling of mathematical resources or manipulatives. They attended to responses through whole class or small group discussions. The teacher also looked closely at students' work as students completed tasks. When attending to students' responses, the teachers would listen to the students' ideas and understandings of the topics being discussed in class. Although, the teachers did attend to the correctness in the students' answers or strategies, they mostly drew on how students came to their conclusions and how they reasoned about their responses. Thus, teachers also attended to the questions or misconceptions that students had. The teachers also noticed the sophistication of their responses, by attending to the words they chose to describe their thinking or the implementation of strategies.

From the information gathered about students' verbal, physical and written responses, the teachers reasoned about how well students understood the concepts. The teacher often integrated

knowledge they had about the individual's understanding of related concepts previously taught in the class to reason about individual's understanding of the topic at hand. This would also serve as an indication of whether students needed additional resources or hints. While all three teachers focused on student responses and written work, there were variations in what they attended to and how they reasoned about mathematical understanding. Table 2.3 describes the similarities and differences in the teachers' noticing of mathematical understanding.

	Attends to students' ...	Reason about
Carter	Sophistication in response Use of learning resources Strategy correctness Reasoning for strategies	Indicates understanding or misconceptions
Raymond	Struggles with problem solving Correctness of strategies/procedures	Indicates needs for hints Indicates understanding or misconceptions Indicates need for extra learning resources
Tim	Strategies in problem solving Work completion and time needed for problem solving Strategy correctness Misconceptions and questions	Indicates understanding or misconceptions Indicates need for teacher to break down concepts for students

Table 2.3 demonstrates that while all three teachers described looking for correctness in strategies, there were variations. For instance, Raymond seemed to focus more on correctness in procedures, while Tim focused on students' questions and Carter looked most for justification for use of strategy.

The following excerpt provides an example of what Carter noticed and how he interpreted mathematical understanding. Carter attended to a student's handling of the manipulative and her response to his questioning. During the lesson, students were asked to

investigate the features of two objects (small, hollow, plastic pyramids and prisms) by using rice to fill the objects. The goal was to have students identify that the base and height of both objects were similar and ultimately understand that the volume of the pyramid was $\frac{1}{3}$ the volume of the prism. In the clip viewed by Carter, he approaches a group of students and focuses on one female student after noticing how she filled the prism with rice. Below, Carter explains what he noticed and what drew him to question the girl about her strategy.

Her prism was already full of rice. I didn't see how she filled it up. So, I asked her how she filled it up. That's why I asked, "Does that help you determine the volume of a pyramid?" ... So, instead of saying "No, that is the wrong way", I said, "Does that help you get closer to what we are going after?" and she said, "No, not really". [Carter, Noticing Interview 1, Clip 1]

Carter described noticing how the student used the resources and how that indicated that she was not going in a direction that would lead her to discovering the formula for volume. He shared that he tried to reason about how she could have come up with the strategy and decided to ask her about her reasoning. He shared that did not tell her she was incorrect. Instead, he questioned her to help her think about what she was doing and how her use of the manipulative could lead her to get closer to the goal of the task.

Attending to Participation in Mathematics. In the instances coded for participation in mathematics, the teachers described attending to participation. They provided details about what students did or said related to participation. The teachers described individual's and/or the whole-class' level of engagement based on forms of communication in small groups or with whole-class discussions. Sometimes the teachers attended to the amount of discourse with students. Other times, they attended to the amount of questions posed by students. They would also infer that students should have questions when learning new material. Aside from listening to students' verbal forms of communication, the teachers also described attending to students'

body language. For example, a student leaning in, perking up shoulders, or nodding while others are speaking served as indicators of engagement. The teachers would distinguish whether they believed a student staring into space indicated that they weren't actively engaged or if they were simply thinking. Thus, these cues sometimes denoted to teachers that the students possibly needed guiding questions to get them back on track. Table 2.4 describes the similarities and differences in the noticing of participation.

	Attends to students' ...	Reason about
Carter	Body language Contributions to team discussion	Indicates engagement
Raymond	Body language Disengagement or opposition to participation	Indicates engagement Need to redirect student to participate
Tim	Body language Disengagement Contributions to whole class discussion Questions raised	Indicates engagement Need to redirect student to participate

The table demonstrates that all teachers attended to body language. Raymond and Tim both noticed when students were disengaged. Tim seemed the most focused on student participation. For example, Tim often described attending to students' responses during whole class discussions, specifically the number of and types of questions that students asked. The excerpt below demonstrates a moment where Tim noticed a student not providing a verbal response to a question he posed during a whole-class discussion to review a homework problem. Tim had asked for questions about the problem since many verbalized having problems solving it. A few students were called on randomly. One student, Arturo¹¹, was called on but was unable to

¹¹ Pseudonyms were used in place of the students' real names.

provide a question. Tim gave him time to think and returned to him about three times during the interaction.

Well, I'm trying to figure out why he's having a hard time not coming up with anything in terms of even a question just to ask. He's a good kid. He does his homework most of the time...I did want to give him time... If he needed me to come back to him, I did want to hear that from him. I didn't want to let him off the hook and make him feel that he can sort of just fade back into the background.
[Tim, Noticing Interview 2, Clip 2]

Tim shared that he noticed that Arturo was not coming up with a question and rationalized about Arturo as a learner. Tim explained that he expects participation, even if it is simply a question. That is why he gives Arturo time to come up with a question.

Attending to Students as Individuals. The teachers noticed students' individual qualities by attending to the topics discussed and the language used by individual students. The teachers also attended to interactions with other students and students' emotional states through facial expressions or body language. They often described an individual student by characterizing their personality or temperament. For example, a student may have been depicted as shy, confident, respectful, or compassionate. Along those lines, the teachers were also attuned to changes in individual's characteristics. When they attended to topics that students discussed, the teachers focused on student interests or stories students shared about their personal lives. The teachers described this knowledge as being useful for designing their lessons, structuring groups, and approaching interactions with students. For example, through a conversation with a student, the teacher could have learned about situations occurring at home that may have impacted an individual student's learning. Table 2.5 describes the similarities and differences in the attending to individual student qualities and interests.

Table 2.5 *Noticing Students as Individuals*

	Attends to students' ...	Reason about
Carter	Use of home and English language Confidence/anxiety in sharing	Indicates need for reassurance Indicates how to interact with students
Raymond	Shifts in students' achievement Individual learning impairments Behaviors that indicate student attributes-shyness, respectfulness, confidence Interests outside of mathematics Socioemotional responses	Brings in information about students' learning histories or lives Indicates students needing individual time with the teacher
Tim	Shifts in students' achievement Behaviors that indicate student attributes-shyness, confidence	Indicates of students needing a break Indicates students' sense of trust

When interviewed about their noticing, all the teachers reported attending to individual students. For example, all teachers noticed students' confidence or shyness in participating in mathematics. However, they differed in what they noticed about those individual students. For example, Carter generally noticed students' language use. Tim seemed to attend to shifts in individual's achievement outcomes in class. Raymond seemed most disposed to notice information about students' home lives and interests. In the excerpt below, Raymond describes noticing a question that a student made in class about how beatboxing¹² could have been related to the mathematical topic being described in class. During a lesson, Raymond was reviewing slopes and rates of change. After having one student demonstrate a strategy learned in the previous class, the students began clapping for a student that completed a problem on the board. The clapping took on a rhythmic beat, so Raymond used the clapping as an example for rates of change. A student, Ivan, asked how that might work for beats per second in terms of beatboxing.

¹² Beatboxing is a form of vocal percussion involving the art of mimicking drum machines, using one's mouth, tongue, lips, and voice.

Raymond shared that he knew from a previous interaction with Ivan that this was an interest of his. He then had Ivan beatbox in class to see if the mathematics would apply.

Ivan asked about beatboxing. He has a hard time just paying attention, just focusing. He is really sharp, but not always into the class. One way to integrate [him] was his beatboxing. He did it the other day. I thought it would be a good way to present a non-linear relationship. [Raymond, Noticing Interview 3, Clip 2]

Here, Raymond noticed Ivan's comment and described how he knew Ivan beatboxed based on previous interactions with him. Raymond described using the information he had noticed about Ivan's interests and past participation in mathematics to integrate him and his interests into the lesson.

Attending to Positioning. The teachers noticed how students were positioned in class by attending to student interactions. Specifically, they attended to how the work was distributed between teachers and students and among groups of students. For example, they would attend to the amount of time students had to struggle through a concept without the help of the teacher. When the teacher noticed that they spent too much time helping students, they described feeling uncomfortable about giving students too much assistance since they wanted students to struggle through problems to build their understanding.

The teachers also described noticing various instances of student positioning among students. The teachers specifically attended to group interactions when students were paired or grouped with others, noticing if teammates were all accountable for each other, working together and all equally engaged. Thus, the teachers attended to the dynamics or group disagreements. The teachers also described looking for opportunities to highlight the contributions of individuals who do not typically contribute. They also attended to students' comments or responses towards others' mathematical ideas, such as instances of listening, nodding or commenting on the

contributions of classmates. Table 2.6 describes the similarities and differences in the teachers attending to student positioning.

	Attends to students' ...	Reason about
Carter	Students voicing math disagreements Affective responses to collaboration Student isolation	Students can be teachers Wants students to feel safe with peers Wants team cohesiveness
Raymond	Collaboration Affective responses to collaboration Student's status among others	Student's potential to be a leader Student empowerment Benefits in working in pairs Opportunities to place student at center of instruction
Tim	[No evidence found in data]	[No evidence found in data]

Interestingly, Tim did not attend to positioning very much. Carter and Raymond both noticed when a student gained confidence through collaboration or were supported by others. Raymond also noticed students' individual statuses among their peers. This attention to student positioning and status is reflected in the example below. Raymond was shown a clip where he circulated the room while students worked on a problem. He noticed something on his student's worksheet and pointed out a missing step. After Margarita fixed her work, he publicly assigned competence to her by verbally praising her work aloud and asked her to help a classmate. In that same interaction, another student, Kelly, said a potentially disparaging remark about Margarita by asking, "what does Margarita know?". Raymond responded, "um, she knows the answers" out loud for the entire class to hear.

She did do the problem correctly... It was a minor detail... I wanted her to feel empowered and that she could explain it to somebody else. Her working with Freddy is a good match because Freddy is pretty polite, respectful in general... Some people in the classroom might be rude to her... They don't want to learn from Margarita. [Raymond, Noticing Interview 2, Clip 2]

Raymond noticed Margarita's work and wanted to highlight her efforts. He recognized that Margarita may have been viewed as an inept learner by her classmates. He described this as an opportunity to "empower her" and have her classmates see her as competent. This demonstrates Raymond's awareness of how students position each other around mathematics and how he uses what he notices to position individual students to a higher-status.

This example, along with the two shared above describe the types of classroom features that teachers were attending to that influenced their instructional decisions. Broadly, the three teachers were attending to mathematical understanding, participation, individual student qualities, and positioning. These findings provide a glimpse into how the teachers reasoned about what they noticed and how this informed their instructional decisions. In the section that follows, I expand on the teachers' noticing by describing the relationship between what teachers attend to, their instructional practices and their pedagogical commitments.

Connecting Noticing for Equity with Practices

A second finding spans across the data analyzed in this study. Analysis of the noticing interviews and instructional practice provides evidence of how the teachers engaged in equitable instructional practices. Specifically, these teachers supported student participation by creating opportunities to learn by focusing on students' individual qualities, mathematical understanding, and interactions with others around mathematical learning. This notion of broadening participation comes from the teachers being disposed to attend to the features described above relating to *mathematical understanding, participation in mathematics, individuals, and positioning*. Their instruction was marked by six common themes associated with these noticing topics. In the section that follows, I elaborate and define the themes, which are summarized with the associated noticing on Table 2.7.

Table 2.7 *Associations between Noticing for Equity and Teacher Practice.*

	Themes	Teacher Noticing	Teacher Practice
Mathematical Understanding	Building Conceptual Mathematical Understanding	Interactions related to student thinking and ideas Opportunities to offer hints Sophistication in students' responses and work	Provides challenging curriculum and student-centered tasks Presses for reasoning Students given time to think Students redirected with questions rather than answers Explicit about connections
Participation in Mathematics	Active Engagement in Mathematics	Verbal (chatting, asking questions) and physical responses (eyes movement, interacting with others, gesturing, notetaking) Student awareness of resources afforded for learning	Makes explicit the importance contribution Students share thinking Students decide validity of answers Use of non-standard representations & discourse structures Establishes routines and expectations
Individuals	Individual Resources & Strengths Honored Language Resources	Students' input to conversations Unique student qualities, experiences and knowledge Body language Connections made between student experiences and math Opportunities to build rapport Use of other languages students choose to use in discussing ideas	Makes connections between student experiences Pairs bilingual students with English learners Students use home language
Positioning	Kinship through Collaboration Positioning Student as Competent	Group dynamics & interactions among students Group cohesiveness (being at the same step with group members, all understand) Outcomes of seating arrangements Opportunities to provide reassurance Students leadership Learner participation Perspectives students were developing of themselves	Classroom arranged socially & physically to foster kinship & physically to foster kinship Students encouraged to collaborate Structures pairs/groups according to individual needs Doesn't overlook responses Students given time to struggle with concepts/ideas Verbally/publicly assigns competence Explicitly asks students to show each other respect

Mathematical Understanding

Building Conceptual Mathematical Understanding. As discussed in the first section of the findings, the teachers attended to student responses and written work as an indication of student understanding. In attending to responses, they noticed the strategies and justifications used. The teachers provided students with challenging and non-standard (reform) curriculum. The curriculum typically used by the teachers granted students the use of multiple strategies and procedures. Thus, it was more inclusive of a wide range of learners, with varying understandings. While students were given ample time to grapple with problems without much help from the teacher, they were given hints or guiding questions when needed. Generally, students were pressed on their thinking. For example, if a teacher noticed a student arriving at a correct answer, the teacher pressed the student to justify the solution.

Participation

Active Engagement. The teachers described attending to body language and verbal (i.e., questions, comments, or conversations) responses that indicated active engagement. Their noticing ranged from specific observations of individuals to general assessments of the entire class. The teachers set norms where all students were expected to contribute to discussions and were held accountable for the learning of their peers. For example, the students were explicitly encouraged to weigh in on mathematical conversations and actively listen to their peers and teacher. The teachers also made it obvious to students that they had an essential role in their own learning by describing the value of inquiry and critical thinking.

Individuals

Resources and Individual Strengths Honored. The teachers noticed students' individual qualities by attending to students' mathematical and off-topic discussions. This involved

attending to interactions between students or students' emotional states through facial expressions or body language. The teachers also looked for opportunities to build rapport with students and gather information about individuals by engaging in frequent individual conversations with students. The teachers often allowed off-topic conversations, to learn about students' home environments or interests. They also sought additional information about their students by talking to their parents or former teachers. This information influenced future interactions and helped assess the need for additional scaffolds to support certain students.

Language Resources. The teachers would listen to the use of other languages (i.e., Spanish) used in discussions with others. Each teacher had a few students that identified as English Language Learners and several bilingual students in their classrooms. Thus, they looked for opportunities for students to use their own language to explain their thinking. While the teachers were not all fluent in Spanish, they encouraged students to explain their ideas to others in Spanish and provided support for students to do so. For example, the teachers would pair English Language Learners with bilingual students to assure that the English Language Learners communicated their ideas without language being a barrier.

Positioning

Kinship through Collaboration. Specifically, the teachers described attending to student conversations and interactions while problem solving to assure that students were accountable for each other's learning. Teachers that promoted kinship through collaboration encouraged students to rely less on assistance from the teacher and instead, value the ideas of their classmates. Students were encouraged to collaborate on problem solving and were given responsibility for their classmates' learning. Students were also grouped thoughtfully, based on needs.

Positioning Student as Competent. The teachers noticed the perspectives students were developing about themselves as mathematics learners. For example, they would attend to changes in student confidence or indications of anxiety in sharing their ideas. The teachers often positioned their students as competent through verbal praise. Sometimes the teachers would privately tell students that they appreciated a student's action or response. Competence was also assigned publically for the entire class to hear. For example, the teachers would highlight ideas that were noteworthy to the entire class. They would often do this for students that were not typically positioned highly when compared to their classmates. Positioning students as competent also involved equalizing the roles between teachers and students. For example, the teachers saw their classroom roles as facilitators, rather than the ultimate source of knowledge. When students asked for support, the teachers would not label ideas as incorrect or correct.

While these themes broadly characterized the noticing and practices related to broadening participation, there were notable variations found among the teachers. These differences, although sometimes subtle, appeared to be tied to the teachers' varying pedagogical commitments. In the cases that follow, I draw on the teachers' pedagogical commitments to depict how they might be disposed to notice certain features related to learning and make instructional decisions based on what they noticed. It is these differences that may influence distinctions between what teachers see and do. A summary of the teachers' pedagogical commitments regarding the six themes described above can be found in Table 2.8. These themes were drawn from the teachers stated commitments. While their commitments were stated in their interviews, they did not always emerge in the teachers' instructional practices or noticing.

Table 2.8 *Pedagogical Commitments across Teachers.*

Equity Themes	Carter	Raymond	Tim
Building Conceptual Math Understanding	Wanted students to explain and reason	Wanted students to explain answers	Wanted students explain and reason Wanted students see conceptual connections
Active Student Engagement	Wanted students to have confidence to share Wants students actively engaged and listening	Wanted students to share answers Wanted students actively engaged and listening	Wanted students actively engaged & listening Wanted students prepared for future mathematics learning
Resources & Strengths Honored	[No evidence found in data]	Wanted to bring out the best in individuals Found value in building rapport with students Found value in learning about students' lives and interests	[No evidence found in data]
Language Resources	Wanted home language to be a resource	Wanted home language to be a resource	[No evidence found in data]
Positioning Student as Competent	Wanted students to be "little teachers" Teacher as facilitator Promotes student confidence Wanted students to rely mostly on their thinking	Wanted to empower students to be leaders	[No evidence found in data]
Kinship through Collaboration	Believed teamwork to be beneficial and essential Believed students should be responsible for others' learning	Believed teamwork to be helpful Wanted mutual respect among students	Believed hearing others' strategies is helpful in learning

Table 2.8 demonstrates that all the teachers expressed wanting students to build strong conceptual understandings of mathematics. For example, they shared wanting students to not just provide an answer, but to share their reasoning and justification at arriving at their responses. Beyond wanting students to build conceptual understandings of mathematics, the teacher varied in their commitments to students. Below, I describe how I positioned the teachers based on how

the teacher organized their stated pedagogical commitments. Specifically, I was attending to the narratives the teachers used to describe their commitments and their noticing. For example, Carter often described wanting students to rely less on the teacher and more on themselves. He would explicitly say that he wanted the students to be the teachers. Thus, I found him to be committed to student positioning. Raymond seemed to offer narratives about individual students, and their identities inside and outside of the classroom. Thus, I posited him as being committed to individuals. Tim generally described teaching instances and his goals in terms of mathematical conceptual understanding. Tim also heavily focused on students being actively engaged in their learning by sharing their understanding. Thus, Tim was positioned as being committed to participation.

The Influence of Pedagogical Commitments on Practices and Noticing

Carter: Making Little Teachers Out of Each Student. Carter can be characterized as being focused on positioning. Through his noticing and pedagogical commitments interviews, Carter often described student collaboration and teamwork to be essential for mathematics learning. He shared that it was his goal for students to be responsible for each other's learning.

My goal is to make little teachers out of each student... they're practicing their collaborative working skills and their communication. I think that those are all really important factors in strengthening the understanding. [Carter, Pedagogical Commitments Interview]

This excerpt captured Carter's key commitment, which valued students developing their skills in collaborating and communicating with others. He saw his role as the facilitator and wanted students to be "little teachers" and have the agency to share their ideas to further the thinking of their fellow classmates.

In the classroom, he engaged in practices to support collaborative skills by setting expected norms for collaboration. For instance, he often reminded students that they had to know

what everyone else in the group was working on and that everyone was on task. Further, many of the tasks that he posed involved group members having different roles. For instance, he had group members serve as investigators, task managers, recorders, and reporters. This assured that all group members had an active role in problem solving. Finally, Carter described that he physically set up classroom to promote student cooperation. For example, he positioned the desks, so that students faced their group members. The excerpt below illustrates how this commitment disposed Carter to attend to group interactions and the outcomes of collaboration for individual students. For example, when shown a clip of him addressing a group member who seemed excluded from a group discussion, he described attending to the following:

Just making sure that everyone was in it. Three students were really engaged, talking... Luisa really wasn't. So, that's when I came around and asked if everyone was involved, maybe they weren't involving her or excluding her... But they came together and really started to discuss it with her and... [I] came back... she was further along... She felt more confident interacting with her team.
[Carter, Noticing Interview 2, Clip 2]

Carter described noticing everyone except Luisa being involved in a group conversation. He intervened by questioning the group and Luisa, but did not explicitly advise them to include her. He gave the group some time to regroup. When he returned, Carter found that the group had shifted their discussion to be more inclusive of Luisa. The group of students had realized that they had isolated Luisa, but Luisa also realized that she had to give her input to the team as well. As a result, the group was now cohesive and Luisa's confidence appeared to be revitalized.

Raymond: A Little One-on-one. Raymond often described the importance of attending to individual students and helping them feel involved in their learning. He sought opportunities to interact with students to build rapport with individuals. For example, Raymond would pull a student aside during class or after class. He shared that building relationships with individual

students helped him gain knowledge about them and their individual lives. Below, Raymond shared how he finds opportunities for these individual interactions with students.

A little-one on-one help, a little extra attention, is just what the doctor ordered and they will start making the effort... Like Jason comes in and he looks down and out. So, I ask him, "Hey man, what's going on? Usually, you are smiling and happy". And then, he starts blurting out his whole world. So, I'm like, "let's go and talk in the back". [Raymond, Pedagogical Commitments Interview]

Raymond believed that giving students individual attention was beneficial for engaging students in their learning. In the previous excerpt, Raymond described both his commitment and provided an example of his noticing of Jason's shift in emotional state. By having an individual conversation with him, Raymond learned that he had recently experienced a personal loss that was affecting his learning. Raymond was often documented as having individual conversations with students, that were not focused on the mathematical concepts. He was open to students to sharing details about their lives with him since he thought it would help him better serve his students. He often looked for opportunities to connect their lives to learning. For example, He also described actively seeking information about individuals by making meetings with students' guardians and chatting with their former teachers. He described doing this specifically for students that are most disengaged from learning.

Thus, Raymond was disposed to attend to individual students. He often described noticing students' perspectives, emotional responses, and interests. He also described continuously looking for ways to motivate students and invite them to participate. For example, below Raymond shared what he attended to during an interaction with his student, Michael. In the clip, Raymond was reviewing a previous lesson on slopes. Michael stood up and walked in front of him. Instead of asking the student to sit down or ignoring him, Raymond asked Michael to volunteer to work on the problem on the board.

Michael got up to throw gum out... So, I turned it around to make him volunteer... Michael is a student that will daydream, get up, wander, not stay focused for more than a couple of minutes... I took advantage of the situation and engaged Michael. [Raymond, Noticing Interview 3, Clip 1]

Raymond shared feeling disturbed by Michael's behavior and thinking about asking him to sit down. Instead, he decided that this was a good opportunity to engage Michael and give him individual attention. While at the board, Raymond provided Michael with support when he noticed he was having difficulty solving the problem. Raymond expressed concern over possibly embarrassing Michael, so he made sure that he was guiding Michael towards the correct strategy. With Raymond's help, Michael solved the problem and the entire class clapped for Michael when he completed the problem.

Tim: Everyone Participates. Tim wanted the students to be engaged, share their thinking, and actively listen to the ideas of others. Thus, he would explicitly ask students to do so and would share the affordances of sharing their ideas and misunderstandings. Specifically, Tim expressed the value of inquiry.

It is a class where everyone participates. And saying you're confused about something is perfectly fine. Asking questions about things is what I expect... When they get to high school, I want them to have skills in terms of being willing to ask teachers for help, being willing to ask why something works, and approaching math from that point of view. [Tim, Pedagogical Commitments Interview]

He described his expectations for students to be active learners by sharing their ideas and asking questions. Since his students were in middle school, Tim was trying to establish norms that the students take with them when they enter high school and into all possible future mathematical experiences.

To assess engagement, Tim attended to students' physical and verbal responses. For example, he would attend to the amount of questions students had and the ideas they would share. After watching a lesson where Tim specifically asked students for questions about a multi-step problem, he expressed concern over noticing that some were not sharing responses.

I'm dealing with some kids being too passive... so, that's why I've started doing this thing of, "I need to hear good questions". You can't just sit there and let this stuff wash over you. I was trying to emphasize that asking questions is really the skill of a good math student. [Tim, Noticing Interview 2, Clip 1]

Tim's response indicates that he wanted students to be more engaged and not be passive learners. Tim shares that learning mathematics requires inquiry and critical thinking. Thus, to encourage engagement, he asked that they ask questions, reinforcing the idea that questioning is part of being a "good" math student.

In the cases described above, the teachers' pedagogical commitments were associated with their dispositions to notice certain things, and their instructional practices. All three teachers also expressed a commitment to helping students build conceptual understanding, but had varying dispositions and commitments on how to do so. Carter was most committed to positioning. Thus, he was disposed to notice group interactions and encourage collaboration. Raymond was committed to giving students individual attention. He, therefore, attended to individual students' emotional responses, interests, and qualities. He also looked for opportunities to engage individually with students and build rapport with them. Tim was positioned as being committed to student participation. Thus, he attended to student engagement and was explicit to students about why active engagement was important. The three cases demonstrate differences in what teachers do and notice to broaden participation in their classrooms. Although all three teachers were committed to equity, they conceptualized it differently and varied in their commitments to students.

Misalignment Between Teachers' Pedagogical Commitments, Practice, and Noticing

I also found misalignment between the teachers' pedagogical commitments, instructional practice, and noticing within the themes. In other words, although pedagogical commitments were stated, they weren't always actualized in practice or focused on in noticing. For example, Raymond explicitly shared being committed to helping students build conceptual understanding and reason about their thinking. However, this was not always found in his instructional practices. Students were often given problems that were more focused on procedures. This misalignment was often evident in Tim's case. He often emphasized that he wanted students to make connections between the concepts and to have a deep conceptual understanding of the topics being discussed in class. While students were given time to think, Tim would often make the connections for the students instead of having them investigate the connections themselves. Alternatively, in Tim's pedagogical commitments interview, he did not state that he wanted to attend to individual students, but when analyzing his practice, I found that he does in fact notice individual's qualities and achievement efforts. Through his noticing interviews, he shared that what he noticed about individual students often influenced how he interacted with them. For example, he noticed shifts in individual students' energy or achievement. This shift influenced Tim to take a student outside to inquire if the was okay or needed support. Students' learning outcomes also impelled Tim to invite individual students to be tutored outside of the class time. Tim often allotted time during the lunch break and afterschool to tutor students.

Discussion

Attention to instructional practices that promote equitable learning opportunities has been the focus of mathematics researchers for some time. Thus, the field has identified practices that support student agency, assign competence, and encourage students to negotiate their own

mathematics learning (Boaler, 2002; Boaler & Staples, 2008; Cohen & Lotan, 1997; Gutierrez, 1995; Gutierrez & Rogoff, 2003; Nasir, Hand & Taylor, 2008). This goal of this study was to understand how teachers engage in these types of practices by examining equity through a lens of teacher noticing. Specifically, this work contributes to the limited field of noticing for equity (Aguirre et al., 2012; Hand, 2012; Jilk, 2016; Roth-McDuffie et al., 2014; Turner, et al., 2012; Wager, 2014) by examining the noticing of teachers who were identified as being committed to equity, and how their noticing was related to their instructional practices and pedagogical commitments.

Specifically, this work provides specific examples of instructional practices related to Esmonde's definition of equity as "fair distribution of opportunities to learn for all students" (2009b, p. 1008) by elucidating moments where the teachers created opportunities for students to learn and participate meaningfully in mathematics. For example, I provided examples where the teachers invited an array of ideas and instances where teachers supported student agency. Specific themes for instructional practices were presented in the findings (*building conceptual mathematical understanding, active engagement in mathematics, resources and strengths honored, language resources, kinship through collaboration, positioning students as competent, and building rapport*). These themes also provided insight into the relationship between teachers' instructional practices, noticing, and pedagogical commitments.

Furthermore, this study extends the research on teacher noticing, which has primarily focused on students' mathematical thinking to characterize the complexities associated with noticing for equity. The analysis revealed similar findings to those described in the literature of noticing for equity (Hand, 2012; Turner et al., 2012; Wager, 2014), which found that teachers positioned towards equity attend to student engagement, the ways students developed in

mathematics, connections between mathematics and students' experiences, and relationships among students. The teachers in this study attended to similar classroom features. Overall, the teachers noticed mathematical understanding, forms of learner participation, individual students, and student positioning. However, the teachers did not all notice similar classroom activity or features, nor did they interpret all interactions in the same way. Within these four topics, the teachers varied in the amount of attention to these topics and focus within topics. All three focused on mathematical understanding by attending to students' responses and work. In terms of equity, the teachers also noticed other aspects about students' learning. For example, Tim noticed student participation, Carter noticed student positioning, and Raymond noticed individual students.

Like Hand (2012), this study also noted the relation between teachers' noticing and practices by drawing on examples of equitable practices discussed in the literature (Boaler & Staples, 2008; Cohen & Lotan, 1997; Moschkovich, 2002; Nasir et al., 2008). Hand identified instructional strategies that invite students to take up space in classrooms. These practices include making connections to students' experiences, fostering solidarity among students, blurring distinctions between teachers and students, validating the range of participation, and promoting dialogic spaces where socio-historical topics are critiqued. Encouraging active student engagement was a notable aspect among the teachers in this study. Their students were expected to contribute to discussions and were held accountable for the learning of their peers. Like Hand's teachers, the teachers in this study attempted to make connections between students' experiences and learning. The teachers in this study were also concerned about their students' individual identities and emotional responses. They also attended to the language students used in class. This information was often integrated into the teachers' interactions with students

around mathematics. For example, language would influence student grouping. Like Hand's teachers, the teachers in this study focused on student positioning by fostering solidarity among students through collaboration and by assigning competence to students of lower-status. This study also identified practices related to building conceptual understanding. The teachers generally provided students with challenging and non-standard curriculum, which allowed students to use multiple strategies and procedures. Unlike Hand's teachers, the promotion of socio-historical topics was not discussed explicitly among this group of teachers. Focus on socio-historical topics in mathematics was not found in any of the teachers' interviews.

This paper was also concerned with the influence of teachers' pedagogical commitments on noticing and instructional practices. I presented case studies of each teacher discussing the relations between their pedagogical commitments, noticing, and instructional practices. Like in the literature, the analysis revealed that the teachers' commitments seemed to be associated with their dispositions to notice aspects about students, their interpretations of what was noticed, and instructional decisions (Hand, 2012; Wager, 2014). Analysis of Raymond's instruction highlights how attention to individual students. Analysis of Carter's demonstrates attention to student positioning and the analysis of Tim underlines the importance of attention to participation.

There were also examples of misalignment between instructional practices and stated pedagogical commitments. For example, both Raymond and Tim shared in their pedagogical commitments interview that it was important for their students developing strong conceptual understandings, knowing the reasoning behind using certain strategies, and justifying their answers. However, their practices were often more teacher-centered, where the teacher provided more of the critical thinking and strategies. Another, plausible explanation for Raymond could be related to the lack of resources or support from his school. For example, Raymond's textbook

was procedurally-orientated, so he may not have seen or experienced concrete examples of conceptually-oriented mathematics. Another explanation may involve the tensions related to teachers not having enough time to prepare students for high-stakes exams. For example, in his pedagogical commitments interview, Tim mentioned that the class had a lot of material to cover before their state exams in a short time period.

Limitations

There were notable limitations in this study. For example, there was no constant unit of analysis for all three teachers. The teachers were only presented and asked to discuss clips of their own teaching. It is difficult to generalize the findings since each teacher taught different courses and in varying teaching contexts. They also had varying personal and professional experiences related to teaching and learning. This was problematic when making comparisons across their noticing. Through their varying teaching contexts, the teachers were provided with different phenomena, which meant they had different features to attend to.

Second, the clips chosen for the noticing interviews were chosen by the primary investigator and I, with no input from the teachers. While, there was a consensus in choosing the clips between the researchers, we did not incorporate the teachers' input when choosing the clips and the teacher only provided insight into moments that were selected for them. It is likely that the team missed other opportunities to better understand their noticing if the teachers helped select notable moments. For example, there may have been other instances in the lesson where the teacher noticed valuable information about their students' learning or participation. Each video observation, provided approximately 50 minutes of a lesson. The noticing interviews only provided teachers a fraction of the lesson. In the next steps for a study examining noticing for equity, researchers could share the entire lesson video with the teacher and have the teacher flag

noteworthy moments to discuss their noticing. Including clips chosen by the teacher could provide more insight into their instructional decisions.

Third, the findings may have been different if collected during a different part of the school year. The teachers in this study were observed during the second half of the school year. At this point, the teachers described having already established learning norms and relationships with their students. A study conducted at the beginning of a school year may better capture how teachers establish these norms and relationships. Teacher noticing may also shift. It could be that the teachers are attending to more aspects about their students early on since they are becoming familiar with them. This could further support the understanding of how teachers determine the best support to offer individual students.

Finally, this study did not measure student achievement or the development of student identity as a response to these practices or teacher noticing. For example, Gutierrez (2012) argued that rigorous curriculum and fair assessments are required to maximize opportunities for all students to learn. Gutierrez (2007) also suggested that students should be able to become better people in their own eyes, not just in the eyes of others (e.g. teachers, other students). This study did not collect student data. Future studies should consider measuring student achievement and the development of student identity through longitudinal studies focused on both student and teacher data.

Implications for Future Professional Development

The implications for this study suggest that there is more to be learned about noticing for equity and ways to support teacher noticing. The results of this study can inform professional development and teacher preparation. For example, the teachers in this study each had strengths for broadening participation that can be used to support others' conceptualizations about

equitable instruction. Teachers may benefit from participating in professional development using the themes developed in this paper. For example, a video club or lesson study could be conducted focused on developing teachers' practices and noticing using the themes found in the analysis to frame the professional development.

For advancement in equitable practices, researchers should focus on not only practice, but consider the associations with teacher noticing and pedagogical commitments. Providing teachers with information through readings about practices is part of, but not the only effort necessary. Teacher collaboration could serve to build teachers' skills in this area. Feedback and new information is best supported through dialogue and interactions with others in the field. For example, Gutierrez (1996) identified that support received through positive learning environments in mathematics departments often led to creating equitable learning experiences together.

This perspective highlights that learning to develop instructional practices and noticing is not an individual endeavor, but one that is social. Communities of practice, especially those focused on video clubs, can serve as sources for changing how teachers interpret learning situations and the information noticed about students. Video clubs can provide teachers with opportunities to discuss their noticing with their colleagues. These discussions can lead to the communication of strategies and interpretations related to noticing for equity. Research on teacher noticing has demonstrated that improvement is possible with ample support. For example, Star and Strickland (2008) found that pre-service teachers typically do not enter methods courses with well-developed observation skills, but can develop these skills with support to help teachers attend to more features of the classroom environment, mathematics, and interactions between the teacher and students. Knowing that some teachers have not developed

noticing skills, some have implemented teacher development that helps teachers focus on students' mathematical thinking and ideas (Jacobs, Lamb, & Philipp, 2010; Star & Strickland, 2008; van Es & Sherin, 2008).

In the case of noticing for equity, McDuffie and colleagues (2013) designed a video analysis activity to support prospective teachers' noticing of student understanding and cultural, linguistic and community knowledge. They found that prospective teachers noticed classroom features early in own preparation, but their noticing developed through the support offered through their mathematics methods course. The use of prompts and structured activities supported prospective teachers in building their depth of noticing. Specifically, the teachers moved away from discussing teacher moves and describing what they literally noticed to becoming more cognizant of interactions with students around learning. Thus, when instructed to do so, teachers can draw on an equity frame to attend to and make sense of equitable instruction.

Further, pedagogical commitments about mathematics learning also seems to be an important factor to consider in terms of equity. Thus, efforts in guiding teachers must consider the role of pedagogical commitments towards equity. This work calls for further investigations into how these commitments develop as teachers participate in teacher preparation and development. This focus is vital since pedagogical commitments may serve as filters for what teachers notice about students. Specifically, I recommend that teachers be provided with sufficient opportunities to confront their dispositions with peers.

Chapter 3: Teachers' Interpretive Frameworks for Equity

Abstract

There has been a recent interest in noticing for equity and how that is connected to teachers' positioning and commitments. This study examines equity by investigating how teachers committed to equity interpret classroom teaching, and the relationship between their noticing and pedagogical commitments. Three teachers were interviewed about their noticing. They were first shown videos of their own teaching and asked to comment about what they noticed. The teachers were also asked to watch videos of other teachers' instruction with varying levels of equitable interactions between teachers and students. Finally, the teachers were each asked about their pedagogical commitments to students. The analysis revealed that teachers committed to equity seemed to use similar frameworks for interpreting what they see. Second, when the interpretive frameworks were used to analyze noticing interviews of their own teaching, the teachers used similar frameworks to interpret what they noticed. While similarities were found among the teachers, there were also subtle differences found among the teachers' interpretations. Case studies revealed that differences in noticing were related to teachers' pedagogical commitments. The findings of this study expand on current research that examines noticing for equity and have implications for understanding how noticing is informed by teachers' commitments and positioning.

Keywords: interpretive frameworks, teacher noticing, equity, secondary mathematics, teacher noticing, pedagogical commitments

Introduction

The construct of teacher noticing concerns the ability to attend to and make sense of complex classroom interactions (Jacobs, Lamb, & Philipp, 2010; Sherin, Jacobs, & Philipp, 2011; van Es & Sherin, 2002, 2008). Classroom lessons provide ongoing information about students and how they interact around mathematics (Sherin & Star, 2011). Teachers continuously and seamlessly choose to attend to some features of classroom interactions, while overlooking others (Miller, 2011). Furthermore, Sherin and Russ (2014) demonstrate that teachers do not just notice a single feature or event and then move on to another independent of the first. Instead, what they notice *about* an event in one moment drives, in part, what they focus on in subsequent interactions. Much of the work on teacher noticing focuses on what teachers choose to attend to (see Star et al., 2011). However, Sherin and Russ (2014) draw attention to the interpretive frames that both guide what teachers attend to and how they make sense of classroom interactions.

The current study builds on this work to better understand noticing for equity, where teachers pay attention to not only student thinking, but other aspects of students' lives and positioning to create more opportunities to be inclusive of other students. Aside from teachers discerning classroom features, teacher noticing is characterized as being "active" (Erickson, 2011, p. 17) and associated with teachers' knowledge and positioning (Schoenfeld, 2011). Thus, I seek to better understand what frameworks that teachers who are committed to broadening participation use to make sense of what they notice and how these are tied to their positioning. Specifically, this study asks the following research questions:

RQ1: What interpretive frameworks do teachers committed to equity draw on as they observe and make sense of classroom interactions?

RQ2: What is the relationship between teachers' interpretive frameworks and their pedagogical commitments?

The aim of this study is to contribute to the growing body of research that focuses on the intersection between noticing and equity (see Erickson, 2011; Hand, 2012; Wager, 2014). Most of the work around noticing for equity has identified a connection between teachers' commitments (i.e., teacher positioning) and what they are disposed to notice in terms of equity. In other words, these studies have focused on selective attention. The current study builds on this work to focus on teachers' interpretation of equitable practices. This study also examines the link between teachers' commitments to equity and the interpretive frameworks they use to make sense of classroom interactions. Because of the inextricable link between noticing and instructional practice, gaining insight into teachers' interpretive frameworks will have implications for advancing theory on noticing for equity as well as have implications for designing learning environments that intend to support more equitable instructional practice.

Conceptual Framework

This study is framed by two lines of inquiry – research on equity in mathematics teaching and research on noticing. I offer a brief review of my conceptualization of equity and then examine prior work on teacher noticing and interpretive frames.

Defining Equity

Equity in mathematics is complex, encompassing issues related to access rigorous curriculum, participation, student status, and student identity (Boaler, 2002; Boaler & Staples, 2008; DiME, 2007; Gresalfi et al., 2009; Gresalfi & Cobb, 2006; Gutierrez, 2002; 2012; Hand, 2012; Nasir & Hand, 2008). Among the several definitions for equity (Gutierrez, 2002; Gutierrez, 2012; NCTM, 2000), this paper draws on Esmonde's broad definition that equity is a

“fair distribution of opportunities to learn for all students” (Esmonde, 2009b, p. 1008). This concept assumes that all students can participate in mathematics and that classrooms are a space for an eclectic collection of ideas and contributions (Cohen & Lotan, 1997; Dunleavy, 2015; Esmonde, 2009b; NCTM, 2000). These opportunities help students master mathematics (Gutierrez, 2012) through explicit communication of expected forms of discourse and student practices around mathematics learning. Further, students’ identities and lives are placed at the center of instruction to foster a sense of belonging, agency, and competence (Boaler, 2002; Esmonde, 2009; Gresalfi, 2009; Hand, 2012; Moschkovich, 2002).

Given this backdrop, this study draws on the construct of teacher noticing to examine how teachers frame classroom interactions from an equity stance and to investigate the relation between the use of interpretive frameworks and commitments to equity in mathematics teaching.

Teacher Noticing and Interpretive Frames

The construct of teacher noticing, the ability to attend to and reason about classroom interactions, contributes to the framing of study. Several studies have already examined teachers’ selective attention (Frederickson, 1992; Kersting, 2008; Miller & Zhou, 2007; Sherin, Jacobs, & Philipp, 2011; Sherin & van Es, 2008; 2009; Star et al., 2011). However, there are few examples that identify how teachers reason about what they notice in terms of student thinking, and even fewer examples in terms of equity.

Specifically, this study focuses on knowledge-based reasoning or sense-making (Sherin, 2007). As we know, noticing is characterized as being “active” (Erickson, 2011, p. 17) and ingrained in teachers’ knowledge and positioning (Schoenfeld, 2011). Thus, the ways that teachers parse out teaching is informed by their commitments to instruction (Lampert, 2001; Leinhardt & Steele, 2005; Mason, 2011). Exploring teachers’ interpretations of mathematics

instruction can provide further insight into how teachers make sense of classroom phenomena and how they come to make instructional decisions.

Knowledge-based Reasoning. Earlier research on professional vision or “socially organized ways of seeing and understanding events” (Goodwin, 1994, p. 606) influenced the work of selective attention and knowledge-based reasoning. Sherin (2001) applied this idea of professional vision to the profession of teaching, which was later termed teacher noticing. The term knowledge-based reasoning was used to describe a “broad range of cognitive processes” (p. 389). Sherin claimed that through participation in video clubs, teachers developed new ways to reason about student conceptions. Specifically, teachers generalized about student ideas and made connections between the ideas of various students. Furthermore, these findings depicted a “complex interactions between selective attention and knowledge-based reasoning” (p. 393). In other words, what teachers noticed informed how they interpreted what they saw. In turn, their interpretation guided what the teacher would subsequently attend to.

Other studies have identified the strategies and frameworks that teachers use to reason about what they see. For instance, Colestock and Sherin (2009) examined the strategies used to interpret videos of classroom teaching. They pulled from the research on reading comprehension to conceptualize teachers’ interpretation (Anderson & Pearson, 1984; Black, Turner, & Bower, 1979; Copeland & D’Emidio-Caston, 1998; Duke & Pearson, 2002). Specifically, they compared viewing videos to reading text in a book. Through the analysis 15 teachers’ noticing interviews, they identified five sense-making strategies that teachers used to interpret videos. These strategies include *comparisons* (compares aspect of clip to something that has happened elsewhere), *generalizations* (identifies activity or behavior that takes place across various settings), *perspective-taking* (speculates state of mind of agent in clip), *reflective thinking* (refers

to respondent as subject of comment), and *problem solving* (teaching as series of actions and decisions to accomplish a goal) (p. 15).

Similarly, Sherin and Russ (2015) proposed that noticing is informed by the frames they bring to the observation of classroom interaction, what they define as interpretive frames. In using this term, they refer to the relationship between selective attention and knowledge-based reasoning, the two sub-processes of teachers' professional vision. They describe the frames as the structures that describe the ways in which teachers' selective attention both grows out of and informs their knowledge-based reasoning and vice versa. In other words, these frames capture the integrated and cyclic nature of attending and interpreting classroom interactions and how they come to shape, or frame, what is seen and how it is understood. They define six categories of frames: *narrative*, *normative*, *personal*, *expectation*, *associative*, and *abstraction*. I offer two to illustrate how they function in noticing. Teachers taking on a normative frame evaluate the quality of what is observed or offer alternatives for action based on what ideas they have about effective teaching. For example, they might suggest a problem with what they see. Thus, from this frame teachers "look out for" what may be problematic and then judge the goodness or weakness of what they see. Alternatively, personal frames include those in which teachers make a personal connection with what they observe, either taking perspectives of the actors or having an affective response. In this case, what teachers see is guided by some affective response they have - a feeling or emotional connection they make to the observed event and reasoning about the interaction based on how a participant in the video may be feeling.

Leveraging Noticing to Make Inferences about Teacher Framing. The literature also explains that noticing is informed by expectation that teachers have about teaching and learning (Hand, Penuel, & Gutierrez, 2012; Lefstein & Snell, 2011; Russ & Luna, 2012). In other words,

when teachers observe classroom interactions, they elicit “dispositions to notice” (Lefstein & Snell, 2011, p. 513). Thus, recent work has suggested that teachers’ noticing can be leveraged to infer teachers’ framing (Hand, Penuel, & Gutierrez, 2012; Russ & Luna, 2012). For instance, Hammer and colleagues (2005) draw on the construct of framing to explain the link between teachers’ observation and sense-making of instruction. Framing is an individual’s or group’s forming a sense of “what is going on here?” (Hammer, Elby, Scherr, & Redish, 2005). It is their “definition of what is going on in interaction” or “sense of what activity is being engaged in” (Tannen, 1993, pp. 59–60). Whenever people engage in an interaction they automatically, either tacitly or explicitly, attempt to make sense of that interaction (Goffman, 1974), use of metaphors (Lakoff & Johnson, 1980), narrative (Bruner, 1991), and perceptual tools (Nesbitt, 2004). This work suggests that framing is multifaceted and tacit for teachers (Russ & Luna, 2012). Finally, Coffey and colleagues (2009) suggest that individual’s contexts influence their framing, which subsequently influences their practices.

Using this framework, Hammer and colleagues (2009) found that “novice teachers have abilities for attending to student thinking, but what they notice in class depends in part on how they frame what they are doing” (p. 151). When their novice teachers were asked to attend to their behavior, curricular objectives and standards and their own behavior, they did not notice the substance of student reasoning, though when asked to use this frame, they focused on student thinking.

Hand and colleagues argue for attention to framing as it reveals at the systemic level the role that power plays in perpetuating inequities (2012). They suggest power and hierarchies play a role in the “narratives and ideologies” (p. 250) that serve to interpret interactions and activities. They argue that individuals may be disposed to certain narratives through frames the use to

engage in interpretation. The literature has also given us examples of teachers using deficit framing. Unfortunately, some teachers are disposed to attribute learning disparities to students' socioeconomic or racial backgrounds (Horn, 2007; Nogura & Wing, 2006; Philip, 2011) for example, teachers may assume that certain students don't care about school or that their parents don't care (Philip, 2011). Assumptions about groups of students can be seen in Horn's (2007) study. After interviewing teachers about their conceptions regarding implementing new reform curricula, the teachers in her study interpreted their students' participation as being as what she defined as "slow and fast" or "lazy and motivated". Philip (2011) documented the transformation of a teacher's sense making from one that puts blame on students' home contexts to focusing more on racial and systemic issues that lead to disparities in learning opportunities.

These ideas raise the question, what frameworks guide teachers' noticing for equity, in other words, what framework might teachers draw upon to interpret a classroom interaction from an equity stance? The equity literature gives us some ideas of how teachers might interpret this interaction. Teachers are likely to pay attention to the rigor of the mathematics, and interpret it in terms of and who has access, how power is distributed, who is given opportunities to participate. They would also focus on who has agency and how people are positioned to the mathematics. Finally, they might focus on the relevance of the mathematics for individual students (Cohen & Lotan, 1997; Dunleavy, 2015; Esmonde, 2009b; NCTM, 2000; Gresalfi, 2009; Gutierrez, 2012; Nasir & Hand, 2008). We can make some connections to the limited body of research on teachers' selective attention related to noticing for equity.

Noticing for Equity

Erickson (2011) theorized that *noticing for equity* associates the empowerment and participation of certain groups of students with the narratives teachers create about these

students. Influenced by this notion, research on noticing for equity has begun to examine how teachers attend to issues of student participation, identity, and access (Hand, 2012; Jilk, 2016; McDuffie et al., 2013; Turner et al., 2012; Wager, 2014). For instance, Hand (2012) concluded that teachers who notice equitably attend to ways students develop in mathematics and make connections to students' experiences, provide various non-standard forms of discourse and representations, and foster solidarity among students. Influenced by this work, others have investigated the ways noticing for equity was linked with teacher positioning (Wager, 2014) and the construction of instructional tasks that incorporate students' home, community and culturally-based knowledge (Turner et al., 2012). They also found, like Levin, Hammer, and Coffey (2009) that when instructed to do so, teachers can draw on an equity frame to see and make sense of equity in teaching. However, they also note that it was not common for all teachers in their study to frame their observations from an equity stance.

My intent in this study is to extend this work by further specifying the interpretive frames that inform teacher noticing, specifically with a lens on noticing for equity. I conjecture that teachers' noticing for equity may be informed by frames that express a commitment to disrupting power status in classrooms, to positioning learners as competent, and to developing students' mathematical identities. Specifically, my goal is to answer the following research questions:

RQ1: What interpretive frameworks do teachers committed to equity draw on as they observe and make sense of classroom interactions?

RQ2: What is the relationship between teachers' interpretive frameworks and their pedagogical commitments?

Methods

Study Context

This study investigated the noticing and dispositions of three secondary mathematics teachers from multiple school sites across Southern California. Local teacher educators and district leaders were solicited and presented with criteria developed from equitable practices previously found in the literature (Boaler & Staples, 2008; Cohen & Lotan, 1997; Moschkovich, 2002; Nasir et al., 2008). The teachers fit the following criteria:

1. addresses the needs of emerging bilingual students
2. looks for meaning making and engagement in students' everyday talk
3. engages students in deep reasoning
4. engages students rather than control
5. holds students accountable for their classmates' learning
6. assigns competence to students' efforts.

The project's primary researcher contacted the nominated teachers and provided with specific details about the study. To see if the nominated teachers were a fit with the criteria, the research team observed a lesson in each teacher's classroom. These initial observations gave the research team a sense of each teacher's instructional practice and this helped determine if the teachers would be invited to participate in the study. Before any data were collected, all teachers provided consent and expressed willingness to be part of the study. The participants were compensated with gift certificates for their involvement in the study. Details about each teacher, teaching contexts, and specific details about the data collected described below.

Participants

Carter. The first teacher, Carter, is a Caucasian male. He has taught high school mathematics for over 10 years, serves as a coach for multiple sports teams and is the leader of a character development program. He left a career in business to pursue his teaching aspirations. While his school is a public high school, it provides a college preparatory program where parents are required to submit applications for their children and admitted students are asked to sign contracts with and high academic standards to enroll. The school serves a student population that is predominantly composed of students from Latino (97%) and lower-socioeconomic backgrounds (91% Eligible for free/reduced price lunch). Nineteen percent of students are considered English learners.

Raymond. The second teacher, Raymond, chose to teach in the same community where he attended elementary and secondary school and has taught in the classroom for over 15 years. Raymond is often chosen as a teacher mentor to pre-service teachers from a local credential program. The school serves a student population that is predominantly composed of students from Latino (76%) backgrounds. There are also students from Caucasian (9%), Asian (10%), Black (2%) backgrounds. Most students are eligible for free/reduced price lunch (74%). Twenty-seven percent of students are considered English learners. His class is particularly diverse. While most students are Latino, there are also two African American students, one Armenian student, and two white students.

Tim. The third teacher, Tim, has taught mathematics for over 25 years. After taking a seven-year break from classroom teaching to be his district's mathematics coach, he returned to teach middle school mathematics. At the start of our observations, Tim had been in his second year of teaching since his return. Aside from his work in the district and the classroom, Tim has

also works as a teacher educator in a local university teacher credential program where he teaches a mathematics methods courses for prospective teachers. The middle school where Tim currently teaches serves a student population that is predominantly composed of students from Latino (97%) and lower-socioeconomic backgrounds (70% Eligible for free/reduced price lunch). Eleven percent of students are considered English learners.

Data

For the broader study, data collection began by conducting observations and interviews in each teacher's classroom. The research team (the primary investigator and I) observed the teachers' classrooms for about one week, watching and taking field notes on 5-7 lessons per teacher. We then conducted a series of interviews: pedagogical commitments interview, three noticing interviews, and one professional noticing interview. For this study, I analyzed the pedagogical commitments interviews, the professional noticing interviews, and the noticing of their own teaching interviews. The data is described below.

Pedagogical Commitments Interview. The teachers were interviewed about their goals for teaching. These interviews each lasted approximately 20-45 minutes. The teachers were asked about their goals for the school year and what they hoped to achieve with their students. They were also asked to discuss their expectations for their students and what they thought it took for them to be successful at mathematics in their classrooms. The specific questions asked in the interviews are available on Appendix B. To describe the teachers' commitments towards equity, we did not explicitly ask them about their thoughts regarding classroom equity in mathematics. Instead, we examined their responses to questions about what they considered to indicate student success in their classrooms and what their goals for their students are. From this

data source, I identified comments connected to equity to help characterize their commitments towards equity.

Videotaped Noticing Interviews of Own Teaching. Each teacher was videotaped facilitating a lesson three times. The researchers selected segments where the teachers seemed to engage in equitable practices during the lesson. These segments (approximately 3-2 min.) were selected to be show to the teacher to discuss their noticing. Shortly after each observation (typically within one week), the teachers were interviewed (approximately 45 min.) about their noticing during the videotaped lesson. Three semi-structured, post-lesson interviews were conducted and teachers were shown the selected segments. The teachers were then asked to discuss their noticing about the interactions. Generally, teachers were prompted with the following question, “what were you noticing while you were teaching in this interaction?” or “what were you paying attention to?” The teachers were also invited to discuss and think-aloud about anything else that they wanted to share regarding the observed lesson. The specific questions asked in the interviews are available on Appendix A.

Videotaped Professional Noticing Interviews. Each teacher was interviewed individually and shown a series of three video clips of mathematics lessons that were between 4 to 12 minutes long. Since the study was focused on examining equity, the research team selected videos that provided evidence of teachers broadening participation in mathematics and of students engaging in mathematics work¹³. Beyond that, the videos represented a wide range of participations structures, mathematics content areas, and instructional strategies. The content of the video excerpts used in the noticing interviews is described in Table 3.1, which presents the clip length, topic discussed, summary of video, and rating for equitable instructional practices.

¹³ The teachers in the clips were from another study and not participants in the current study.

We sought to show a range of instructional episodes that provided examples of teachers broadening participation through classroom interactions with students to capture variations in the ways they observed and made sense of equity during instruction.

Table 3.1 *Video Excerpts used in Professional Noticing Interviews*

	Duration (minutes)	Math Topic	Summary & level of equitable practices
clip 1	4:49	Graphing absolute value functions	Students were asked to discuss a graph's correctness. While other students shared with the class, the teacher shushed talking students. The teacher called on a student to share on the board. The student discussed his response using imprecise mathematical language. The teacher asked the rest of the class to come up with the proper vocabulary and then asked two more students to explain their thinking, assigning competence to each student. (medium)
clip 2	8:12	Number patterns	The teacher displayed a chart of square, rectangular and triangular number patterns on the projector and asked students to look for patterns. Several students described the patterns they noticed and the teacher continuously responded with "good, I hadn't seen that one". After several patterns were presented, the teacher asked students to focus on the final two rows. He gave students time to look find new patterns and then asked for students' responses. (low)
clip 3	12:20	Solving inequalities	The teacher began by describing a dream she had about a monster wanting cups and caps to make cookies. This was to demonstrate variables that cancel each other out. The teacher then had students work on a problem in small groups while she circulated the room. The teacher asked a student to share his thinking with the class on the projector. His thinking seemed incorrect, so the teacher asked a second student address the first student's misconception. Then, asked the first student to explain his thinking. In the end, she has the first student re-explain his answer and guided him towards the correct idea using his original thinking. The teacher assigned competence throughout the segment. (high)

After each clip was viewed, the participating teacher was asked, “What did you notice in the clip?” Following the teacher’s response, the teacher was asked with “Is there anything else that you noticed?” and given another opportunity to share their noticing. This question was repeated until the teacher responded that there was nothing else that they noticed. The teachers were often prompted to elaborate on their statements. The process was repeated for each video clip and for each teacher. Each interview lasted anywhere from 50 to 80 minutes. The interviews were video-taped and transcribed.

The focus of the interviews was to solicit what stood out to the teachers in the videos. At times, the teachers were pressed to say more about their noticing. While the teachers were not asked directly about how they would have responded, they were asked what they thought the teacher in the clip was paying attention to during the interaction.

Data Analysis

I begin by describing the analysis of the teachers’ professional noticing (i.e., noticing of others’ teaching) interviews. It was with these interviews that I developed the interpretive frameworks that emerged in the findings. I then discuss how these frameworks were applied to the teachers noticing of their own teaching and their pedagogical commitments interviews.

Analysis of Noticing Interviews. Analysis of the noticing interviews proceeded through several stages. These stages were helpful in organizing to the data for eventual interpretation coding. For example, the teachers’ interview transcripts were segmented by the participation structures to distinguish selective attention and knowledge-based reasoning. The research team (an undergraduate research assistant and I) reviewed the transcript and tagged moments as “event noticing” to distinguish teachers’ selective attention - what they focused on. For example, to determine event noticing, the research team listed the features or events explicitly noted by the

teachers by coding for the actor (who was discussed) and topic of conversation (what was discussed). Reliability was over 90%. Disagreements were resolved through discussion and consensus.

After distinguishing what teachers attend to from their knowledge-based reasoning, the research team captured how teachers interpreted what they noticed, or rather, their knowledge-based reasoning, we highlighted the teachers' interpretation and reasoning by paraphrasing what they were saying about their noticing. I focused on capturing what they found to be noteworthy, what stood out to them, and the language they used to decipher what they saw. Dimensions and codes were both theoretically driven by prior research (etic) and emergent (emic) from the data. My research assistant and I coded all professional noticing interview data together. Reliability was over 95%.

To better capture how commitments to equity framed their noticing, the research team decided to describe teachers' interpretations in terms that drew on perspectives the teachers have about students and the tensions that teachers have in terms of implementing equitable instruction. The goal was to identify any patterns in the ways that the teachers reasoned about equity. This resulted in identifying six distinct interpretive frameworks that the teachers used to reason about equitable instruction: (a) *participation as learning*; (b) *status and participation*; (c) *mathematics disciplinary engagement*; (d) *notion of justice*; (e) *re-humanizing mathematics*; and (f) *student resources as strengths*. These frameworks were developed through conversations with my research assistant and an additional research group of 4 other individuals. Through conversations and analytic memos, the definitions for each framework were refined. These codes were then applied to the professional noticing interviews. The reliability for the coding between my research assistant I was 85% agreement. Disagreements were resolved through discussions.

I then conducted analysis across teachers. I looked for similarities and differences by teacher. I then compared the frames that the teachers seemed to adopt and tied those to their dispositions as mathematics teachers. Once the frameworks were established, they were applied to the noticing of their own teaching interviews using the same methods.

Analysis of Pedagogical Commitment Interviews. To code the pedagogical commitments interviews, I implemented a bottom-up coding strategy, without predetermined codes. Using Microsoft word, I began by recording keywords on the side or margin of the transcript for one teachers. An initial set of tentative codes was generated to look for themes. I generated analytic memos (Miles, Huberman, & Saldana, 2013) that captured the nature of each teacher's positioning and commitments. I followed this procedure for the remaining teachers. I then, took those codes and did a cross case analysis for similarities and differences in teachers' commitments. I then applied the frames that emerged from the professional noticing interviews to examine if there was an alignment between their commitments and their interpretation.

Findings

The analysis of the noticing interviews focused on the teachers' sense making and interpretation of videos of other teachers' and their own instructional practices. Specifically, the videos focused on instances where the teachers were interacting with students and broadening participation in their classroom. As expected, the teachers did not simply list what they. Instead, they described what they saw, and these depictions appear to have been rooted in trying to figure out what was going on in the video clip. Take the example below into consideration. Here, Carter described noticing a male student staring into the camera during group work.

One student was just staring off for I don't know how many minutes and other kids were like this. I noticed the desks. The other boy would have to turn his seat in order to see there. It's difficult when you arrange [desks] like this. I find the best way is for all the desks to point to the zero on the number line [in front of the

class]. Just the easiest collectively for people to see the front without doing too much movement. Because if that one is facing over there, the backs of students would be in front. [Carter, Professional Noticing Interview, Clip 3]

Carter noticed a student staring into the camera. He wondered about the length time that the student was disengaged. Noticing the student prompted Carter to connect the student's attention to the classroom setup and how the setup could have potentially made it difficult for certain students to see the front of the board and the rest of their classmates based on where they were seated. Further, Carter compared this to how he typically sets up desks in his room to prevent obstructions to students' views to the front of the room, while at the same time facilitate collaboration within students table groups. This example reflects Carter's implicit use of varying interpretive frames to describe noticing the male student's gaze.

Additionally, one could imagine another teacher noticing the same student, but discussing him in different ways. For example, another person could have suggested that the student possibly misunderstood the concept and assumed that he needed additional time to think to himself before joining in on the group discussion. Another teacher may have conjectured that the student had a previous negative experience with his group members or sensed that the boy may have been shy, which may have made the boy reluctant to collaborate. The analysis revealed that the teachers often made sense of the events in the videos by implementing the use of varying interpretive frameworks. These interpretive frameworks are defined and discussed in further detail below.

The analysis yielded two sets of findings concerning the teachers' interpretation of videos. First, the analysis revealed overlap in the interpretive frameworks that the teachers drew from to discuss their noticing. When viewing videos of other teachers' equitable practices, the teachers implemented the following interpretive frameworks to discuss their noticing:

participation in mathematics as learning, agency and accountability, mathematics disciplinary engagement, notions of justice, student resources as strengths and re-humanizing mathematics.

These interpretive frameworks were also applied to interviews where the teachers viewed and discussed their own teaching. Second, the extent to which teachers used the different frameworks varied. Some teachers emphasized one framework more, while others consistently used a variety of interpretive frameworks. I discuss these differences by presenting cases for each teacher and relate their use of interpretative frameworks to their commitments and positioning.

Summary of Interpretive Frameworks for Equity

The example of Carter’s extended interpretation of noticing the boy staring into the camera reflects what was found among the other teachers’ noticing. Typically, the teacher would notice a move made by the teacher or a response from a student and would expand their descriptions and create a narrative around what they had noticed. In what follows, I describe the interpretive frameworks in more detail using selected examples from the data. The six interpretive frameworks were clustered into three broader categories: participation, access, and identity. See Table 3.2 for a summary of the interpretive frames and the broader categories.

Table 3.2 Interpretive Frameworks for Equity

Interpretive Framework	Features
Participation	
Participation in mathematics Learning	Interprets learning as occurring through legitimate participation in a community of practice, views knowledge as being constructed through interactions with others, focus on opportunities to participate
Status & Participation	Interprets participation in terms of student status. There is also a focus between the teachers and students’ statuses in being the primary source of knowledge. Opposition to teachers “telling” students what to do rather than learning from them. Highlights

when competence is assigned to positioning lower-status students highly.

Access	
Mathematics disciplinary engagement	Focus resources and curriculum for challenging and meaningful mathematical interactions, reflect on connections to learning outcomes, focus on student thinking and building on existing knowledge
Notion of justice	Focus on unjust or inequitable situations involve students: lacking resources, such as rigorous or challenging curriculum. They address systemic issues in mathematics learning
Identity	
Student resources as strengths	Focus on resources that students bring into classrooms that interrupt traditional perceptions of what has value, with less focus on deficits, and teacher leveraging the resources students bring into the classroom to support learning
Re-humanizing mathematics	Focus to change student perceptions about school mathematics being a narrow set of rules and algorithms, connecting math learning and relevance to students' lives, attention to classroom climate and students' affective responses to learning

Participation Frameworks

The first two frameworks were focused on how students participated individually and in their classroom community. Using the *participation in mathematics learning* framework, the teachers view learning as occurring through legitimate participation in a community of practice. In other words, the ways students participate influences their learning. Thus, teachers using this framework view knowledge as being constructed through interactions with others. They may also believe that participation affords agency since they view students' identities as being shaped by opportunities to participate. Thus, this framework disposes teachers to attend to the distribution of opportunities to participate.

Status and participation is another framework in which teachers focused on student participation. Teachers interprets participation in terms of student status with a focus on

distorting differences between the teachers and students' statuses in being the primary source of knowledge. Opposition to teachers "telling" students what to do rather than learning from them. They tend to challenge traditional oppressive structures of teacher-centered learning. Thus, teachers using this framework to highlight instances where competence is assigned to position lower-status students highly.

Access Frames

The next set of interpretive frameworks focuses on access to rigorous curriculum and tasks. The teachers drew on the *mathematics disciplinary engagement* framework to discuss the ways in which students are given opportunities for challenging and meaningful mathematical interactions. Thus, the teachers reflect on connections to learning outcomes. At a low level, teachers may focus their attention on curriculum, classroom routines, and the teachers' behavior. At a higher level, the focus is on mathematical student thinking and building on existing knowledge. Thus, they will discuss ways that teachers support students' ideas or logic building to help students justify their responses and strategies.

Access also involves the interpretive framework, *notion of justice*. When implementing this framework, the teachers demonstrate concern over the availability of rigorous curriculum and resources for students. The teachers might express awareness of the injustices related to the opportunities that some students are afforded by the school system. In other words, the teacher may comment on the resources that students have available to them to participate in mathematics learning. For instance, a teacher may voice a concern over classroom resources not being demanding.

Identity Frameworks

The identity frameworks focus on teachers having to know their students' individual qualities and leveraging what they know about students to create learning environments that are comfortable and inclusive. The first interpretive framework in this cluster is *student resources as strengths*. With this framework, teachers reason about the knowledge they have about students and how one might use that knowledge to influence their interactions with students. The focus here is for teachers to leverage the resources that students bring into classrooms and to view individual differences as assets to learning.

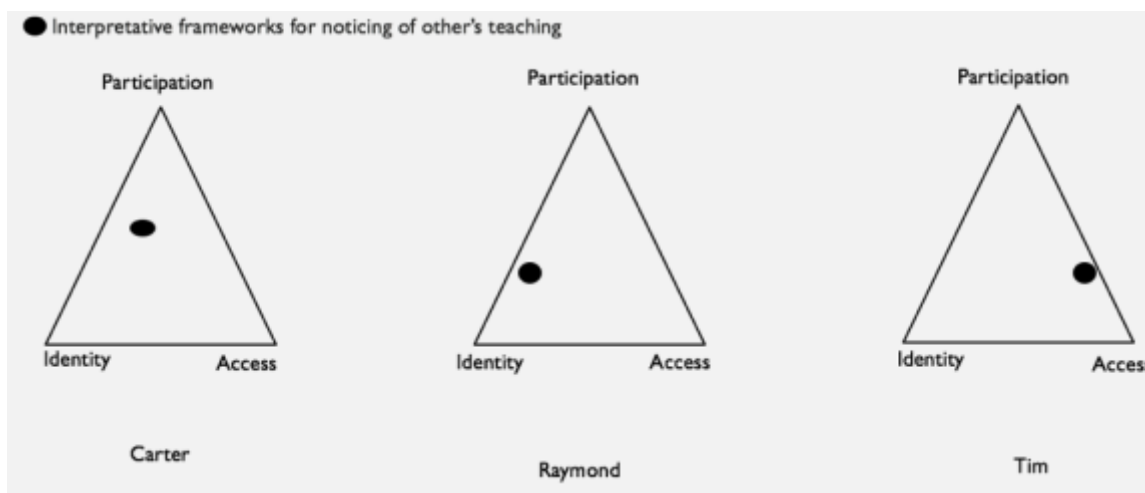
The *re-humanizing mathematics* framework is also part of the identity frame. The focus of this frame is to change student perceptions about school mathematics being a narrow set of rules and algorithms that have little or no meaning to their lives. Teachers taking on a frame of re-humanizing look to see how mathematics is used as a tool for understanding the world. This frame also focuses on changing the climate around mathematics learning and building rapport with students. Thus, teachers attend to levels of comfort, belonging and support in learning environments. This can include a focus on students' and teachers' affective responses.

In sum, the teachers did not simply list what they noticed when observing segments of teachers' practices and interactions with students. Instead, the teachers' comments about features of instruction were centered around tacit use of interpretive frameworks. While there was an overlap in the frameworks that the teachers used in discussing their noticing, there were variations in the amount of times that the individual frameworks were implemented in their responses to watching videos of others' practice and their own practice. Below, I discuss differences found among the teachers and connect those variations to their dispositions by describing the teachers individually.

Interpretive Frameworks in Action

Carter, Raymond and Tim's interviews all reflected the implementation of the interpretive frameworks described above. While the frameworks were used by these teachers to discuss their noticing, the analysis revealed each teacher had an individual frame that was used more often in their interpretations. Variations in the teachers' noticing of others' practices can be seen in Figure 3.1.

Figure 3.1 *Interpretive Framework for Noticing Others' Teaching*

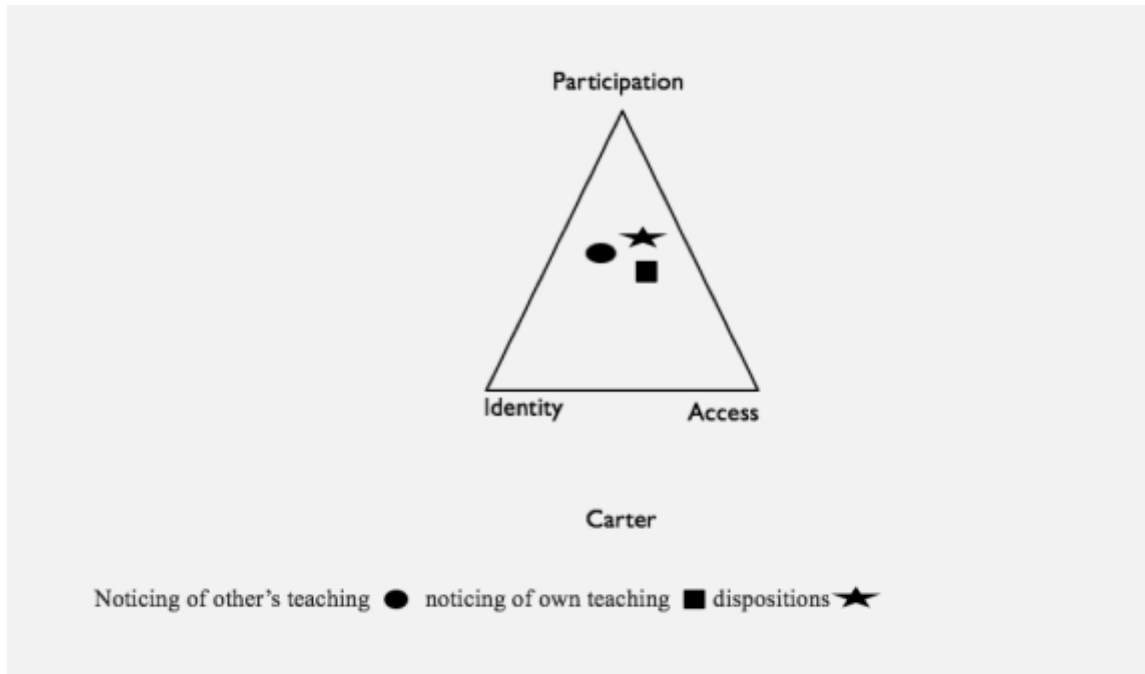


The analysis revealed that most of the teachers interpreted what they saw in terms of participation, but they varied in their inclination to use other frameworks. For instance, while Carter seemed to lean most toward participation, Raymond seemed more inclined to identity and Tim had more of a stance on access.

Generally, the teachers' use of interpretive frameworks overlapped. While this commonality was apparent in most of the data for the independent teachers, there were cases where the video source for noticing prompted the teachers to draw more from another frame than they typically used. Below, I present cases of each teacher to describe how the frameworks were underlying the teachers' noticing and how their noticing was aligned to their dispositions.

The Case of Carter: “That’s equity!” Carter’s case demonstrates a close alignment between his noticing of others’ instructional practice, noticing his own teaching and his commitments. He typically used the *status and participation* framework, demonstrated in Figure 3.2.

Figure 3.2 *Carter’s Interpretive Frameworks in Noticing and Dispositions*



For instance, when shown the third clip of the professional noticing videos, Carter noticed an interaction between two students explaining their varying strategies to the rest of the class. One student seemed to have a correct strategy, while second was having some difficulty. Below, is Carter’s response to the clip segment.

She explained it with confidence, “I’m going to explain it this way”. That would be my goal as a teacher; to make everyone accountable. Make them all little teachers so they all understand to the degree where they could teach it... Then, the other student came up and he didn’t understand it as well... He represented one side of the class and she represented another side of the class, and that’s equity! If [the teacher] just took the first student’s correct response and said, “alright good let’s move on”. Then you are leaving certain students behind. [Carter, Professional Noticing Interview, Clip 3]

Carter highlighted the confidence that the student displayed when sharing her thinking with the rest of the class. He considered her to be at the status of a “little teacher” and shared was his goal for his students. Carter also focused in the second student in the clip, which he had perceived as struggling with the concept. He insinuated that a student with his understanding may have been left behind in another classroom setting. This demonstrates that he is cognizant of the varying student statuses and looks for ways that the instruction equalizes their statuses to promote participation. Carter explicitly characterized this interaction as equitable and inclusive of all students.

In discussing noticing his own instructional practices, Carter also implemented the *status and participation* framework. When Carter watched a clip of a group collaboration in his classroom, he described noticing everyone’s worksheet. He continued to describe that he was looking to see if the team members were accountable of each other.

She had something that wasn’t on everyone else’s paper... I pointed it out... I left it open-ended so they could rely on each other to troubleshoot the mistake. The key goal of mine is to build confidence into them where they don’t feel like they have to have me to solve that problem... I want to draw as of it out of them as possible with that team... encouraging them to make sure that they are collaborating the way that I want them to. [Carter, Noticing of Own Practice, Interview 2]

In this example, Carter using the *status and participation* framework describe the statuses between him, the teacher, and the group. He wanted the group to rely on each other instead of the teacher to solve the problem.

The *status and participation* framework was also evident in Carter’s commitments. Carter’s commitments tend to focus on status in his classroom between the teacher and students and among students. He prefers to shift power away from himself and into his students’ hands through collaboration. This collaboration promotes what he really wants for his kids, which is

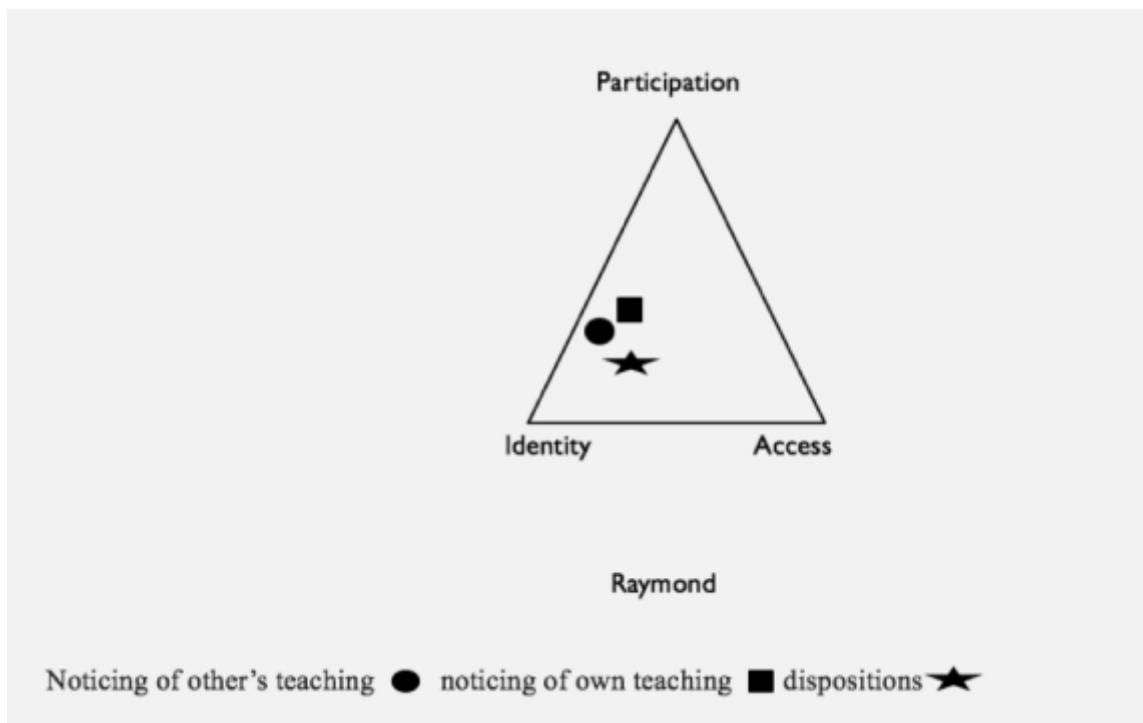
having students communicate their mathematical understanding. For example, like he described in the noticing of other’s interview, Carter shared that he wants to make “little teachers” out of his students,

My goal is to make little teachers out of each student; so not only are they practicing their math skills in here... In addition to that to develop their confidence as they work with groups, sharing out loud more, not constantly second guessing themselves about what their first thought or their first approach to solving a problem. [Carter, Pedagogical Commitments Interview]

The Case of Raymond: “It’s the little things that make a huge difference”

Raymond’s case demonstrates a close alignment between his noticing of others’ teaching, noticing his own teaching and his commitments. He typically used the *identity* frame, demonstrated in Figure 3.3.

Figure 3.3 *Raymond’s Interpretive Frameworks in Noticing and Dispositions*



When noticing other’s teaching, he was specifically focused on *re-humanizing mathematics*. For instance, when shown the third clip of the professional noticing videos, Raymond noticed the

teacher's verbal response to a student that was struggling in front of the class. Below, is Raymond's response to the clip segment.

They seem very they seem comfortable with getting in front of the class... The class was respectful of the wrong answer... The language she used was very supportive, nurturing. You know the, "he has a beautiful mind...what's going on in your beautiful mind?" ...By just saying that, she is saying, "hey keep up the good work". You might be getting the wrong answer but that beautiful mind is working. It's the little things in the classroom that make a huge difference.
[Raymond, Professional Noticing Interview, Clip 3]

Raymond was attuned to the overall tone of classroom, but also the nuanced ways that the teacher in the video is interacting and talking to her students. He had a sense that the students feel supported and comfortable in this learning environment. By focusing in on the teacher's discourse with the student, he noted how "it's the little things...that make a huge difference" in student persistence.

In discussing noticing his own teaching, Raymond also implemented the *re-humanizing mathematics* framework. Raymond watched a clip of himself having a conversation with a student after class. Earlier in the lesson, he noticed that a student, Javier, had been disengaged, but shifted to be more active after Raymond commented on his behavior. In the clip, Raymond used an inequality example with the student about who should care more about the student's grade, the teacher or student. Indicating that the student should have greater than or equal to concern over his grade.

He needed some attention... He is someone I could talk to, and anytime I could use math along the way with my lectures in the kindest way possible, "You know, I care about you. But, if I care more about your grade than you, there is an issue here" ... There's times when I'm like, "You're screwing up today" ... Then, I talk to him later and say, "look, this is why I did what I did". [Raymond Noticing of Own Teaching, Interview 2]

Raymond described sensing that Javier needed attention and encouragement. Raymond noted to Javier that he was misbehaving, but does not have the conversation to discipline the student.

Instead, he stated being direct to the student about “screwing up”, and was explicit that he genuinely cared about Javier and his achievement. The attention to *re-humanizing mathematics* was also evident in his commitments interview. Below, Raymond described how he addressed students having difficulties in class and how he invited them to participate.

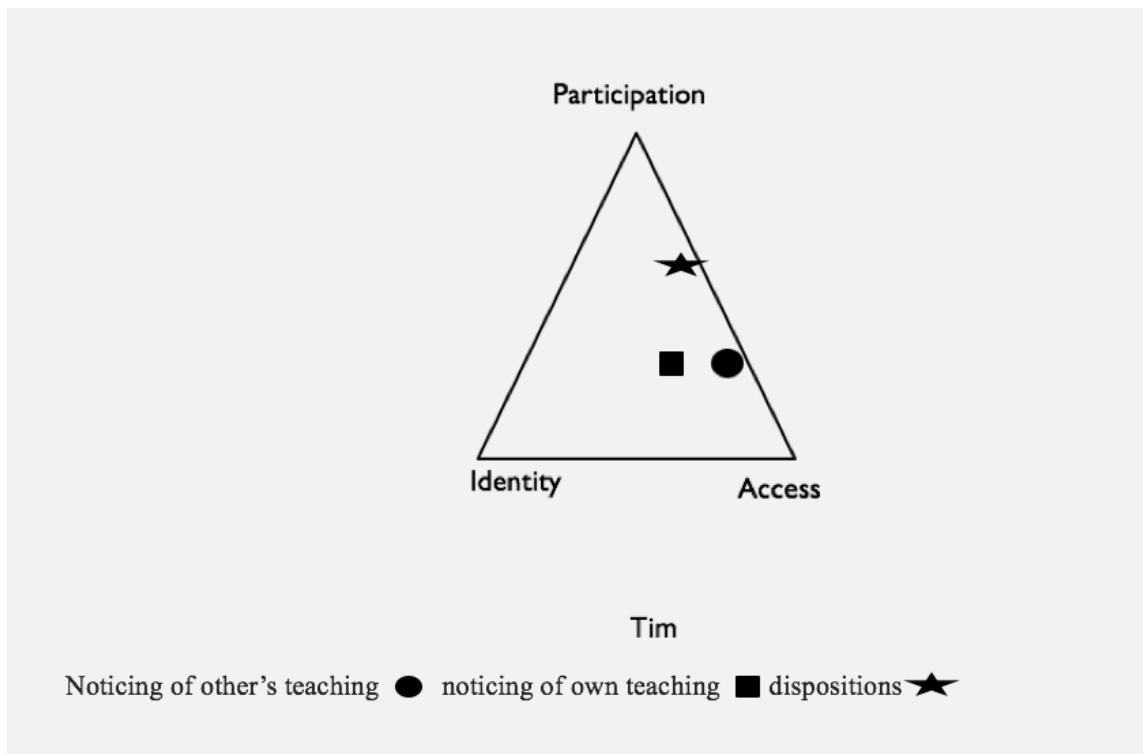
Raymond’s demonstrated that he was also attuned to his students’ individual qualities and emotional responses.

I sat down and talked to him; I explained to him, I understand this material is getting harder and We’ve been hard on you lately, but we don’t want you giving up. I gave him that one-on-one attention and told him what we are doing. Sometimes the frustration comes from that they don’t know what they’re doing, so a little one on one help, a little extra attention, is just what the doctor ordered and they will start making the effort. [Raymond, Pedagogical Commitments]

Raymond demonstrated concern over potentially losing students’ attention and believed that students may not understand concepts if they are not engaged in the lesson. So, he described success in his classroom as being connected to students’ participation.

The case of Tim: “Reworking attitudes students have brought with them from previous math experiences” Tim’s use of frameworks varied. In Tim’s case, watching videos of other’s teaching, prompted him to draw more from the access frame, mostly drawing from the *participation as learning* framework. Notably, watching videos of others prompted him to use the *notions of justice* framework. However, his noticing of his own teaching and his commitments seemed most framed by participation. Another thing to note about Tim was that watching videos of his own was the only time he discussed individual students in terms of *re-humanizing mathematics*. Figure 3.4 depicts his variations in using the frameworks.

Figure 3.4 *Tim's Interpretive Frameworks in Noticing and Dispositions*



After watching a clip of the teacher in the professional noticing interviews, Tim was curious about the mathematics concepts being taught in terms of the rigor for high school students. In the clip, the class was discussing strategies on pair numbers.

One reaction I had along the way was an extending discussion that looked like high school kids, that should have been in their basic math knowledge at that point.... So, I think it could have been that ... she identified that they were having a problem with numbers and this was a way of getting a fresh look at it. Umm, I think sort of a general statement of math education; it's sad that we can have kids at the high school level who need instruction on the idea of pairs of numbers and zeros. That should go back to, in terms of teaching that actual concept, back to fourth and fifth grade. [Tim, Professional Noticing Interview, Clip 3]

This clip prompted him to draw more from the access frame, specifically the *notions of justice* framework. Tim described concern for the level of rigor in the lesson. He wondered why the high school students in the video were learning a task that he believed to be learned earlier on in schooling. It's important to note that he is not necessarily focused on the teacher or on placing

deficits on the students. Rather, Tim was highlighting the disparities in opportunities to learn afforded by the schooling system. He seemed to have an affective response to the students working on a concept that he felt students should have reached proficiency at in earlier grades.

His use of interpretative frameworks varied when discussing his own teaching, where he mostly used the *participation as learning* framework.

I wanted to make sure they were making drawings, somehow trying to deal with the information in the problem they worked on it in tutoring... One of the issues I feel I'm dealing with the class is just kids being too passive... So, that's why I've started doing this thing of, "you have to ask me questions about it". You can't just sit there and let this stuff wash over you [Tim, Noticing of Own Practice, Interview 2]

Here Tim focused on student participation as being part of learning. He noticed that some of students did not seem as engaged as he would have expected. At the very least, he wanted to hear questions from students. Thus, he seemed to frame the noticing of his own teaching more around the participation. Finally, it's important to note that watching videos of his own teaching prompted Tim to draw from the identity frame, particularly the *re-humanizing* framework. This is important to highlight because it was not explicitly stated in his pedagogical commitment interview or used in his noticing of other's practice interview. For example, below Tim reasons about an individual student's participation by drawing on things Tim noticed about him.

I think he had been absent. And there's something going on with him. Like today I had to send him outside for a minute because like you saw he had his head down. I'm not quite sure what's going on... I'm seeing it from him more often in the last couple of weeks. He seems really out of it. My concern there was trying to get him caught up and encourage him to watch what's going on and trying to figure it out. [Tim, Noticing of Own Practice, Interview 1]

He had noticed the student's emotional response and energy. The student having his head down indicated to Tim that something may have been wrong with his health or moods.

In terms of his commitments, Tim draws on the *participation as learning* framework most often. For example, below he explained his expectations of his students.

That's kind of the tone I am trying to set is that it is a class where everyone participates and saying you're confused about something is perfectly fine, asking questions about things is what I expect. But at some level, you either have to be able to give an idea and explain why it works or ask some kind of question. [Tim Pedagogical Commitments Interview]

Again, Tim's response indicated the value that he placed on students participating in class by communicating their understanding or their misunderstanding. He described encouraging all students to participate by setting explicit expectations. These are expectations that he thought would help them become successful mathematics students as they enter high school and beyond.

My core value as a math teacher is really trying to have math make sense to kids and to help rework attitudes that they have brought with them from previous math experiences, that it is just not about getting the right answer, but more that it's valuable to be able to explain things and look at things in different ways in math... When they get to high school, I want them to have some skills in terms of being willing to ask teachers for help, being willing to ask why something works, and approaching math from that point of view. [Tim, Pedagogical Commitments Interview]

In describing his goals for his students' futures in mathematics, he indicated what he thought it took to be successful, not just in his classroom, but in future schooling. This reinforced the idea that he wanted to provide students with tools for developing conceptual understanding, and develop agency in their learning. There was an alignment between Tim's commitments and his interpretation of the clips of others' teaching. For example, he expressed concern towards the mathematics being taught in viewing the clip of the teacher's instruction. He shared that he found it "sad" that students of this age level are working on a concept he feels should have been learned years ago. This seems associated with his concern over providing students with the resources they need the future learning. This also hints at his knowledge about where students should developmentally in middle school versus high school.

Discussion & Implications

The primary objective of this study was to understand how teachers who are committed to equity interpret videos of instructional practices. Other studies have identified the strategies and frameworks that teachers use to reason about what they see. For instance, Colestock and Sherin (2009) examined the strategies used to interpret videos of classroom teaching. Similarly, Sherin and Russ (2015) proposed that teacher noticing is informed by interpretive frames. These frames help us understand how teachers interpret classroom interactions. However, they seemed broad in terms of understanding equitable mathematics instruction. Drawing from the idea of interpretive frames, I analyzed the data to understand the frameworks teachers use for interpreting equitable instructional practices in mathematics.

Results from the first part of the analysis suggested that the teachers in this study share common frameworks for interpreting classroom teaching for equity. Through analysis of their interviews, I presented common themes in their interpretations of instructional practices. Interestingly, the teachers were not consistent in the ways they implemented the other frameworks for noticing, which were tied more to their individual commitments. For example, Carter seemed to implement the *status in participation* framework more than the other teachers and Raymond used a *re-humanizing mathematics* framework. Finally, Tim seemed to focus on *notions of justice*. Since the teachers were each presented with the same video clips and prompted with similar questions about their noticing, one would imagine that they would have similar interpretations. This variability in interpretation suggests that there may be something else at play.

Some plausible explanations that relate to the teacher's varying interpretations include the distinctions in teachers' commitments to equity. All the teachers described focusing on

engaging a wide range of learners and teaching conceptually rigorous mathematics. However, like the teachers' interpretations described above, there was also variation in teacher' commitments.

The literature has given us ample examples of how teachers' unfavorable portrayals of non-dominant students and deficit framing (Hand, 2010; Horn, 2007; Martin, 2003; Nogura & Wing, 2006; Philip, 2011; Spencer, Santagata & Park, 2010). These frameworks informed how teachers viewed students from non-dominant backgrounds. The findings in this paper provide examples of the frames teachers draw from when noticing for equity. The findings demonstrate that the teachers draw from participation, access and identify frames and the frames that the teachers used to interpret was tied to their commitments to students.

Generally, all three teachers described valuing student engagement and participation in mathematics learning. They all found it important for students to be active learners and not be passive in the classroom. While student engagement was a prominent feature in the teachers' commitments, they varied in the emphasis which they used to describe engaging learners. For example, focus on *participation* was prominent in Tim's commitments, *status in participation* was evident in Carter's commitments, and *re-humanizing mathematics* was pronounced in Raymond's commitments.

Pedagogical commitments about mathematics learning seems to be connected to achieving equity in mathematics classrooms. This work calls for further investigations into how commitments and positioning develop as teachers participate in teacher preparation and development. This focus is vital since they may serve as filters for what teachers notice about students. Specifically, I recommend that teachers be provided with sufficient opportunities to confront their positioning with peers through conversations and analysis of teaching.

Video clubs can serve as sources for changing the frames teachers use to interpret learning situations and information noticed about students. Video clubs can provide teachers with opportunities to discuss their noticing with their colleagues and possibly shift their interpretations. For example, van Es and Sherin (2008) described a similar relationship between the selective attention and knowledge-based reasoning. Through the analysis of teachers' interpretation of mathematical thinking, they identified paths (cyclical, direct, and incremental) that teachers used for learning to notice students' thinking over time. They found that through conversations with peers, teachers began to attend to different classroom features and changed the ways they analyzed those events. Through discussing noticing with colleagues, teachers will be able to hear other's noticing and interpretations, which may reveal things not originally observed or noticed.

In terms of equity in mathematics instruction, Jilk (2016) sought to understand shifts in teachers' perspectives about students. Through the implementation of a video club, teachers were given a network focused on helping teachers shift their deficit perspectives to "re-culture mathematics classrooms" so that students become empowered and challenged by their mathematics instruction. The video club provided a shared vision to "develop collaborative learning experiences with equal-status interactions between students" (Jilk, 2015, p. 192). The teachers' conversations about students shifted slightly to speaking about students more positively, highlighting their strengths, rather than deficits.

Chapter 4: Conclusion

Goals and Results of Dissertation

The central goal of this dissertation was two-fold: to add to the limited literature of noticing for equity and to consider possibilities for supporting noticing for equity in future professional development. The two papers analyzed data collected from three secondary mathematics teachers who were identified as being committed to equity by broadening participation for students from non-dominant backgrounds. To answer the dissertation's research questions, I analyzed field notes, noticing interviews, and pedagogical commitments interviews. Specifically, I examined what teachers noticed when watching videos of mathematical instruction and how they made sense of what they saw. Below, I discuss the findings as they relate to the three broader goals of the study discussed in the introduction of the dissertation. First, I discuss the relationships between teacher noticing, instructional practices, and pedagogical commitments. Second, I explain how this work expands on the literature of noticing for equity by focusing on interpretation. Third, I explain the differences in watching videos of others versus one's own teaching. Finally, I end by discussing the implications for future work based on the findings of the dissertation.

Relationships between Teacher Noticing, Instructional Practices, and Pedagogical Commitments

Both studies closely examined the relationship between the teacher noticing and pedagogical commitments. Paper one also included examining instructional practices in this relationship. First, I describe the associations between the teachers' equitable instructional practices, noticing for equity, and pedagogical commitments found in the first study of this dissertation. The analysis of the teachers' classroom observations revealed that they engaged in

various instructional practices that have been shown to promote equity in mathematics classrooms (Boaler & Staples, 2008; Civil, 2007; Cohen & Lotan, 1997; Esmonde, 2009; Gutierrez & Rogoff, 2003; Hand, 2007; Ladson-Billings, 1995; Leonard & Guba, 2002; Moschkovich, 2002; Nasir et al., 2008; Rogoff, 2003). However, while each teacher was committed to equity, they engaged in different instructional practices to do so.

Carter's instructional practices emphasized student relationships and collaboration. Carter continuously emphasized to his students that they were responsible for their classmates' learning and encouraged everyone to struggle through concepts together with little help from him. To Carter, the key to learning was giving students time to collaboratively think through problems and tasks together. In a sense, he was promoting kinship among his students and blurring distinctions (Hand, 2012) between himself, the teacher, and the students by placing more value on students' thought processes. Essentially, Carter created an environment that supported student agency and instilled responsibility for their peers' learning (Engle & Conant, 2002; Gresalfi et al., 2009; Gresalfi & Cobb, 2006; Nasir & Hand, 2008).

Raymond's instructional practices were centered around giving individual attention to students and building off their interests and strengths. He made sure to give students individual time through individual conversations in class about mathematics learning, but also made time for off-topic conversations. He also shared seeking out further information about students' learning histories from their past teachers and learning about home environments from guardians. Some of his students' learning disabilities may have been perceived as deficits by some teachers, but Raymond described his students as just needing a little extra attention. He, in turn, sought for ways to support his students' varying aptitudes and the "tangible resources that students have available" (Gutierrez, 2012 p. 2) to participate in mathematics learning.

Tim placed more emphasis on encouraging active student participation. Tim adopted the idea that all students can and should participate in mathematics by contributing varying ideas (Cohen & Lotan, 1997). Thus, he would encourage his students to participate by asking questions and sharing their ideas. During a lesson, Tim would ask students to share ideas, confusions, or questions. If a student did not provide a response, he would give the individual student time to think and always returned to that individual student to assure that the student continued to be engaged in the lesson. Tim had expectations of his students to be engaged by elucidating these participation and discourse norms (Engle & Conant, 2002).

When considering the differences between the teachers' instructional practice, it is important to note that the accessible and implemented curriculum influenced some of their instructional decisions. For example, Carter's instructional practices focused on collaboration. These practices aligned with the curriculum implemented by his school, IMP. This curriculum lends itself to group worthy, challenging content that emphasizes conceptual reasoning. Tim's school used CPM, a curriculum focused on engaging all students in learning through problem solving, reasoning, and communication. Tim's instructional practices seemed to heavily encourage the communication of student thinking. The curriculum used at Raymond's school was generally based on the use of traditional mathematics textbooks, heavily focused on the memorization of procedures. However, since Raymond noticed that his students came in to his course with varying mathematical aptitudes, he felt that his textbook alone was inadequate for developing his students' mathematical understanding. Thus, he sought out additional resources to teach his students based on their individual needs in the form of multi-step problems, real-world mathematics applications, and visuals online. While the varying curriculum provides some

insight into the teachers' varying instructional approaches, it is not the only explanation for the variations found across teachers.

The findings related to the teachers' pedagogical commitments provided a more profound explanation for the variations found across the teachers in both studies. I drew on the teachers' pedagogical commitments and their noticing interviews to characterize each teacher's "philosophy of practice" (Erickson, 2011, p. 28). The teachers' varying philosophies of practice inform the connections they make between things they see in the classroom and how they make sense of what they see (Erickson, 2011). The teachers' varying personal and professional experiences influenced their philosophy of practice and commitments to their students.

Raymond's personal and professional experiences were closely tied to the community where his students lived. Specifically, Raymond taught in the community where he completed his elementary and secondary schooling. He not only had familiarity with his students' community, he also had personal motives to teach students within this community. Aside from his broad commitments to this community, Raymond described being committed to the various students in his class. He knew that he was to teach a class with students diverse in age, grade, ability, and achievement status. Furthermore, the students also demonstrated variations in their initial level of engagement in the class. For example, Raymond provided examples of student opposition to learning, such as lack of engagement. For example, some of his students had re-taken the core-concepts course, and most of the students in his class were at a level lower than students at their grade level. Taking these things into consideration, Raymond found it important to focus on individuals and provide the resources necessary to help further each students' mathematical identities.

In the case of Carter, he described initially changing his perspective of teaching through his credential program. He shared that prior to teacher preparation, he held traditional views of teaching, where a teacher was regarded as the primary source of knowledge in the classroom and students are to take in the information given by the teacher. He shared that his mathematics methods course and the course instructor¹⁴ impelled him to change his views about teaching and learning. He now finds it important to put the learning in the hands of the students and finds collaboration to be highly beneficial. This conceptualizing about mathematics teaching was reinforced by his experience serving as a teacher, sports coach, and a character development program leader at his school. Furthermore, his school has further influenced his philosophy of practice. As previously described, his school's vision focused on helping students become independent thinkers, effective communicators, and collaborative workers. Through conversations with colleagues and support from district leaders, Carter continued to develop his commitments and instructional practices.

Like Carter, Tim's involvement in teacher preparation and teacher development influenced his philosophy of practice. Tim's instructional practices focused on being explicit to students about what it means to be a successful mathematics learner in his classroom and in future learning experiences. He wanted students to be engaged, share their thinking, and actively listen to the ideas of others. Tim also described that building strong foundational knowledge and helping students make connections between mathematical concepts was important for learning. Thus, he also attended to the connections students were making among concepts. He attributed this conceptualization of mathematics learning to his involvement as a district mathematics coach and as a mathematics methods course instructor at a local university. Tim would often

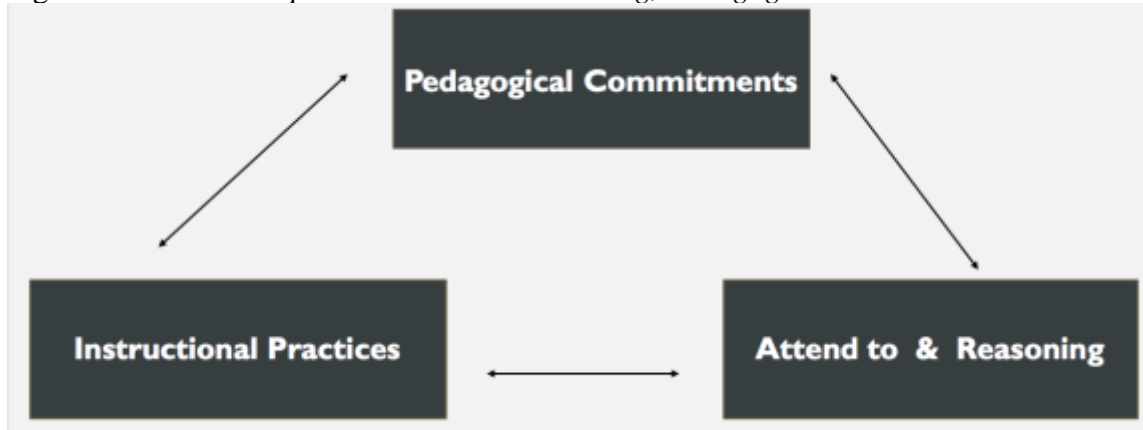
¹⁴ The instructor is the same person that recommended Carter and the other teachers for this study.

reference readings on best practices found in the literature he had encountered. Thus, he was continually researching teacher practices and attempting to develop his own teaching.

The teachers' individual philosophy of practice can be interpreted as a lens through which they see learning and teaching. This lens was influential to their pedagogical commitments, instructional practices, and teacher noticing. These teachers were identified as being committed to equity in mathematics learning. Unlike past studies that demonstrated teachers characterizing non-dominant students as being unproductive mathematics learners (Hand, 2010; Horn, 2007; Martin, 2003; Spencer, Santagata & Park, 2010), the three teachers in this study believed that all students are capable learners and should be given the opportunity to learn. They all had constructive portrayals of their students, which influenced how they promoted student participation. The teachers focused on attending to student ideas and looked for ways to build off those ideas. While creating opportunities for all students to learn served a basis for each teachers' philosophy of practice, they went about realizing equitable instruction by implementing varying instructional practices, expressed distinct commitments, and attended to different classroom features.

Directions in the Relationships between the Teachers' Pedagogical Commitments, Instructional Practices and Noticing. The analysis revealed patterns in the relationships between the teachers' pedagogical commitments, practices and noticing. This conceptualized relationship is presented in Figure 4.1.

Figure 4.1 *Relationship between Teacher Noticing, Pedagogical Commitments and Practices*



The teachers held pedagogical commitments that directly influenced their noticing and their instructional practices. In other words, certain pedagogical commitments influenced what that teachers attended to, and what they noticed influenced their practices. I also found part of this relationship to progress in the opposite direction. At times, the teachers would hold a pedagogical commitment, which influenced a practice. After implementing an instructional practice based on what they initially noticed, the teachers noticed other learning features that may have not emerged without the practice.

In the following example, I describe this complicated relationship. Carter shared that one of his commitments was for students to share their ideas without language being a barrier. Thus, to have Spanish speaking students share their ideas, he paired them with bilingual students. In an interaction that Carter watched through one of his noticing interviews, he described noticing the Spanish language that his students had used in class earlier in the school year. The video prompted him to describe one specific student struggling to share her ideas in English in the past. He also noticed that some bilingual students would try to help the English learners. The students' language abilities influenced Carter's grouping. He grouped English learners with bilingual students. The video clip demonstrated this pairing. When watching this pairing, Carter attended to how those students interacted with each other and the benefits to the pairing. This example

demonstrates the three constructs constantly informing each other. The teachers tacitly described the relationship between the constructs when interviewed about their noticing, demonstrating that their instructional practices, commitments and noticing are continuously informing each other and the arrows in Figure 4.1 are constantly bidirectional. In other words, teacher noticing may influence instructional practice and commitments, but teachers' commitments could also influence their instructional practice and what they are disposed to notice.

Selective Attention and Knowledge-based Reasoning.

In terms of teacher noticing, this dissertation examined both teachers' selective attention and knowledge-based reasoning. Like in past studies, this dissertation found that these two components of noticing are not distinct but rather they are tightly connected (Colestock & Sherin, 2009; Sherin & Russ, 2015). In analyzing teacher noticing of their own instructional practices, I found similar findings to those described in the literature of noticing for equity (Hand, 2012; Turner et al., 2012; Wager, 2014). Previous studies argued that teachers committed to equity attend to student engagement, the ways students develop in mathematics, connections between mathematics and students' experiences, and relationships between students. The teachers in this study attended to similar classroom features.

When asked about their noticing teachers tend to describe how they make sense of the observed phenomena. Few studies examining teachers' interpretation have found that teachers use frameworks (Sherin & Russ, 2015) and strategies (Colestock & Sherin, 2009) to organize their narratives about the observed phenomena. These narratives seem to be ingrained in individual teachers' knowledge, experiences, and positioning (Schoenfeld, 2011). Thus, seeing similar phenomena elicits various interpretations among individuals. These varying interpretations are informed by what teachers are looking during classroom interactions. After

analyzing the data, I found that the teachers were using the strategies described in these previous studies. For example, the teachers often used generalizations or comparisons. Among these strategies and frameworks, the teachers mostly drew from the perspective taking frame described in Sherin and Russ's (2015) work. Notably, the teachers often took on students' perspectives in reasoning about what they had observed. For example, a teacher may have commented, "If I were that student..." or "the students probably felt...". Taking a student perspective can work as a mechanism for teachers in making decisions about equitable instruction. Taking on individual students' standpoints can influence the narratives teachers make about groups of students.

While the strategies and frameworks described by the studies above help explain how teachers make sense of classroom teaching, I initially found the strategies and frameworks to be broad in describing how teachers reason about what they see. That realization influenced me to explore what these frameworks might look like in terms of equity and mathematics. This analysis resulted in the identification of interpretive frameworks used by teachers to make sense of equitable mathematics instruction. Furthermore, there was an overlap in the interpretive frameworks that the teachers drew from to discuss their noticing. Six interpretive frames emerged in the findings (participation in mathematics as learning, agency and accountability, mathematics disciplinary engagement, notions of justice, re-humanizing mathematics and resources as strengths). These frameworks seemed to frame how the teachers described what they were watching on the videos.

Noticing of Own Practices versus Instructional Practices of Others

Third, I explored the distinctions between watching videos of one's own instructional practices versus looking at the practices of others. Watching videos of their own teaching provided teachers with a replay their lessons and instructional practices. Thus, they were

reminded of why they may have made a certain instructional decision. Watching videos of one's own teaching promotes the "development of critical reflection" (Gaudin & Charies, 2015, p. 51). Thus, in these studies, the teachers watched segments of their lessons and provide detailed insight into their thinking and decision making. Another benefit to watching videos of their own teaching is that the teachers were prompted to notice classroom features previously missed in the moment of teaching. For instance, when shown a clip of a group discussion, Carter described that in the moment of teaching, he thought that one student was not engaged.

The body language of the student made it seem like he wasn't engaged. As I heard [his response]. I didn't hear the question he asked his team member just now. So, I am pleased with that. That was exactly the question I wanted. But by his body language and his tone, by appearance, if I'm looking at him from across the room looks like he isn't engaged.

After watching this interaction, Carter realized that he made an initial incorrect assessment about his student's engagement. Watching the group from across the room, Carter interpreted the student's body language as an indication that he wasn't engaged. However, the video revealed that the student had posed some interesting points to his team mates. Viewing videos of one's own instruction could serve as a way for teachers to better capture students' conversations and overall engagement.

Viewing videos of other's teaching is also beneficial. For instance, videos of other's teaching provide examples of varying forms of instruction for teachers to reflect on. Teachers may notice a more effective approach to a problem and may want to implement these strategies in their own teaching (Onk, Goffree, & Verloop, 2004). In terms of equity, watching videos of others' instructional practices can provide teachers with explicit examples equitable instructional practices. They can take those new practices to reflect upon their own practices. For example, when watching videos of the third professional noticing clip, the teachers each commented on

the teacher's approaches in making the student that had a seemingly incorrect strategy feel confident in sharing his thinking. They also seemed to admire how the teacher in third clip reached students of varying understandings.

There were notable findings regarding how these teachers reasoned about their own teaching and the teaching of others. For example, Raymond and Carter's noticing of others' teaching seemed to align with how they reasoned about their own teaching. Raymond was consistent across the videos in drawing from the identity frame and often took on student's perspectives. Carter seemed to frequently draw on participation frame. He was mindful of the varying student statuses found across the videos and how that impacted how students participated. Tim's case was notable because viewing the videos of others prompted him to use a framework not used when watching his own teaching (i.e., notions of justice). Specifically, watching the third professional noticing clips prompted Tim to comment on systemic educational issues involved in mathematics. However, his noticing of his own teaching seemed mostly framed by participation.

Implications

This dissertation has both practical and theoretical implications. The variations found among the teachers demonstrate the complexity of equity in mathematics instruction. This work calls for further investigations into how teachers' philosophy of practice is shaped and developed. It is possible for perspectives about teaching, learning, and students could shift with the appropriate support. This focus is vital since teachers' philosophy of practice seemingly serve as filters for what teachers notice about students and how they interpret what they see. Specifically, I recommend that teachers be provided with sufficient opportunities to confront their philosophy of practice with their colleagues and other experts in the field of equitable

mathematics instruction. Working with others may influence the frame that teachers draw from for interpreting instruction. By hearing others' perspectives, teachers may think more critically about their own perspectives and implement another lens.

Aside from hearing others frame equitable instruction in a different manner, teachers' commitments, noticing and instructional practices may also benefit from professional development that implements some of the frameworks developed in this dissertation. For example, in the second paper, I presented the interpretive frameworks that teachers used for interpreting videos of classroom teaching. Six interpretive frameworks emerged that centered around participation, access, and identity (see Table 3.2). I recommend that these interpretive frameworks be applied in future professional development focused on equitable instruction. The use of these interpretive frameworks in viewing videos of classroom practice can help teachers focus in and reason about the important features related to equity. The use of these frameworks could help teachers develop critical perspectives about classroom instruction that they had not previously had. For example, the identity framework could help teachers leverage what they notice about students to focus on the resources that students bring into classrooms rather than focusing on their deficits. Using this frame could shift the perspectives that some teacher may have about certain groups of students and could in turn help them better support students.

While the frameworks described above may influence teacher noticing and possibly teachers' philosophy of practice, the themes found in the first study of the dissertation may also be used to study and develop teachers' instructional practices. Specifically, this work also provides examples of instructional practices related to Esmonde's definition of equity as "fair distribution of opportunities to learn for all students" (2009b, p. 1008) in a classroom setting. The first study elucidated moments where the teachers created opportunities for students to learn

and participate meaningfully in mathematics. Table 2.7 describes common themes found in the teachers' instructional practices and noticing. As previously described, these themes were not consistently seen across the three teachers. The implementation of the themes found in Table 2.7 could serve to be beneficial in teacher development. This table could be used as a framework to guide teachers to discuss and think critically about the varying dimensions of equitable instruction.

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Appendix

Appendix A. *Post-observation Noticing Interview Questions*

Thank you for participating in this interview today. After observing your lesson, we identified some interesting moments in your teaching. What we'll do today is view those clips and then talk about what you were thinking during these moments. Our discussion is going to be video and audiotaped and I may take notes as well. Do you have any questions before we get started?

Show Clip #1

What do you notice as you watched this clip?

What kinds of things were you paying attention to during this interaction? What was standing out to you? What about the students' math work was standing to you?

Can you describe some of the choices you made in your interactions with [x student] and why you made them?

- Why did you choose to pursue a student's question?
- Why did you respond to a student's idea that way?
- How did you decide which students to invite to participate?
- How is that student's experience in your class/ at home/ etc.... relevant to this interaction?

Is there anything else you want to share about what was standing out to you during that interaction? Anything that stood out to you in this clip?

Note: The interview will follow this format for each video clip. After discussing these segments, the interviewer will ask:

Is there anything else that stood out to you from this lesson that we did not highlight in these clips that I should know about?

Appendix B. *Pedagogical Commitments Interview Questions*

What are your goals for the rest of the year for the class we are observing? What are your goals generally for your classroom?

How do you expect your students to participate in your class in general?

What does it take for a student to be successful in learning mathematics in your classroom?
