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This dissertation, SHIFTING PROFESSIONAL DIALOGUE: ENGAGING ALGEBRA 1 TEACHERS IN RESEARCH-BASED PROFESSIONAL DEVELOPMENT, by JENNIFER K. HENDERSON, was prepared under the direction of the candidate's Dissertation Advisory Committee. It is accepted by the committee members in partial fulfillment of the requirements for the degree, Doctor of Philosophy, in the College of Education & Human Development, Georgia State University.

The Dissertation Advisory Committee and the student's Department Chairperson, as representatives of the faculty, certify that this dissertation has met all standards of excellence and scholarship as determined by the faculty.

_____
Pier Junor Clarke, Ph.D.
Committee Chair

_____                _____
Draga Vidakovic, Ph.D.                                              Caroline Sullivan, Ph. D.
Committee Member                                                   Committee Member

_____
Date

_____
Gertrude Tinker-Sachs, Ph.D.
Chairperson, Department of Middle and
Secondary Education

_____
Paul A. Alberto, Ph.D.
Dean, College of Education &
Human Development

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Jennifer K. Henderson

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Jennifer K. Henderson
Middle and Secondary Education
College of Education and Human Development
Georgia State University

The director of this dissertation is:

Pier Junor Clarke
Department of Middle and Secondary Education
College of Education and Human Development
Georgia State University
Atlanta, GA 30303

# CURRICULUM VITAE

Jennifer Kathleen Henderson

ADDRESS:                      1111 Anemone Way
                              Acworth GA 30102


EDUCATION:

| | | | |
|---|---|---|---|
| Ed.D. | 2018 | Georgia State University<br>Curriculum and Instruction<br>Mathematics Education |
| Ed.S. | 2010 | Lincoln Memorial University<br>Curriculum and Instruction |
| Teacher Certification | 2009 | Georgia State University<br>Behavior/Learning<br>Disabilities |
| Masters' Degree | 1997 | Regis University<br>Psychology |
| Bachelors' Degree | 1992 | Florida State University<br>Child Development |
| Associate of Arts | 1991 | University of Florida<br>General Studies |

PROFESSIONAL EXPERIENCE:

| | |
|---|---|
| 2018-Present | **Mathematics Educator**<br>Etowah High School<br>Cherokee County School District |
| 2010-2018 | **Mathematics Educator**<br>Sprayberry High School<br>Cobb County School District |
| 2007-2010 | **Special Education Educator**<br>Sprayberry High School<br>Cobb County School District |

PRESENTATIONS AND PUBLICATIONS:

Henderson, J. K. (In press). Geometry at the kitchen table. Book Chapter, Chahine, I.C., &

DeBeer, J. (Eds.). *Evidence-based inquiries in ethno-STEM research: Investigations in*

*knowledge systems across disciplines and transcultural settings.* Charlotte, NC:

Information Age Publishing Inc.

Henderson, J. K. (2017, October). *Veteran Teachers as Catalysts for Social Justice: Building on*

*Teachers' Experiences to Advance Scholarship and Action*,

Sources of Urban Educational Excellence Conference, Atlanta, GA.

Henderson, J. K. (2017, October). *Open Source Technology for Teaching Mathematics.*

GCTM State Conference, Eatonton, GA.

Henderson, J. K. (2017, July). *Lessons from Jamaica.*

CREST-ED Institute, Atlanta, GA.

Henderson, J. K. (2016, October). *Catapulting Quadratics*.

GCTM State Conference, Eatonton, GA.

PROFESSIONAL SOCIETIES AND ORGANIZATIONS

| 2010-Present | NCTM |
| 2016-Present | GCTM |
| 2018-Present | AERA |

# SHIFTING PROFESSIONAL DIALOGUE:  ENGAGING ALGEBRA 1 TEACHERS IN RESEARCH-BASED PROFESSIONAL DEVELOPMENT

by

**JENNIFER K. HENDERSON**

Under the Direction of Pier Junor Clarke

## ABSTRACT

The purpose of this qualitative research study was to determine how learning about research-based principles of student learning shifts teacher professional dialogue within an Algebra 1 professional learning community (PLC) using single case study methodology.  Golden High School (pseudonym) – a large socioeconomically and racially diverse school in Georgia was chosen as a convenient, yet purposeful site for the study.  The participants were four Algebra 1 teachers, members of the same PLC and participating in job-embedded professional development within their PLC.  Data collection included group discussions, reflection journals, student artifacts, lesson plans, and researcher field notes.  This case study bridged the gap between PLC participation and professional development participation. Through exploration on how a PLC of Algebra 1 teachers were engaged with sustained professional development, its collaborative culture created and/or enhanced teachers' use of professional dialogue.  INDEX WORDS: Professional learning community, student learning, professional dialogue, embedded professional development.

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**SHIFTING PROFESSIONAL DIALOGUE:  ENGAGING ALGEBRA 1 TEACHERS IN**

**RESEARCH-BASED PROFESSIONAL DEVELOPMENT**

by

JENNIFER K. HENDERSON

A Dissertation

Presented in Partial Fulfillment of Requirements for the

Degree of

Doctor of Education

in

Curriculum and Instruction

in

Middle and Secondary Education

in

The College of Education and Human Development

Georgia State University

Atlanta, GA
2018

## DEDICATION

I dedicate this dissertation to my husband, Rob Henderson. Your unwavering support and boundless optimism kept me moving forward in times of struggle. There are not enough words in the world that could help me express my love and gratitude for you. I could not have completed this journey without you by my side. I am looking forward to the rest of our journey together. I love you.

# ACKNOWLEDGMENTS

I would like to acknowledge the deep gratitude I have for my committee. Dr. Junor Clarke. You have been a source of guidance and support since the beginning of this doctoral program. You gave me space when I needed it and reigned me when I needed it. Your reminders to "keep it tight" not only kept me from going down rabbit trails but also brought a smile to my face. Dr. Sullivan, I will never forget that day in your office when you wrote my thoughts all over your office wall. Your willingness to meet with me at various eateries all over Marietta and guide me through this process was appreciated beyond what you can ever imagine. Dr. Vidakovic, your attention to detail in reading my writing and suggestions for clarity were most appreciated. Thank you for helping me be a better writer. I hope I make you all proud.

"We are small, but mighty" is the best way to describe the 2015 curriculum and instruction cohort, my Georgia State family. Ladies, where do I begin? We have laughed, loudly and a lot! We have cried, but not too often. Hannah, Mariana, Julie, Erika, and Margaret where would I be without you? From Quant 1 (who could ever forget!) to graduation, I am glad I was on this wild ride with some of the most amazing women I have ever met. I am proud to be a member of your academic family. Go forth and make big waves!

This dissertation would never have been completed without the love, support, and sacrifice of my family. To my husband, Rob. My rock. I love you! You read, and re-read this dissertation and always gave valuable advice. You listened, often long after we should have gone to bed, to my ever evolving ideas of what to research, how to research, and what does it all mean. You were always there. To my children Andrew, Laurel, and Braeden. I know I could not have been successful in the completion of this dissertation without you. You were always supportive during this long process. I appreciate your willingness to share me while I completed

this program.  Your love and support were a source of strength for me.  To Carol, thank you, thank you, thank you!  You were a nonstop cheerleader, chauffer, cook, and nurse.  Thank you for helping keep everything running smoothly.  To my brother, Mark.  You have always believed in me.  You knew what I could accomplish before I did.  I cannot thank you enough for your love and support.  To Andrea, Chad, Bob, and Donna, and Dave your encouragement and support was very important to me.

Last, but never least.  My mother, Cara Manz Randolph.  I wish you were here to see this day.  You always said I should get my doctorate.  You were right.  I never would have considered this journey without your voice in my head telling me to go for it.  You always believed I could do more and know more.  Thank you for being a role model of going back to school and persevering through adversity.  You are loved, you are missed.

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**CHAPTER 1:  INTRODUCTION**

My entire professional career changed one summer, when I began my doctoral program. While carpooling with a classmate, we would talk about what we were learning and how our classroom practices were going to change because of what we were learning.  It was during these rides that I noticed that our conversations were changing.  The topics were still essentially the same, still centered around teaching and classroom practices, but *how* we were talking about teaching was different.  Our professional conversations shifted from less formal speaking about teaching to a more formal professional dialogue that deepened the understanding of our practice. Was our change in language indicative of a change in our understanding of our craft, which eventually could lead to a change in our teaching within the classroom?  I also noticed how conversations were different with my colleagues, also secondary mathematics teachers, who were not currently reading research or engaged in professional development, we returned to a less formal, surface talk about lesson planning and pacing of content.  We were not delving into student learning and understanding and its relationship to teaching.  Eventually, I started to wonder if my colleagues would experience the same shift in language I did when exposed to current and relevant research about student learning of mathematics.

**Context of the Study**

A great deal of attention and research has been given to improving the current state of mathematics education (Alfieri, Brooks, & Aldrich, 2011; Au, 2007/2013; Banilower, Boyd, Pasley, & Weiss, 2006; Battista, 1999; Cobb, Wood, & Yackel; 1990).  Despite evidence of attention and support of mathematics teaching in the academic literature, overall, students in the United States still perform lower than students in other nations (OECD, 2012). Every three years the Organization for Economic Co-operation and Development (OECD) sponsors the Program

for International Student Assessment (PISA) evaluation of 15-year-olds' reading, mathematics, and science literacy in 65 nations throughout the world (OECD, 2012). The most recent PISA data available for the mathematics focused assessment is from 2012, showing students from the United States continue to fall behind other industrialized nations in mathematics. Out of 34 OECD countries, the United States ranked 27th in mathematics literacy. According to PISA, about one in four students from the United States do not reach a baseline proficiency of employing basic procedures, algorithms, or conventions of mathematics (OECD, 2012). This statistic has not changed since 2003 (OECD, 2012).

The 2015 PISA survey focused mainly on science, but still included mathematical components (OECD, 2016). The results from the 2015 PISA show that for the third consecutive PISA evaluation the mean mathematics assessments scores dropped from 487 in 2009 to 470 in 2015 (OECD, 2016). Among 35 PISA participating nations, the United States ranks between 29th-31st, depending on the margin of error (OECD, 2016). According to the PISA data, these scores indicate that despite the research into improving mathematics education there has not yet been a corresponding increase in assessment scores in the United States. Test results from the participating high school in this research study show the same decline and below average rankings as demonstrated with the PISA (CCSD, 2015).

The State of Georgia does not participate in national testing for Algebra 1. Instead, the Georgia Department of Education developed its own Milestones End-of-Course (EOC) assessment for ten different high school courses, including Algebra 1. The Georgia Department of Education describes the Milestones EOC as "a customized program designed to fit the needs of our state and our students… [it is] not an 'off-the-shelf' commercial testing program" (GaDOE, 2015, p. 1). This new EOC was given to every Algebra 1 student in Georgia for the

first time during the 2014-2015 school year.  The scores that students earned from this new EOC were divided into four achievement levels:  beginning learner, developing learner, proficient learner, and distinguished learner (GaDOE, 2016).  Beginning learners and developing learners either did not demonstrate proficiency, or demonstrated only partial proficiency in Algebra 1. The Georgia Department of Education considers students identified as proficient learners and distinguished learners as being ready to progress to the next mathematics level.

The participating school, Golden High School, is located in a county in a major metropolitan area in Georgia, located in Arapahoe County (all pseudonyms).  Arapahoe County has produced Algebra 1 test score averages for the 2016-2017 school year that were higher than the state level test averages by more than four points (CCSD, 2017).  In addition, Arapahoe County enrolled a higher percentage of students scoring in the proficient learner and distinguished learner categories than does the state, meaning more of the students from this particular county are ready for the next course than the state average.  An examination of a two year test score trend, the only years available under the new EOC system, indicated Arapahoe County consistently had test score averages higher than the state (CCSD).

Golden High School, however, does not have Algebra I EOC scores as high as the rest of Arapahoe County.  Not only do the Golden High School students earn Algebra 1 EOC scores lower than state and county test score averages, there are also fewer students scoring in the proficient learner and distinguished learner categories (CCSD, 2017).  Golden High School's average Algebra 1 EOC test score decreased by over eight points from the previous year during the 2016-2017 school year.  In addition, the percentage of students scoring in the proficient learner and distinguished learner categories dropped by almost seven points in the same time frame (CCSD).  The Algebra 1 teachers at Golden High School are concerned with this trend and

are looking for ways to improve student learning in Algebra 1.  This research introduced the

Algebra 1 teachers to the research-based principles that support the NCTM suggestions for best

practices in teaching mathematics.

In 2014, NCTM published *Principles to Action*, linking research-informed teaching

practices to classroom practices because "effective teaching is the nonnegotiable core that

ensures that all students learn mathematics at high levels" (NCTM, n.d., p. 1).  The publication

outlined eight essential research-based teaching practices designed to enhance teaching and

learning specific to mathematics that include making sense of problems, reasoning abstractly and

quantitatively, constructing arguments and critiques, modeling mathematics, use tools

strategically, precision, the use of structure, and express regularity in repeated reasoning.  These

same eight teaching practices are highlighted in the Algebra 1 state required curriculum

comprehensive course overview as well as each of the six unit curriculum frameworks and are

described as the "expertise that mathematics educators at all levels should seek to develop in

their students" (GaDOE, 2015, p. 19).  The preceding list of practices are what teachers should

be doing in the classroom to help students learn mathematics.

The following list represents what the students should be doing when learning

mathematics.  This research study focused on how teachers' dialogue shifts as they gain

expertise in what students should experience in the mathematics classroom that support active

meaning making (NCTM, 2014).  Grounded in both cognitive science and mathematics

education research, NCTM (2014) developed principles of learning that are the foundation of

effective mathematics teaching are engage in challenging tasks, connect new learning with prior

learning, conceptual and procedural knowledge, construct knowledge socially, receive timely

and descriptive feedback, and develop metacognition.  These classroom experiences can be

fostered in the classroom by teachers employing the eight essential teaching practices designed to enhance teaching and learning suggested by NCTM (2014).

**Statement of the Problem**

When an examination of two years of EOC scores revealed Algebra 1 test scores at Golden High School below state and county averages, with a downward trend, the Algebra 1 teachers felt a change was needed in order to improve their students' learning. Student learning "depends fundamentally on what happens inside the classroom as teachers and learners interact over the curriculum" (Ball & Forzani, 2011, p. 17). With the focus of changing what happens in the classroom through teacher interaction in mind, the participating teachers targeted learning about what students should experience in the mathematics classroom to support mathematical learning to attack the problem of lowered student achievement. Research indicates that teachers need to "work together toward the implementation of a common set of high-leverage practices that underlie effective teaching" (NCTM, 2014, p. 8) such as the previously mentioned list of eight best practices.

Defining effective classroom teaching using the research-informed framework of what students should experience in the mathematics classroom was the focus of a series of professional development sessions for the Algebra 1 teachers. Through professional dialogue within the Algebra 1 PLC, the Algebra 1 teachers may construct a shared understanding of what constitutes effective teaching for student learning. After experiencing a shift in my own professional engagement and how my thinking began to change after being exposed to research about curriculum and instruction within a doctoral program, I wanted to know if the Algebra 1 teachers in this school would experience a similar shift in professional thinking. As the Algebra 1

teachers learned about research-informed principles supporting students' learning would their professional thinking, as demonstrated in professional dialogue, begin to shift?

After conducting preliminary research on this idea, and realizing the Algebra 1 teachers at Golden High School had an existing professional learning community (PLC) and were already willing to take action in making changes to their current situation, I decided to follow-up and determine the possibilities. Within their PLC, the Algebra 1 teachers work collaboratively on lesson planning, common summative assessments, and pacing of content delivery. Student learning and teaching are also part of teacher dialogue during the weekly PLC meetings. Each teacher is free to teach content as they wish, but there is not a common understanding within the PLC of effective classroom teaching for student learning of mathematics such as described by NCTM (2014).

**Purpose of the Study**

The purpose of this study was to enhance teacher understanding of student learning via professional dialogue using professional development aligned with the research based principles in the NCTM *Principles to Action* (2014) within an existing professional learning community. While there is a wealth of research surrounding the teaching and learning of Algebra 1, about teacher professional development, and about pedagogical content knowledge, there is a gap in the literature as to whether professional dialogue within an Algebra 1 professional learning community can improve student learning (Deglau, Ward, O'Sullivan, & Bush, 2006; Guskey, 2002; Prestridge, 2009; Reeves, Pun, & Chung, 2017; Ronfeldt, Farmer, McQueen, & Grissom, 2015). Professional dialogue is one component of teacher collaboration that has a growing base of literature regarding its importance and positive effect on student achievement (Nelson, Deuel, Slavit, & Kennedy, 2010; Reeves, Pun, & Chung, 2017; Ronfeldt, Farmer, McQueen, &

Grissom, 2015).  As previously stated, research has shown the positive effect effective

professional learning has on student learning as well as the positive relationship between

professional dialogue and student learning.  The aim of this research was to link the two by

exploring how engaging with sustained professional development within the capsule of a

professional learning community's collaborative culture and community responsibility created

and/or enhanced teachers' use of professional dialogue that could positively affect student

learning.

Despite teachers already meeting as a professional learning community twice a week to

discuss classroom lessons, course pacing, and assessment, they still faced reduced student

achievement scores on the EOC.  According to Dufour, Dufour, Eaker, Many, and Mattos (2016)

there are three big ideas that drive the work of a PLC, a focus on learning, a collaborative culture

with collective responsibility, and a results orientation.  A more in depth exploration of

professional learning communities can be found in chapter 2.  The intent behind a PLC's focus

on learning is that all students should learn at the highest level possible (Dufour, Dufour, Eaker,

Many, & Mattos, 2016).  In order to do this, PLC members must have a "clear and compelling

vision" (Dufour, et al., 2016, p. 11) of what that means in specific terms.  Within the bounds of

the PLC seemed to be the best place to develop this shared understanding of student learning in

the mathematics classroom.

Algebra 1 teachers were chosen as participants in this research study because Algebra 1 is

a gatekeeper course (Douglas & Attewell, 2017; Herlihy, 2007; Neild, Stoner-Eby &

Furstenberg, 2008).  It is a crucial first course that must be passed in order to engage in higher

level mathematics and science courses. In addition, students with a failure in an academic course

such as mathematics in their first year of high school have a higher proportion of dropout rate

than their peers who do not fail an academic course (Herlihy, 2007; Neild, Stoner-Eby & Furstenberg, 2008). Research shows that only 10-15% of students who repeated ninth grade graduated (McCallumore & Sparapani, 2010). Dropping out of high school has long-range social and economic implications. Consequences can include higher levels of unemployment and lower median income levels across their lifetime. In addition, dropouts from marginalized groups, such as Black males, are more likely to be in prison than they are likely to be employed (Neild et al.; Bowers, Sprott, & Taff, 2013). These consequences have been a continuing issue over time, as evidenced when more than two decades ago Schoenfeld (1995) noted

> Algebra has become an academic passport for passage into virtually every avenue of the
> job market and every street of schooling. With too few exceptions, students who do not
> study algebra are therefore relegated to menial jobs and are unable often to even
> undertake training programs for jobs in which they might be interested. They are sorted
> out of the opportunities to become productive citizens in our society (pp. 11-12).

Enhancing Algebra 1 teachers' understanding of how students learn mathematics is important because of far reaching implications. Students' learning of Algebra 1 extends beyond academic achievement and can be viewed as a predictor of achievement beyond the academic arena. For this reason, having Algebra 1 teachers as participants in this research study is important to long term student achievement.

**Research Question**

The purpose of this study was to examine how engaging in professional development affects the professional dialogue of secondary mathematics teachers. In other words, does learning about the NCTM (2014) student learning principles change how mathematics teachers talk to each other? Using a qualitative case study methodology guided by socioconstructivist

epistemology I examined the research question: How does learning about the NCTM's *Principles to Action* (2014) shift teacher professional dialogue within an Algebra 1 professional learning community?

**Significance of the Study**

This research explored how learning about the NCTM's *Principles to Action* (2014) may shift teacher professional dialogue within an Algebra 1 professional learning community. As a colleague of the participating teachers, together we have experienced many single day workshops, even single hour, professional development opportunities that never affected our day to day teaching practices. Unlike many of the *Principles to Action* (2014) professional development opportunities previously experienced by the participating teachers, the professional development the Algebra 1 teachers engaged in was designed for sustainability. This was achieved by making the professional development long term, job embedded, interactive, practical, and results-oriented. These characteristics were used in the development of the professional development to take into account what research says what works for adult learners to promote change (Fogarty & Pete, 2009; Guskey, 2014; Knowles, Holton, & Swanson, 2014). The research focused on teacher professional dialogue within an Algebra 1 professional learning community. Professional dialogue makes possible "the learning of new knowledge, questions and practices and, at the same time, the unlearning of some long held and often difficult to uproot ideas, beliefs, and practices (Cochran-Smith, 2003, p. 9). Professional dialogue is important to teachers' developing of a common understanding, in this case student learning (Simoncini, Lasen, & Rocco, 2014). Bereiter and Scardamalia (1993) asserted that an absence of professional dialogue among teachers may make learning slower.

**Definition of Terms**

For the purpose of this study the following words are defined. They will be discussed to a greater extent in the chapters that follow.

**Ambitious Teaching.** Teaching that aims to equitably get all students to acquire, understand, and use knowledge to solve authentic problems (Lampert & Graziani, 2009). In mathematics, the NCTM principles support authentic teaching. In mathematics, ambitious teaching emphasizes both conceptual understanding and procedural fluency, using multiple representations, make mathematical arguments to communicate mathematical ideas effectively, and developing productive dispositions towards mathematics (Gibbons & Cobb, 2017).

**Calendaring.** The process of pacing what content needs to be "covered" and the logistics of teaching such as on which day does the content occur, or how long to spend on the content. Calendaring is not focused on the process of student learning.

**Curricular Pressure.** Self-imposed pressure on the part of teachers. The teachers feel the need to complete content prior to standardized testing. This pressure can be exhibited through the narrowing of curriculum and teaching with more traditional methods of instruction.

**High-leverage teaching practices**. Teaching practices that are most likely to positively affect student learning (Ball & Forzani, 2010).

**Professional Dialogue**. Professional dialogue is written or oral communication between two or more teachers. For the purposes of this research, professional dialogue is also considered part of the teachers' self-reflection journal because the journal is being shared with me, the researcher, thus communication between two teachers has occurred.

**Professional Learning Community (PLC).** Dufour, Dufour, Eaker, Many, and Mattos (2016) defined a professional learning community as "an ongoing process in which educators

work collaboratively in recurring cycles of collective inquiry and action research to achieve better results for the students they serve" (p. 10). For the purposes of this research, the term PLC encompasses the terms communities of practice, professional learning networks, collaborative teams, and teacher collaboration.

**Summary**

Algebra 1 teachers at Golden High School are looking for new and innovative ways to improve student learning. Examining teacher dialogue is one way to explore how teachers are thinking about their practice. Using the professional learning communities' characteristics of teacher collective learning as a way to improve student learning, this research examined how learning about the NCTM's *Principles to Action* (2014) shifted teacher professional dialogue within an Algebra 1 professional learning community.

The remainder of the dissertation is organized into four additional chapters. Literature related to professional learning communities, professional development, professional dialogue, and NCTM's *Principles to Action* (2014) will be examined in Chapter 2. Chapter 3 details the research design and methodology of the study. In this chapter instrumentation to collect data, data collection procedures, and real-world context are described. Chapter 4 discloses the findings of the study. Lastly, Chapter 5 discusses the study's findings by connecting them to literature as well as discussing implications of the study and recommendations for further research.

**CHAPTER 2: REVIEW OF THE LITERATURE**

In this research study, I examined the effect of professional development on the professional dialogue of Algebra 1 teachers. What follows is a literature review that focuses on the research used to guide my study. The first section of this literature review discusses the theoretical framework I used to help me answer my research question. A socioconstructivist epistemological lens was used in this research as social interaction was the basis of the teacher interaction and learning during the professional development sessions. The second section discusses professional development, including the characteristics of effective professional development. The third section explores the characteristics of effective professional learning communities. The fourth section examines empirical studies about the six learning principles from NCTM the participating teachers learned about during the professional development sessions.

**Theoretical Framework**

While there are many learning theories in education, there are two prominent theories of learning that were explored for the theoretical framework for this research. These theories are behaviorist learning theory and constructivist learning theory. Behaviorist learning theory uses the underlying assumption that learning is observable and measureable (Bush, 2006). In addition, behaviorists view learning as a stimulus-response scenario where all students have the same understanding at the conclusion of a lesson (Bush, 2006). Instruction in mathematics based on behaviorist learning theory involves the teacher providing direct instruction while students listen. The teacher is responsible for the construction of steps and procedures students will need to complete practice problems. This method of instruction requires students to work problems through rote reproduction of isolated and independent facts (Kohn, 1999).

The other prominent theory about learning is constructivist learning theory. There are two main types of constructivist theory that inform teachers how students make meaning, cognitive constructivism and socioconstructivism (Powell & Kalina, 2009). Constructivism has its roots in the work of developmental psychologists Jean Piaget and Lev Vygotsky. Both Piaget and Vygotsky viewed the role of the teacher as a guide, supporting the idea that guided forms of teaching help students construct their own understanding of the material being taught. They felt constructivism should be the foundation in every class, every teaching situation, and every activity in order for actual learning to occur (Powell & Kalina, 2009). A third kind of constructivism that may show itself in the classroom is radical constructivism von Glasersfeld, 1995). Socioconstructivism fits the epistemological stance of this research the best due to the collective learning that occurred during the professional development sessions.

**Socioconstructivist Theory.** Socioconstructivist theory is grounded in the work of Russian psychologist Lev Vygotsky. The premise of Vygotsky's research is that social interaction is the basis of all learning. He argued knowledge is constructed through dialogue and interaction with others (Vygotsky, 1930/1978). Vygotsky viewed language development as first social, then egocentric (Vygotsky, 1934/1986). The individual develops an understanding of language through others before eventually internalizing the language into an internal speech, which is thought. According to Vygotsky (1934/1986), learning occurs then social and collaborative understandings are transformed into an inner understanding or belief by the learner. In this research, I hoped that the teacher professional dialogue would transform into inner speech, eventually resulting in teacher belief and practice change.

The guiding research question is how learning about NCTM's *Principles to Action* (2014) may shift teacher professional dialogue within an Algebra 1 PLC. The participating teachers

build their understanding of student learning of mathematics through dialogue with their peers during professional development supported by the research-based principles of student learning found in NCTM's *Principles to Action* (2014). Participating teachers also engage in self-reflection through written journals exploring their internal private speech as develop into thoughts (Vygotsky, 1930/1975). Social learning precedes development, and in the case of this research, participating teachers professional dialogue is constructed socially and would precede teaching development within the classroom (Vygotsky, 1930/1978). In order for a change in instructional practice to occur, teachers may first need to rethink how they teach (Horn, Garner, Kane, & Brasel, 2017). In this research, the first step to changing instructional practice is a collaborative reframing of professional dialogue as teachers discuss instructional practices using collective interpretation (Bannister, 2015; Horn et al, 2017). Teacher professional dialogue can support instructional improvement (Horn et al., 2017). There is an assumption that when learning occurs in a PLC knowledge is co-constructed and shared by the participants (Kelly, 2006). The PLC context is crucial to the development of professional dialogue as it is derived from social theory where people learn by "seeing, discussing, and engaging in shared practices and understanding (Levine, 2010, p. 111). The co-constructed learning constructed within the PLC was highly contextualized and idiosyncratic to the Algebra 1 PLC at Golden High School (Richardson, 1997). The formal knowledge they constructed together may not have the same meaning in a different school or even a different PLC. What is important is when they engaged in professional dialogue together they had shared understanding of student learning that may enhance their communication and teaching. An important component of socioconstructivist theory in this research was the zone of proximal development.

***Zone of Proximal Development.*** The professional development sessions within the PLC leveraged the socioconstructivist zone of proximal development (ZPD). Vygotsky (1930/1978) originally defined ZPD as "the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined though problem solving under adult guidance, or in collaboration with more capable peers" (p. 86). This research uses ZPD in teacher peer-to-peer interactions. Participating teachers may have differing levels of expertise and understanding of how students learn mathematics prior to engaging in the professional development. The discussions facilitate the participating teachers constructing a shared understanding within their PLC, constituting a collective ZPD (Horn & Kane, 2015). ZPD relies on the premise of a more knowledgeable other (MKO) to act as the more competent peer. In this research study, at any given time, the MKO could be me as the facilitator of the professional development or could be one or more of the participating teachers based on their knowledge or experience with the topic. Within the ZPD, the MKO helps group members develop deeper thought and understanding through guided learning than they would have working alone (Vygotsky, 1930/1978). Adults' prior experiences provides a rich reservoir of resources for learning (Merriam, Caffarella, & Baumgartner, 2007). The PLC concept supports workgroups of teachers where there is likely a MKO to assist other teachers in the group

This research study examined how learning about the NCTM's *Principles to Action* (2014) shifted teacher professional dialogue within an Algebra 1 professional learning community as they engaged in research-based professional development. In other words, how were the words, and therefore thoughts, of the teachers affected through interaction with other teachers? The social interaction within the professional development required the use of a Socioconstructivist theory to guide the current research study. Dewey (1916/2012) suggested

that "the use of language to convey and acquire ideas is an extension and refinement of the principle that things gain meaning by being used in a shared experience or joint action" (p. 20). Dewey went on to say when words are not a part of a shared situation, those words do not have meaning or intellectual value. Studying teachers' words gave me insight to their development of knowledge regarding students' mathematical learning.

## Review of Literature

As previously discussed, mathematics teaching has been grounded in more traditional theories of education such as behaviorism. These theories ignore scientifically conducted research by national professional organizations that demonstrate traditional methods of instruction as ineffective for student learning (Battista, 1999; NCTM, 2014). Despite the research indicating ineffectiveness, the behaviorist based teaching practices are still prevalent in the modern classroom, with evidence suggesting "classroom practice has changed little in the past 100 years" (Stigler, 2004, p. 12). Traditional instruction in mathematics involves the teacher providing direct instruction while students listen. The teacher is responsible for the providing steps and procedures students will need to complete the practice problems. This traditional method of instruction has students working problems through rote reproduction of isolated and independent facts (Kohn, 1999; Au, 2007/2013). A traditional teaching method of instruction may actually stunt mathematical growth due to mathematical thought not being personally constructed by the student (Kohn, 1999). Students memorize procedures and formulas without understanding what they really represent (Clements & Battista, 1999). In mathematics education, the NCTM (2014) principles support ambitious teaching by emphasizing both conceptual understanding and procedural fluency, using multiple representations, making mathematical arguments to communicate mathematical ideas effectively, and developing

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productive dispositions towards mathematics (Gibbons & Cobb, 2017). In contrast to behaviorist practices, ambitious teaching aims to equitably get all students to acquire, understand, and use knowledge to solve authentic problems (Lampert & Graziani, 2009). As introduced in chapter 1, a great deal of research has been dedicated to improving mathematics instruction and achievement, and yet student achievement remains flat or drops from year to year. Could one of the reasons the United States has not seen an improvement in mathematics achievement be teachers are not receiving the research being produced? This could be due to a variety of reasons from not realizing the research is available to not having time to add reading research into an already packed teaching schedule. This research study can provide an opportunity for Algebra 1 teachers to engage with research on mathematics education within their daily work schedule through professional development within the PLC.

Much of the professional development provided to mathematics teachers is ineffective (Gulamhussein, 2013); supporting the idea of limited use of or access to research on mathematics education. Most professional development is given in a one day workshop style, which does not lead to a long lasting effect on teacher practices or on student learning (Wei, Darling-Hammond, Andree, Richardson, & Orphanos, 2009). This workshop style professional development is built on the faulty premise that the only reason teachers do not change current practices and use a particular lesson or teaching method is because they aren't aware of its existence (Gulamhussein, 2013). In reality, for professional development to be effective, teachers need many hours of coaching, practice, and instruction to avoid an implementation dip and bringing the new skill into the classroom (Wei et al., 2009; Fullan, 2002).

**Professional Development**

According to the status report of teacher development by Wei, Darling-Hammond, Andree, Richardson, and Orphanos (2009), 92% of all teachers who responded to a survey during the 2003-2004 school year participated in professional development. However, of the 91.5% of teachers participating in was workshops, conferences, or training sessions, where 57% of the teachers received less than a total 16 hours of professional development over that same time frame (Wei et al., 2009). Professional development is often implemented to create a change in teachers' practices, beliefs, or understanding of their craft (Guskey, 2002). Most often professional development is purposefully designed to help teachers improve student learning (Loucks-Horsley, Stiles, Mundry, Love, & Hewson, 2010). Guskey (2002) suggested in order to make a significant change in teachers beliefs or attitudes there must be evidence of success within their classrooms. In other words, teachers believe that the professional development worked because they saw it work for themselves. Seeing a change in the classroom and in student achievement results leads to a change in teacher beliefs and practices (Guskey, 2002). This research focuses on the professional development and shift in professional dialogue that would precede changes in classroom practices in this model of teacher change because learning precedes development (see Figure 1) (Vygotsky, 1930/1978).
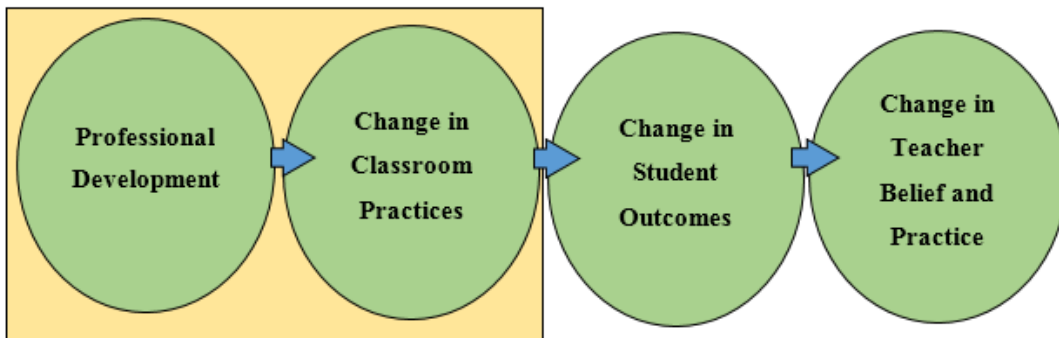


Figure 1. A Model of Teacher Change (Guskey, 2002)

Schmoker (2004) emphasized the best way to improve instructional practices was to have teachers collaboratively examine and adjust teaching practice within the context of a PLC. Huffman, Thomas, and Lawrenz (2003) found that only 17% of mathematics teachers in their study were engaged in continuing collaborative work that involved teacher learning or some kind of professional development within a PLC where teachers can learn from one another; that learning can equate to improvement in student achievement (Schmoker, 2004). Joining professional development and professional learning communities together Dufour, Dufour, and Eaker (2008) described characteristics of what they consider the best professional development design to support teacher learning which includes, but is not limited to, (a) job-embedded; (b) ongoing; (c) learning collectively; and (d) sustained, focused initiatives.

Professional development that is meaningful to teachers promotes their growth and learning, and in turn their students' growth and learning (Darling-Hammond & Richardson, 2009). Making ongoing professional development a routine part of the work of teachers is essential as it becomes a part of the day to day professional culture of the school and its teachers. In this way, teachers are able to experience the direct link between the professional development and their classrooms (Darling-Hammond & Richardson, 2009; Dufour, Dufour, & Eaker, 2008; Loucks-Horsley et al., 2010). This link with the classroom makes the professional development more meaningful to the teachers, since the support is ongoing and job-embedded, thus more viable in promoting student growth.

In addition to the characteristics of professional development design, Desimone (2011) suggested core characteristics of professional development that lead to teacher learning which include the following characteristics, (a) content focused, (b) include active learning, (c) have coherence, (d) have a duration of contact time, and (e) have collective participation. Duration of

contact is one characteristic that has been typically absent in the workshop style, conference, or training types of professional development (Wei et al., 2009). Desimone (2011) recommended that teachers should work as a group over the course of a semester, with at least 20 hours of contact time. Engaging in professional development during PLC meetings aligns to necessary time commitments and duration for effective professional development that leads to teacher learning (Desimone, 2011).

The collective learning and participation characteristics of effective professional development aligns with the socioconstructivist theoretical framework of this research. Learning occurs through interaction with others in the professional development (Vygotsky, 1930/1978). Participating teachers construct a shared knowledge of student learning through engagement with each other. This shared knowledge is the best way to achieve the goals of the PLC team, the improvement of student learning in this research study (Dufour et al., 2016). Learning collectively also aligns with Wenger's (1998) notion of negotiated meaning and shared repertoire, these notions will be discussed in the next section. As the participating teachers learn collectively about student learning, this research explored how their professional dialogue was affected by these interactions. The purposeful design of the professional development to include the above characteristics allows the participating teachers the opportunity to "develop a shared language for talking about practice" (Gibbons & Knapp, 2015, p. 18) as they take on new learning about their teaching practice. As discussed previously language precedes development, the teachers engage in professional dialogue as part developing a new understanding of their teaching practice (Vygotsky, 1930/1978).

**Professional Learning Communities**

Vygotsky (1930/1978) asserted that community was important to the process of construction of meaning. Researchers have established a positive relationship between teacher collegial learning in a PLC and student outcomes (Boaler & Staples, 2008; Darling-Hammond, 2014-2015; Horn, 2005). As such, social interactions promote learning in a PLC by providing a platform for discussions and sharing of ideas (Wenger, 1991, Wenger 2008; Levine, 2010). For these reasons, this research focuses on professional development conducted within the context of a PLC.

Professional learning communities are increasingly provided a space in schools because they are associated with higher student achievement (Goddard, Goddard, & Tschannen-Moran, 2007; Reeves, Pun, & Chung, 2017; Ronfeldt, Farmer, McQueen, & Grissom, 2015). Ronfeldt, Farmer, McQueen, and Grissom (2015) found that collaboration had a significant positive effect on students' mathematics and reading scores in all three levels of public schooling, drawing a causal relationship between teacher collaboration and student achievement. Schools with stronger teacher collaboration environments had greater student achievement gains. Ronfeldt et al.'s research did not only focus on specific structures of collaboration such as analyzing student data or curriculum and instruction decision making, but also focused separately on teachers' experiences of collaboration using measures of helpfulness and extensiveness. A limitation to this research is the possibility that the self-reported data from the teachers' experiences may be influenced by subjective factors other than the quality of the collaboration, which may limit the causal relationship between teacher collaboration and student achievement (Ronfeldt et al., 2015).

Dufour (2013) stated the best school systems that are focused on student learning support improved student achievement through the use of professional learning communities. Within the educational setting there are three big ideas that drive the work of PLCs (Dufour et al., 2016). These three big ideas are (a) a focus on learning; (b) a collaborative culture and collective responsibility; and (c) a results orientation. These big ideas are not dissimilar to Wenger's (1998) characteristics discussed above. Of particular importance to this research is the big idea of a focus on learning.

The very essence of a PLC in an educational setting should be a focus on student learning. The most basic purpose of education is to ensure that all students attain a high level of learning (Dufour et al, 2016). This is true not only for the students in school, but should also be true for the teachers. In order to best help students learn, teachers must also be willing to engage in and be supported in their participation in ongoing learning (Dufour & Mattos, 2013; Dufour et al., 2016). In order to best support ongoing teacher learning the learning should be a regular workplace practice that is job embedded (Dufour & Mattos, 2013; Dufour et al., 2016). Ongoing learning can be successfully accomplished through professional development within the context of a professional learning community by providing a space in which ongoing learning is supported as a regular part of the work day.

**Collaboration.** In a research study investigating how teacher collaboration influences teacher job satisfaction and student achievement, Reeves, Pun, and Chung (2017) found mixed results on the effectiveness of collaboration. Reeves et al. (2017) examined five collaborative activities: discussing how to teach particular topics, collaborative planning and preparation of instructional materials, sharing of teaching experiences, collaborative exploration of new ideas, and visiting other teachers' classrooms. Of these, collaborative planning provided a significant

predictor of student achievement. However, Reeves et al. did not define and examine collegial learning as one of the collaboration activities of interest. How collaboration is defined can influence the effect on student achievement, Reeves et al. suggested further research into the individual collaborative activities to better understand how professional development could be designed to provide the greatest benefit. This research study furthered the literature in this area by investigating the collaborative activity of collegial learning and student achievement.

Horn (2005) conducted ethnographic research regarding teachers on the job learning in the mathematics department of two secondary schools. The results indicated the secondary school with the mathematics department that sought to change teachers' teaching of mathematics did so through the use of a rigorous common curriculum, teaching as a collective enterprise, commitment to students' learning, and innovative instructional practices. There was a collaborative effort by the teachers through sharing of practices and learning together that raised student achievement levels to a point where student failure was low. Horn's study found that being part of a community of practice and engaging in the collective work of teaching and curriculum helped these teachers be successful in their ambitious teaching.

**Student centered and research based.** Boaler and Staples (2008) investigated successful ambitious teaching in a longitudinal study of mathematics instruction at three secondary schools. The results of this research indicated that students taught by teachers who based their curriculum on student learning and research attained higher achievement levels and the differences in achievement between ethnic groups was diminished, even eradicated in some cases. While the teachers successful in ambitious teaching in the Horn (2005) and the Boaler and Staples (2008) studies were not officially noted to be members of a PLC in the research, their work could be considered a PLC due to three characteristics that represent a community of practice. Wenger

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(1998) described three characteristics that members of communities of practice engage in as being (a) they are mutually engaged in an activity; (b) they are engaged in a joint enterprise; and (c) they have a shared repertoire (Wenger, 1998).

**Professional Relationships.**  Membership in a PLC is not just social or assigned category. Just as with Vygotsky's MKO, mutual engagement relies on what members of the community do and do not know and how they facilitate the construction of knowledge in others.  Members of the PLC act as MKO's and contribute to the knowledge of each other through the use of ZPD within the established PLC.  If practice is to be shared within the PLC, then the members must be mutually engaged to create the shared understanding.  Having a shared understanding fosters a relationship amongst the members of the PLC that extends beyond social categories and contributes to the collective learning (Wenger, 1998).   As members of a PLC, teachers are afforded opportunities through sharing of information that is unique to their context of practice.

The second characteristic of a PLC is involvement in a joint enterprise that keeps the community cohesive (Wenger, 1998).  A joint enterprise is a condition or dilemma the PLC shares, such as the participating Algebra 1 teachers' concerns regarding student achievement on the EOC.  The responses of these teachers was connected as they engaged to find ways to improve student learning (Wenger, 1998).  There was mutual accountability among the teachers as they negotiated an interdependent learning partnership about student learning (Dufour et al., 2016; Wenger, 2010).  Mutual accountability supported and developed the mutual learning, and thus the practice, of each group member.

**Shared Language.**  The final characteristic of a PLC is a shared repertoire.  A shared repertoire includes many things such as routines and resources used within the PLC.  But what is particularly germane to this research study is the shared words, or professional dialogue.  Within

the PLC there is "discourse by which members create meaningful statements about the world, as well as the styles by which they express their forms of membership and their identities as members" (Wenger, 1998, p. 83). This research study explored the professional dialogue of teachers within a PLC and how it was affected as they engaged in professional development. In other words, what shared repertoire of language are the members of the PLC creating together? This is important to growth because the development of the teacher is supported through the language used as part of their shared repertoire; learning precedes development. The interplay between what the teachers know academically and what the teachers have experienced in the classroom is supported and demonstrated through their shared language (Vygotsky, 1934/1987). This shared language is key to teacher growth by connecting research-based theory with practice to improve students' mathematical learning.

**Professional Dialogue**

Teacher professional dialogue can support instructional improvement (Fullan, 2010; Horn et al., 2017). Professional dialogue was the manifestation of negotiated meaning participating teachers constructed through the professional development (Wenger, 1998). Research indicates when teachers engage in professional dialogue it can positively affect their teaching practices. Horn and Kane (2015) found that participants who are active in professional dialogue are "more accomplished in ambitious teaching [and] tend to have conversations invoking richer conceptualizations of instructional issues and linked to specific future work" (pp. 380-381). Bannister (2015) found changing how high school mathematics teachers discussed struggling students corresponded with a positive change in the instructional practices for those same students. These examples of professional dialogue associated with positive and ambitious

teaching outcomes indicate the importance of teacher professional dialogue and its implications in the classroom.

Research in fields other than mathematics education has indicated the positive relationship between professional dialogue between colleagues and improved teaching outcomes (Deglau, et al., 2006). Research on the influence of professional dialogue between veteran physical education teachers found an increase in professional power and authority (Deglau et al., 2006). After being given the opportunity to engage in professional dialogue with other content specialist physical education teachers empowered the participants to expand their knowledge base and made the best of the space they occupy, gymnasiums in this case (Deglau et al, 2006). This research investigated professional dialogue in an informal social setting specifically for physical education teachers, not a formal professional development as with the current research study. However, a space was created where teachers could collaborate with each other about teaching and professional dialogue grew out of that space.

In Australia, Prestridge (2009) investigated how professional dialogue supported teacher change in their belief in information and communication technologies (ICT) in the classroom. Learning environments of online only interaction, face-to-face only interaction, and a combination of online and face-to-face interactions were explored. Prestridge (2009) reported that the combination online and face-to-face interactions allowed teachers to develop community and engage in critical discussions focused on learning. The face-to-face interactions allowed teachers to develop their community while the online interactions allowed teachers the space to challenge current understandings within the community. This combination of interactions provided the opportunity for a transformative ICT professional development. This research indicated that teachers preferred computer-based interaction when delving into critical

conversations about student learning.  This is different from the current research study, which is challenging teachers to engage in deep conversations about student learning in a face-to-face interaction but still important due to the acknowledgement that engaging in deep conversations about student learning can be difficult.

As stated previously, teacher professional dialogue can support instructional improvement (Fullan, 2010; Horn et al., 2017).  However, not all professional dialogue can lead to improved teaching.  An analysis of middle school mathematics teacher collaboration meetings by Horn, Garner, Kane, and Brasel (2017) found that professional dialogue regarding instructional decisions were made constituted about 35% of the conversations.  The most common discussion Horn et al. (2017) found in these mathematics collaboration meetings pertained to the logistics of teaching, amounting to 40% of the professional dialogue.  To have a greater impact, professional dialogue needs to move beyond typical sharing of activities and student anecdotes and engage teachers with instructional practices and learning goals (Nelson, Deuel, Slavit, & Kennedy, 2010).  Facilitation and modeling is key to supporting collaborative construction of professional dialogue.  Situating the professional development within the structure of a PLC allows the facilitator to "shape conversations that encourage teachers to develop a shared conception or vision" (Gibbons & Knapp, 2015, p. 18).  It is instrumental to teacher professional growth that teachers are encouraged to talk in ways that foster a development of shared understanding of teaching leading to deeper, more meaningful professional dialogues (Lampert et al., 2013).

Part of the development of shared understanding through professional dialogue is that teachers may better connect the "why" of teaching to the "how" of teaching (Routman, 2002).  Classroom artifacts are a key component of linking theory and practice via professional dialogue

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that demonstrates growth (Gibbons & Knapp, 2015). Teachers discussing student artifacts helps make the elements of their practice in the classroom concrete. The connection between professional development and the classroom is also further strengthened by the professional dialogues fostered by student artifacts. Discussing student artifacts directly links the discussion to what happens in the classroom (Darling-Hammond & Richardson, 2009; Dufour, Dufour, & Eaker, 2008; Loucks-Horsley et al., 2010).

Professional dialogue centered around the topic of student learning and teaching encourages teachers to try new or counterintuitive practices as well as support them when they do (Gibbons & Knapp, 2015). Professional dialogue within a PLC gives teachers a safe place to try out not only new instructional practices, but maybe also new paradigms, without fear of judgment or mistakes. The Algebra 1 PLC was challenged to engage in professional dialogues differently, focusing dialogue more on student learning and less on activities than previously. Members of the PLC encouraged each other to try new practices based on research about students' mathematical learning in the classroom. PLC members then discussed the outcomes of the practice and supported adjustment and refinement of the practice in an iterative, socioconstructivist process of learning. In addition, professional dialogue about professional learning allowed teachers to operationalize what was learned through replays and rehearsals (Horn, 2005). The professional dialogue was the important link between the learning in the professional development and what happened in the classroom (Horn, 2005; Darling-Hammond, 2009).

Finally, professional dialogue can serve as a catalyst to practice change in the classroom (Horn, 2005; Penlington, 2008). In order to create change in the classroom, Penlington (2008) suggested the kind of professional dialogue between teachers is key. Professional dialogue must

encourage teachers to examine their assumptions upon which their practice is based, and what effect those assumptions have on their students.  A focus on effective outcomes, the "why" instead of the "how", is an important catalyst to change (Penlington, 2008).  Instructional leaders, or MKO's, promote and contribute to the professional dialogue between teachers (Gibbons & Knapp, 2015).  The professional dialogue may extend beyond the Algebra 1 PLC and into conversations with teachers in different PLCs, departments, and school leaders, provoking further change.  Eventually, a school-wide professional dialogue about instructional practices and student learning may support a school-wide PLC, collectively supporting student achievement in all content areas.  Professional dialogue fosters a professional collaborative relationship between teachers, removing the isolation teachers have traditionally experienced while working alone in their classrooms (Horn et al., 2017; Routman, 2002; Simoncini, Lasen, & Rocco, 2014).  The aim of this research study is to explore how learning about the NCTM's *Principles to Action* (2014) may shift teacher professional dialogue within an Algebra 1 professional learning community.  It is important to understand why the NCTM (2014) teaching principles are a focus of the professional development sessions.

**NCTM Principles**

After three consecutive testing cycles of falling scores, the results of the PISA assessment warrants examination of a possible disconnect between how mathematics is taught in the classroom and what research shows about how students learn mathematics (White-Clark, DiCarlo, & Gilchriest, 2008; Ball & Forzani, 2011).  In addition, student learning "depends fundamentally on what happens inside the classroom as teachers and learners interact over the curriculum" (Ball & Forzani, 2011, p. 17).  Bridging the possible disconnect between

achievement scores and what happens inside the classroom are the teaching principles recommended by NCTM (2014).

In its publication *Principles to Action* (2014), NCTM outlined six ambitious teaching practices for strengthening mathematics instruction that include active meaning making and learning using challenging tasks, connect new learning with prior learning, develop conceptual and procedural knowledge, socially construct knowledge, give effective feedback, and develop students' metacognitive awareness. The NCTM (2014) teaching practices incorporate principles of learning that give students a strong foundation for learning mathematics, which may improve student achievement. Though there is no constructivist pedagogy based on constructivist learning theory, learning these teaching principles may help develop the relationship between teachers' values and beliefs about student learning and how that relates to what the teachers do in the classroom (Richardson, 2003). These research-based principles are the "why" teachers make the pedagogical choices of "how" they promote student learning in the mathematics classroom.

**Challenging Tasks.** Teachers using ambitious teaching practices provide challenging tasks to students that affords opportunities for active meaning making (NCTM, 2014). These tasks should promote opportunities for high-level thinking by engaging in mathematical reasoning and problem solving. In order to be challenging, these tasks should require high cognitive demand of the students that builds on and extends the students' current mathematical understanding. As opposed to lower level cognitive tasks that require students to use algorithms, procedures, or formulas with no connection to mathematical concepts, higher-level cognitive tasks require the students to use different mathematical representations, active inquiry, tools, and a variety of strategies to solve the tasks (NCTM, 2014). In these learning scenarios, students take an active role in learning; they are not passive receptors of information (Marlowe & Page,

2005).  This promotes the socioconstructivist learning theory over the behaviorist learning theory.  As part of the socioconstructivist theory, challenging tasks provide the opportunity to employ ZPD to support students' learning.

**Prior knowledge.**  Teachers using ambitious teaching principles connect students' prior knowledge with new learning (NCTM, 2014).  Activating prior knowledge alerts students where the new concepts fit into their current schema.  In addition to helping students know how to organize their learning, an understanding of prior knowledge helps teachers adjust lessons, if necessary, to meet the strengths and needs of the learners in the classroom.

**Conceptual and procedural knowledge.**  Teachers using NCTM's (2014) ambitious teaching principles provide opportunities for students to build conceptual knowledge as well as procedural knowledge. According to Schoenfeld (2004/2008), "the mark of powerful learning is the ability to solve problems in new contexts or to solve problems that differ from the ones one has been trained to solve" (p. 146).  NCTM (2014) advocates for the conceptual understanding as well as the procedural understanding.  Students with conceptual understanding are able to apply mathematics flexibly.  When mathematical concepts and procedures are linked together students are better able to remember the procedures and use them in novel situations because they have become part of their schema (Fuson, Kalchman, & Bransford, 2005), as opposed to the Skinnerian (1971/2002) belief that students were not responsible for mental processes in the classroom.  Skinner believed in breaking down learning into the smallest steps, however these steps only provide the student with procedural knowledge.  Students having only procedural knowledge may have no understanding of why they are using the steps to solve mathematics problems.

**Build knowledge socially.** Teachers using ambitious teaching principles described by NCTM (2014) provide opportunities for students to build knowledge socially, supporting a socioconstructivist epistemology. Teachers act as mentors as students learn new concepts, guiding and instructing students until independence is reached (Vygotsky, 1930/1978). However, educators should not only focus on what students can complete on their own, but what they can produce in groups. Peers can also act as mentors, or as the MKO within a ZPD. Grouping students is one way to create a ZPD for students. They can watch others in the group to learn how to complete a task before beginning completion of the task on their own. Another way teachers can target students' ZPD by scaffolding instruction and implementing social supports and collaboration in groups that aids students' cognitive growth. The social support within the ZPD can lead the students to internalize the learning process which leads to deeper understanding because learning precedes development (Powell & Kalina, 2009; Vygotsky, 1930/1978). In other words, when learned mathematics is internalized it becomes knowledge rather than something produced or replicated. Vygotsky believed this internalization process is more effective when students collaboratively learn together through social interaction (Powell & Kalina, 2009).

**Feedback.** Teachers using ambitious teaching principles provide students with feedback that is timely and descriptive (NCTM 2014). As students construct their understanding, content errors can occur. It is important that these errors in understanding are caught early before the student incorrectly internalizes the learning and constructs faulty understandings. In order to be received by the student, feedback needs to be in the form that directs the student to their next action otherwise it is likely to be ignored (Hattie, Fisher, & Fray, 2016).

**Metacognition.** Teachers using ambitious teaching principles develop students' metacognition (NCTM, 2014). A survey of literature revealed multiple definitions for the term metacognition. Essentially, metacognition means to think about thinking. In terms of this research, metacognition refers to self-regulation skills such as planning, the organizing of thoughts and experiences, capacities and limitations, and the monitoring of progress (Schunk 2008; Labuhn, Zimmerman, & Hasselhorn, 2010). Research has shown that metacognition is positively linked with academic achievement (Labuhn, Zimmerman, & Hasselhorn, 2010; Veenman, Wilhelm, Beishuizen, 2004). This link with academic achievement is what makes metacognition important for mathematics teachers to ensure students have the opportunity to learn how to think about how they think. Students' ability to be metacognitively aware of their learning aids in the construction of understanding of new knowledge and can support students' application of knowledge in novel situations.

**Summary**

In this literature review, I demonstrate that socioconstructivist learning and teaching theory is foundational to this research study. Socioconstructivist learning theory is evident in PLCs that promote collaboration between teachers, professional development within PLCs creates provides effective learning opportunities for teachers, and professional dialogue that is collectively created by members of the PLC. PLC's, professional development, and professional dialogue are all grounded in socioconstructivist theory and may constitute best practices for teaching and learning mathematics.

# CHAPTER 3:  METHODOLOGY

The participating Algebra 1 teachers from Golden High School were concerned about student learning after two consecutive years of reduced EOC scores, each lower than the previous year's scores.  In addition to the scores dropping for two consecutive years, the students at Golden High School were scoring lower than their peers in the county where the school is located, Arapahoe County.  The students at Golden High School also had EOC scores below their Algebra 1 peers in the state.

The purpose of this case study was to explore how learning about the NCTM's *Principles to Action* (2014) shifted teacher professional dialogue within an Algebra 1 professional learning community.  The units of analysis in the case study were four general education Algebra 1 teachers in an existing PLC from Golden High School.  The research question for this study was: How does learning about the NCTM's *Principles to Action* (2014) shift teacher professional dialogue within an Algebra 1 professional learning community?  To answer this question data was collected from multiple sources including group discussions before and during the professional development cycle.  Other data collected included teacher reflection journals with writing prompts written both before the professional learning through its entirety.  Teacher lesson plans, de-identified student artifacts, and my researcher field notes were also collected.

## Research Design

The best way to respond to a research question that asks why or how a contemporary phenomenon occurs within a real world context is through case study (Yin, 2014). This qualitative research design was chosen because the purpose of this research was to explore a real world condition.  The qualitative analysis afforded by case study allows me as the researcher to

consider all variables encountered, anticipated or not, to form a complete picture of how the teacher's professional dialogue shifts as they learn about NCTM's (2014) *Principles to Action*.

A qualitative single case study design was employed because the four Algebra 1 teachers experienced the professional development on student learning together within the bounds of their PLC. Yin (2003) described five rationales for single case study research design, one of which is the unique case. Given that I explored how the Algebra 1 teachers' professional dialogue shifted as they learn about NCTM's (2014) *Principles to Action*, this research is unique because it is the first time this group of teachers has experienced purposeful job-embedded professional development about research-informed student learning principles.

The use of single case study in this research aligned with this my socioconstructivist epistemology (Stakes, 1995; Yin, 2014). This case was co-constructed and interpreted through interaction between the participants and myself. The participants presented their responses to journal writing prompts and discussions with their PLC members through their individual lens of themselves as educators. As researcher, I interpreted these responses through their own lens and records the data in case reports. Each person who reads or interacts with the case does so through their individual lens, coming away with a different understanding and view of the case. This creates multiple epistemological realities as each individual creates an understanding based upon his or her personal perspective (Stake, 1995; Yin, 2014).

**Real World Context.** The hallmark of case study is that the research takes place in a real world context (Yin, 2014). The real world context of this research was a suburban high school located in a major metropolitan area in Georgia, in the southeast of the United States. Golden High School enrolls 1,761 students in grades ninth through twelfth. Of the 1,761 students 43% are categorized as white, 30.2% as African American or Black, 15.3% as Hispanic/Latino/a, and

7.3% as Asian. The school participates in the federal free or reduced lunch program with 40.5% of the student body enrolled. There are 101 full time teachers including special education teachers employed at the school along with the principal, six assistant principals, four counselors, 2 media specialists, and a half time social worker. In a 2015 report the U.S. Census Bureau (www.census.gov) reported the demographics of the city in which this school is located. The city had a total population of 59,579. The report included the race and Hispanic origin report dated April 2010 which characterized the population breakdown as 42.8% categorized as white, 30.7% as African American or Black, and 20.6% as Hispanic. The school's demographics are a microcosm of the city in which the school is located.

**Professional Learning Communities.** The PLC at Golden High School was an important part of the real world context where the research occurred. The professional development sessions occurred within the boundaries of the PLC. The practice of the PLC is due to the relationships and negotiated meanings constructed by the members of the PLC such as when they mutually engage in the professional development about student learning (Wenger, 1998). The participating teachers were members of the Algebra 1 PLC, as assigned by administration at the school. The PLC meets some of the characteristics of PLC discussed in chapter 2, (a) mutually engaged in an activity; (b) are engaged in a joint enterprise; and (c) have a shared repertoire (Wenger, 1998).

Through the professional development series, the Algebra 1 teachers developed a shared repertoire about student learning of mathematics. The Algebra 1 teachers engaged in a negotiation of meaning within their PLC (Wenger, 1998). The process of negotiating meaning is twofold, through participation and reification of learning materials such as student artifacts. Participation in the negotiation of meaning involves participating in the professional

development by engaging in conversations during professional development sessions, personal reflections via written journals, and other activities (Wenger, 2010). Additionally, teachers gave physical and/or conceptual form to their experiences through reification (Wenger, 2010). In the case of this research, the Algebra 1 teachers produced lesson plans, brought student artifacts to discuss, and any other resources they deemed necessary to support their learning (Wenger, 2010). Both participation and reification are important to the negotiation of meaning. They are complimentary and one is incomplete without the other (Wenger, 1998; Wenger 2010). The professional development in this research promoted meaningful learning by using the characteristics of PLCs as defined by Wenger (1998) to promote mutual engagement, joint enterprise, and a shared repertoire to help teachers create shared meaning. Additionally, Dufour et al.'s (2016) three big ideas of a focus on learning, a collaborative culture and responsibility, and results orientation, were also used to promote meaningful learning.

**Professional Development.** Another part of the real world context for this research study was the professional development series. In this research, the professional development sessions were part of the regular previously established twice weekly PLC meetings, making them job-embedded and ongoing (Dufour, Dufour, & Eaker, 2008; Darling-Hammond, 2009) . Throughout the sessions, teachers were expected to bring student artifacts to the PLC to reify concepts learned in the professional development. Discussion about the student artifacts linked the professional development to the participating teachers' classroom context, thus making it relevant to the work of teachers. In addition to being relevant and job-embedded, this professional development focused on the single initiative of improving student learning (Dufour et al., 2016). Focusing the professional development on student learning gave the teachers a goal to focus the refinement of their practices towards (Gibbons & Knapp, 2015).

As the researcher, I developed the professional development sessions for the participating teachers. While developing the sessions I kept in mind the socioconstructivist epistemology of this research, characteristics of effective professional development, and aspects of adult learning theory. Before adult learners engage in the learning process, they need to know not only what will be learned, but also why they need to learn it (Knowles, Holton, & Swanson, 2014). To help the participants understand why they should engage with the professional development I explained the purpose of the professional development. It was important the participants understood the purpose was to increase student achievement via learning more about how students best learn mathematics. Stewart (2014) suggested a cycle for continuous improvement that acted as a guide for me, the researcher, during the development of the professional development (see Figure 2).
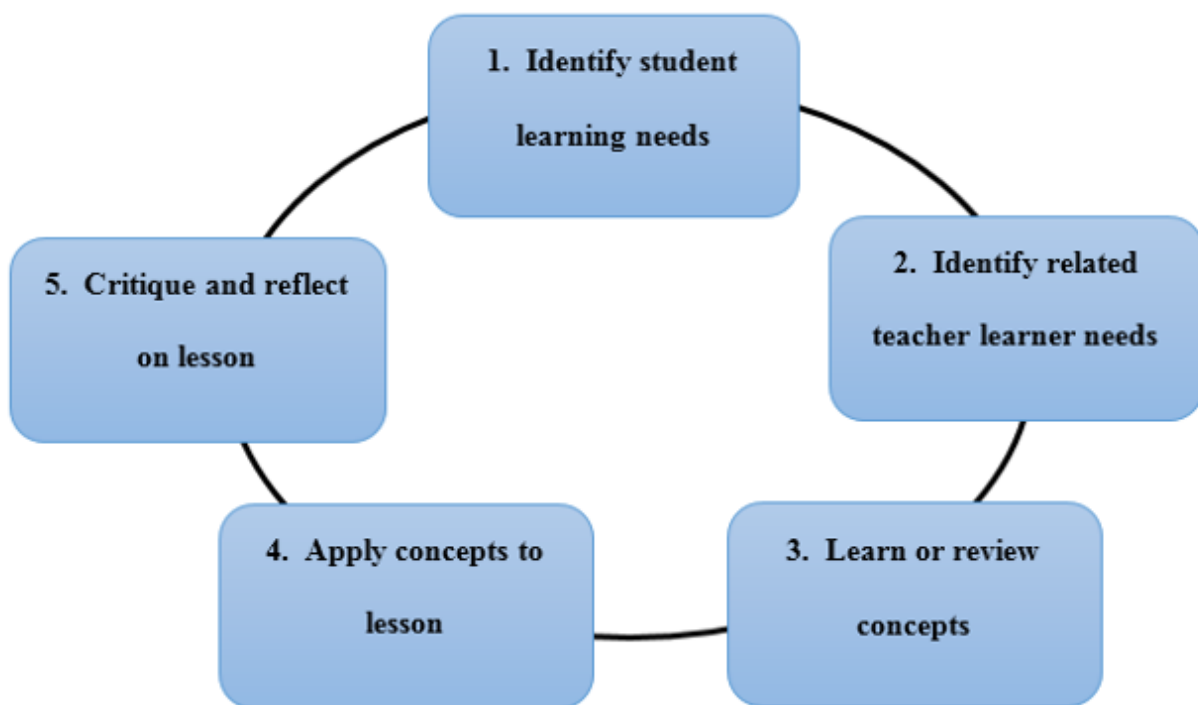


Figure 2. Processional Development Cycle for Continuous Improvement (Stewart, 2014, P. 29)

The adult learners' prior experiences help to shape future experiences by either enhancing or inhibiting new learning (Knowles, Holton, & Swanson, 2014). In order for a change in current knowledge structure to occur, learning needs to be built around experiences that value the prior experiences of the adult learner. Each participating teacher was provided a copy of NCTM's *Principles to Action* (2014) from which reading assignments were completed prior to professional development sessions. Additional research articles supporting the NCTM learning principles were also provided to teachers. Reading assignments and article selection were dependent upon the participating teachers' current understanding of student learning as determined from observing group discussions during professional development sessions and reading responses of the teacher reflection journals.

The participating teachers at Golden High School engaged in professional development about how students best learn mathematics. As noted in the literature review, there are characteristics of professional development that can improve the learning outcomes of participants. These characteristics include (a) job-embedded; (b) ongoing; (c) learning collectively; and (d) sustained, focused initiatives was used to design and implement the professional development for this research.

The professional development sessions were administered as part of the Algebra 1 regularly scheduled twice weekly PLC meetings. The participating teachers engaged in five professional development sessions facilitated by me, the researcher. The purpose of these sessions was to familiarize the participants with each of the six NCTM (2014) principles of learning that support student learning of mathematics discussed in chapter 2. During these sessions participants were exposed to relevant literature regarding the learning principles, discussed student artifacts and lesson plan strategies that supported these principles, and engaged

in group discussions about the principles.  The participants collectively constructed the meaning of student learning and what it looks like in Algebra 1 at Golden High School.  See Table 1 for the weekly professional development and data collection schedule.

Table 1

*Professional Development and Data Collection Schedule*

| Weeks 1 – 2<br>Before Professional Development | Weeks 3 – 6<br>During Professional Development |
| --- | --- |
| Teacher Reflection Journal<br><br>• Writing prompts about current understanding of student learning<br><br>Group Discussion<br><br>• Using current PLC format before professional development begins | Professional Development Sessions<br><br>• Weekly topics six NCTM learning principles<br><br>Teacher Reflection Journals<br><br>• Writing Prompts given weekly after PLC meeting were either about the current learning principle or directed by me to better understand a participants point of view.<br><br>Group Discussions<br><br>• De-identified student artifacts supporting the learning principles<br>• Lesson Plans<br>• Student learning principles |

The Algebra 1 PLC at Golden High School had a total of seven members.  The four participating teachers and three special education teachers.  All of the general education members of the PLC elected to participate in this research study.  During the data collection period the PLC meetings took place on Tuesdays and Thursdays in Diana's room, as they had since the beginning of the spring 2018 semester.  There is an expectation from the administration of the school that when teachers are engaged in PLC meetings they sit in close proximity to each

other. With this in mind, the teachers chose their seats close to the leader of the group, Diana, with their laptops open and ready to use. There was collegiality amongst all the teachers with lively banter between the teachers prior to the beginning and after the conclusion of each of the meetings. PLC meetings were held during the first 30 minutes of the common planning period. This is primarily due to additional time constraints on the teachers during their planning period. Time constraints were not only the two required PLC meetings per week, the mathematics teachers at Golden High School were also required to complete 30 minutes of lunch duty every day during their planning period. This reduced the remaining amount of planning time in which teachers would plan, grade, contact parents, and eat lunch.

    **Participants.** Algebra 1 teachers were purposefully selected for this research due, as previously discussed in chapter 1, to its gatekeeper course status for high school students (Douglas & Attewell, 2017; Herlihy, 2007; Neild, Stoner-Eby & Furstenberg, 2008). Algebra is important for students to learn due to its foundational role in mathematics (Knuth, Stephens, Blanton, & Gardiner, 2016). The demographics for the participants follows in Table 2 below. All participants, except for myself, were given pseudonyms.

Table 2

*Participants' Demographic Information*

| Name | Ethnicity | Gender | Age | Teaching Experience (in years) | Algebra 1 Teaching Experience (in years) | Highest Degree Earned |
|------|-----------|--------|-----|-------------------------------|------------------------------------------|----------------------|
| Anna | White | Female | 33 | 8 | 8 | M. Ed. |
| Diana | White | Female | 31 | 10 | 10 | Ed. D. |
| James | White | Male | 35 | 3 | 3 | B.A. |
| Sara | White | Female | 50 | 2.5 | 2.5 | M. Ed. |
| Jennifer | White | Female | 48 | 11 | 11 | Ed.S. |

I have been a co-worker to the four participating Algebra 1 teachers multiple years at Golden High School.  In this research I was considered a participant-observer in the study as the facilitator of the professional development.  While Golden High School enrolls ninth through twelfth grade students, only the teachers of Algebra 1 students, who are ninth graders, were selected to participate.  I was a mathematics teacher at the school and contributed to the school's continuing education by providing professional development to the Algebra 1 PLC about student learning and mathematics.  In addition, I have been a mathematics teacher at the school for 11 years, and has earned a Specialist in Education degree in curriculum and instruction.

The participating teachers in this research study each taught at least one Algebra 1 class, each with 31-34 students.   Most of the students were randomly assigned to classes, but some were be purposefully placed in classes due to individualized education plan (IEP) requirements for special education.  Two of the classes were be co-taught with both a general education teacher and a special education teacher present in the classroom each day.  Only general education teachers were chosen for this case study research because the focus of a general education teacher is different than that of the special education teacher.  The general education teacher is responsible for the content and pacing of the class.  The special education teacher is responsible for adapting what the general education teacher has planned to meet the specific needs of individual learners.  Since the general education teachers are responsible for content instruction and its delivery to the students they are chosen as participants.  In addition to only general education teachers selected as participants for this research, two of the school's Algebra 1 teachers were not included in the research due to the focus of their Algebra 1 classes.  One of these teachers taught an English as a second language Algebra 1 and the other teacher taught an Algebra 1 as part of the International Spanish Language Academy where 20% of the course was

taught in Spanish.  These teachers were selected as participants in this research because they were not members of the Algebra 1 PLC due to the different focus of their classes.  The Algebra 1 PLC served as the bounds for the case study.

     ***Profile of the Participants***.  Four Algebra 1 teachers participated in this case study.  I assumed the role of participant-observer and was involved in the process of planning, designing, and implementing the professional development for all Algebra 1 teachers.  The four Algebra 1 teachers who participated in this study had worked with me for a minimum of two years prior to the time of the study.  The participants came from varied backgrounds and had a variety of teaching experiences.

     *James*.  James initially went to college right out of high school, but eventually left college to become a professional tile installer.  In his early thirties, James returned to school to complete a Bachelor's degree in mathematics education.  The 2017-2018 school year was James' third year of teaching, his second year of teaching at Golden High School.  He has taught Algebra 1 each of his three years of teaching.

     *Diana.*  Diana attended college right after high school.  She completed a Bachelor's degree in History but decided to take the mathematics certification exam to widen job opportunities.  After five years of mathematics teaching experience Diana returned to college to earn a Master's degree in mathematics education.  Immediately upon graduation with her Master's degree, Diana began a doctoral program in Curriculum and Instruction with a concentration in mathematics education.  Diana completed this doctoral degree and graduated during this research study.  She has taught at Golden High School for eight of her 10 teaching years.  She has taught Algebra 1 each of those ten years.  Diana is an exuberant and vibrant

teacher that develops strong rapport with her students, often sharing her personal interest in movies and video games with her students.  She is the PLC leader for the Algebra 1 teachers.

*Anna*.  Anna attended college immediately following high school to study biomedical engineering for three years before transferring to another school to complete a Bachelor's degree in Modern Language and Culture (Spanish).  After graduating she worked in sales management for several years before returning to school to complete a MAT in mathematics education.  She completed her "student teaching" as part of her first year of teaching on a provisional teaching license.  Anna spent four years at this school before transferring to Golden High School.  She has been at Golden High School for four years.  Anna has taught Algebra 1 each of the eight years of her teaching career.

*Sara*.  Like the previous teacher participants, Sara attended college immediately after high school where she earned a Bachelor's degree in business.  She worked at various financial firms for 11 years as a computer programmer/consultant.  She earned her MAT in mathematics education 8 years after her bachelors.  Sara did not begin teaching until 15 years after the completion of her MAT as she stayed home with her children.  She stepped back into teaching by becoming first a substitute teacher and then a paraprofessional before becoming a full time mathematics teacher.  She is in her third year of teaching, her second year at Golden High School.  She has taught Algebra 1 each semester, on a 4x4 block schedule, each semester except one since she began teaching.

**Data Sources and Collection.**

Multiple sets of data were collected for this research to enable the me to construct as complete of a picture as possible of how the participating teachers' professional dialogue shifts as they learn about NCTM's (2014) *Principles to Action*.  Data was collected from the

participants through recordings of group discussions before beginning and during the professional development sessions, teacher lesson plans, de-identified examples of student artifacts, my field notes, and teacher reflection journals with writing prompts written both before the study and throughout the entirety of the professional development (see Table 3).  As suggested by Yin (2014) and Stake (1995), I triangulated collected data as a way to construct robust descriptions and interpretations of how professional dialogue shifted as teachers learn about NCTM's *Principles to Action* (2014).

Table 3

*Data Collection Matrix*

| Research Question | Data Sources | Time Collected |
|---|---|---|
| How does learning about the NCTM's *Principles to Action* (2014) shift teacher professional dialogue within an Algebra 1 professional learning community? | Group Discussions | April-May 2018 |
| | Teacher Reflection Journals | April-May 2018 |
| | Lesson Plans | February-May 2018 |
| | Student Artifacts | April-May 2018 |

**Group Discussions.** Teacher participants met twice weekly during the regular school day each week on Tuesday and Thursday during their planning in an existing PLC meeting.  The purpose of these meetings was to collaboratively discuss and compare formative and summative assessments results, course pacing, differentiation, and lesson ideas.  The professional development on student learning occurred during the Thursday PLC meeting time because it facilitated the goal of the PLC, improving student learning.  The professional development comprised about 20-30 minutes of each hour long PLC meeting.  I recorded and transcribed each of the PLC meetings, including meetings for two weeks prior to the *Principles to Action* (2014) professional development beginning.  The meetings took place in Diana's classroom, as they had

prior to the beginning of data collection.  I prepared guided questions to begin discussion each week using progressive focusing, given that the purpose of this research was to understand the case (Stake, 1995).  To thoroughly understand the case, questions were modified or changed mid-study if there are issues that arise that may necessitated a change (Stake, 1995).  Progressive focusing was used in the development of the questions for this research.  The question topics were informed from teacher reflection journals, prior group discussions, or other needs that required addressing.

After group discussions from the guiding question were completed I shared research-informed information about student learning in mathematics.  Additional group discussions included considerations of what the research says about student learning and what it meant to individual teachers in their classrooms as they negotiated the meaning of what they were learning (Wenger, 1998).  During this time, the participants and I examined two de-identified student artifacts, chosen by James to support the learning principles being discussed.  These artifacts served as additional prompts to group discussion as to how they supported student learning or could be altered to better support student learning.  If none of the participating teachers brought a student artifact to discuss I provided a short activity that supported one or more of the student learning principles for the participants to see how these principles could be integrated into their classrooms.  During the group discussions prompted by the artifacts or activities I was specifically looking for how professional dialogue was used during these group discussions and how it may have shifted over the course of the professional development period as the participants learned about NCTM's (2014) *Principles to Action*.  Rubrics were used to identify shifts in professional dialogue in the group discussions, teacher reflection journals, and teacher lesson plans.  See appendices B and C for these rubrics.

**Teacher Reflection Journals.** Teacher participants were asked to keep a reflection journal throughout the research period. I have been a co-worker with the participants for multiple years. For this reason, I decided it may be easier for the participating teachers to be more open with their responses to questions if they were part of the written reflections and group discussions instead of during a one-on-one interview.

The participating teachers began to keep the reflection journals with two entries before the professional development commenced. This established a baseline of how the teachers write about their teaching so any changes in written professional dialogue could be identified. After each professional development session, participants were given a writing prompt to guide their reflection. The writing prompt focused the reflection on the learning principle from that week's professional development session. The reflection journals provided additional opportunities for teachers to exhibit professional dialogue as they described their rationale for lesson as well as the strengths and weaknesses of the lesson. In addition to the writing prompts and lesson reflections, participants were encouraged to free journal about what they experienced as they applied some of the concepts learned in the professional development in the classroom. The reflection journals were also a space for the participants to express themselves outside of the sessions and for them to ask me further questions. The teacher participants were aware they would give the journal to me for data analysis. The participants were also be aware and assured that I would not share the content of their reflection journal with another participant, other faculty or staff, or with the school's administration. In addition, pseudonyms were used for all participants except me.

**Lesson Plans.** As part of Golden High School's PLC requirements, lesson plans were placed on a shared drive on the school's computer network, where they were monitored by school administration. Also, per school policy, these lesson plans were shared among all

Algebra 1 teachers in the PLC.  The lesson plans included a daily common curriculum pacing, how students demonstrate learning, and how the individual teachers differentiated for students who understand a concept and for students who didn't understand a concept.  In addition, the daily class work session was included in the lesson plan.  Each teacher added to the lesson plan individually with their own column describing their work session.  The purpose of collecting these lesson plans was to see if participating teachers' planning for learning shifted as they progressed through the professional development cycle.  The lesson plans were also used to prompt discussions about student learning during the *Principles to Action* (2014) professional development.  For example, there were discussions as to why certain classroom practices were implemented versus others and the teacher's rationale for the instructional decision I was looking for the use of professional dialogue during the explanation of lesson plan choices.  In addition, I used the lesson plans to determine if the language used in the professional learning was present in the word choices teachers use in their lesson plans.  See appendix C for an example of lesson plans.

      **Student Artifacts.** James was the only participant to bring de-identified student artifacts to the professional development as examples of how the student learning principles were fostered in his classroom.  Student artifacts were chosen as evidence of teachers' use of student learning principles from the professional development because they provided a discussion prompt for the PLC related to the professional development.  James described the reason activities were chosen and how the activity supported the student learning principles.  The teacher participants were asked also include reflections about the student artifacts in their reflection journal to further develop the evidence of student learning as well as the teachers' understanding of what the artifact represents about student learning.  Concepts from professional development were reified

by grounding the professional dialogue into concrete examples of practice (Gibbons & Knapp, 2015).

**Data Analysis**

Data was triangulated using multiple sources including de-identified student artifacts, group discussions before and during the professional development sessions, lesson plans, and teacher reflection journals. Merriam (1998) stated "without ongoing analysis, the data can be unfocused, repetitious, and overwhelming in the sheer volume of material that needs to be processed" (p. 162). Therefore, as I collected data, I analyzed it to keep the findings focused on the research question and utilize the data to inform the professional development as well as reflection writing prompts. This progressive focusing allowed me to follow up on information from earlier data collection to inform later research actions such as writing prompts or group discussion during the professional development session.

**Data Coding and Theme Generation.** Coding allows a researcher to assign meaning to data to help establish patterns (Saldana, 2016). The coding process is subjective to the person creating the codes, leading to the possibility of multiple realities. Merriam (1998) stated "our analysis and interpretation – our study's findings – will reflect the constructs, concepts, language, models, and theories that structured the study in the first place" (p. 48). Therefore, coding of the collected data fits with my socioconstructivist epistemology. I filtered the collected data through my socioconstructivist lens by assigning codes that I believed best represented the data. The coding process was not a onetime event, but required a cyclic process of revisiting the data until the essence of the data was captured (Saldana, 2016).

Figure 3.  Cyclic Coding Process

Collect and transcribe data as it was collected. Verify transcript accuracy by listening to audio and making corrections and notes as necessary.

Read data once through for overall impression, no coding.

Begin analytic memoing

First Coding Technique: Descriptive Coding

Read the data looking for professional dialogue usage about the student learning principles, repeat for all six student learning principles.

Continue analytic memos.

Second Coding Technique: Magnitude

Reread descriptive coding to assign magnitude of vague or specific use of professional dialogue.

Continue analytic memos

Reread analytic memos, look for and note patterns

Generate themes from the patterns that emerged from the analytic memos.

Repeat as necessary

Compose findings.

I chose to manually code the data instead of computer-assisted qualitative data analysis software (CAQDAS).  Manual coding of data "gives you more control and ownership over the work" (Saldana, 2016, p. 29).  I understood the data better as I physically interacted with it on paper versus a computer screen.  The data was analyzed as it was collected.  This was done to help keep the data organized and identify emerging patterns and themes.  I used two main coding techniques to analyze the data (see Figure 3).  I used the first cycle coding methods of descriptive

coding and magnitude coding (Saldana, 2016). After each PLC meeting, I sent the audio recording of the meeting to a professional for transcription. Once the transcript was returned to me I listened to the audio recording while reading the transcript, making corrections and notes as I went along. Once the transcripts accuracy had been verified, the first step in my coding cycle was to read the transcribed data once through without assigning codes. During this first read through I did begin analytic memoing of overall impressions of the data. Analytic memos are similar to researcher notes. The memos were written as I analyzed the data and were the thoughts and impressions of what I was reading and thinking (Saldana, 2016).

After the initial read through, I used the first coding technique of descriptive coding. Descriptive coding was chosen as my first coding technique because it is appropriate to use in qualitative research and is easy for novice researchers to use (Saldana, 2016). Descriptive coding was used to assign labels to passages in the transcribed group discussions, teacher reflection journals, and the lesson plans. I analyzed each data source looking for one code type at a time. For example, as I read the group discussion transcript I looked only for passages that could be descriptively coded for the student learning principle of challenging tasks. I repeated this process with each of the other student learning principles. Additionally, I added analytic memos during each iterative reading of the collected data.

The second step in the coding cycle was assigning magnitude coding. Magnitude coding is a supplemental, symbolic code that indicates intensity that is added to data that has already been coded (Saldana, 2016). I returned to the data sources that had been coded using descriptive coding and read through the passages again to identify whether the magnitude code of specific or vague would be assigned to the data. In the context of this research study, vague referred to language not consistent with the language of the professional development sessions or only

hinting at a student learning principle without fully developing what the learning principle entails. For example, in her first journal response to the writing prompt that asked how assignments are selected for use in the classroom, Sara responded with "group work" (Journal 1, line 9). This response was coded as a vague reference to the student learning principles. While group work can indicate social construction of knowledge, this is not specifically indicated as the goal for choosing this assignment. A code for specific referred to whether the teacher participant used the same language used in the professional development sessions. For example, James responded to the reflection journal 4 prompt that asked how does the after EOC projects support student learning by writing "These projects also created mathematical discourse between the students in each group. They were able to have great discussions about catapult designs and finding the zeros to create the functions for the catapult." (Journal 4, lines 6-7). James specifically used mathematical discourse and indicated the discourse would be among students in a group.

Once I completed the descriptive and magnitude coding I used rubrics I created to help identify whether there was an indication of any shifting of professional dialogue in the teacher lesson plans, group discussion, and teacher reflection journals. The rubrics for transcribed group sessions, teacher lesson plans, and teacher reflection journals were completed by me as the data was collected. I revisited and reanalyzed the data again at the conclusion of data collection. If there was a discrepancy between the initial rubric rating and the second rubric rating I would reanalyze the data to determine which rubric rating was most accurate. See appendixes B and C for the rubrics.

The next step in the coding cycle was to read the analytic memos created during initial coding. The purpose of reading these memos was to look for patterns that emerged during

coding that may not have been obvious during the coding process. I identified three patterns that emerged through the analytic memos. The patterns that emerged were there was a shifting in the use of professional dialogue associated with the student learning principles, participating teachers stating there was a lack of time for teaching content and using the student learning principles, and participating teachers stating they viewed their teaching as better after the conclusion of standardized testing. The shift in professional dialogue was expected, as it was the focus of this study. The other two patterns that emerged, time and teachers prefer post-EOC teaching, were not expected and had not been coded during initial coding. I modified the codes by creating two additional descriptive code categories for time and teachers prefer post-EOC teaching. I then revisited the data with these codes in mind to add descriptive coding to include the new codes.

To continue focusing the codes into themes, categories were from the assigned codes. Additional revisiting of the coding allowed me to identify concepts from those categories. Specific and vague professional dialogue use categories were generated during the second coding technique, magnitude coding. The time categories were developed after revisiting the data and noting that time was mentioned by the teachers in two prominent ways. Time was repeatedly referenced when teachers discussed altering curriculum to enable teaching of as much content prior to state mandated standardized testing. Additionally, time was repeatedly mentioned as a barrier to including the student learning principles to the everyday classroom. The teachers prefer post-EOC teaching category was generated after I analyzed the coded data that indicated the way the teachers perceived the post-EOC time period made it seem to almost to be a teaching utopia.

With the research question in mind and the codes, categories, and concepts developed from the

data, I generated three themes that emerged from the data (see Table 4). The three themes

identified were professional dialogue shift, curricular pressure, and post-EOC testing.

Table 4

*From Codes to Themes*

| Codes | Categories | Concepts | Themes |
|---|---|---|---|
| Challenging Tasks Feedback Metacognition Best Practices Constructing | Specific and Vague uses of professional dialogue | Teacher use of the language of the professional development | Professional Dialogue Shift |
| Knowledge Socially Conceptual and Procedural Knowledge Activate Prior Learning | Use of specific professional dialogue during every PLC meeting | Teacher specific professional dialogue use inconsistent between PLC meetings | |
| Time | Teacher perception there is a lack of time for teaching content | Teachers feel self-imposed pressure to complete content prior to standardized testing | Curricular Pressure |
| | Teacher perception there is a lack of time for including student learning principles | Teachers feel the only way to incorporate the student learning principles is through projects | |
| Teachers prefer post-EOC teaching | Teacher perception that post-EOC teaching is fun | Teachers feel released from self-imposed pressure to complete content | Post EOC Teaching |

This study generated a large amount of data that needed to be analyzed. Since multiple

sources of data were used in this research triangulation was used as part of the data analysis.

Using triangulation of data helped to "strengthen reliability as well as internal validity" (Merriam, 1998). In addition to triangulation, I provided an opportunity for member checks where teacher participants reviewed pertinent parts of the analysis at the conclusion of data collection. This was done to ensure that I was accurately depicting the role and responses from the participants (Merriam, 1998).

**Validity**

According to Yin (2014) there are four criteria for judging the quality of empirical social research such as case study. They are construct validity, internal validity, external validity, and reliability. Each of these criteria were considered in the design of this case study.

Construct validity is whether the data collected measures what is actually being studied (Yin, 2014). To help ensure construct validity for this research multiple sources of data were collected in different forms. Some of the data, such as the coding of themes from the reflection journal and group discussions, was filtered through me. Other data is generated by the teacher participants such as the reflection journals and lesson plans. I also had the participants review portions of the data analysis draft to ensure accuracy. The purpose of this research is to determine what influence the professional development had on teachers' professional dialogue. If, after the member checks, the teacher participants agree they have been correctly represented in their views and feelings on their practices and I provided a chain of evidence of how the data collected to the research questions, then construct validity was established.

Merriam (1998) defined internal validity as how well the research matches reality. Through multiple sources of data, triangulation, and participant review I examined the constructed interpretation of the data for signs of bias. These steps helped ensure I accurately portrayed the events being researched. External validity is the ability for the research results to

be generalized beyond the study participants (Yin, 2014). A single case study cannot be generalized to a larger population. However, this case study can serve as the basis for new research in another similar setting.

Reliability is how well the study can be repeated with the same results (Yin, 2014). As a socioconstructivist, I wondered: "can the same input always have the same output?" A hallmark of socioconstructivism is multiple realities, because reality is constructed by the individual interacting with the outside world. Merriam (1998) stated that instead of requiring another researcher to get the same results, do outside researchers think the results obtained make sense and are consistent with the data. This definition fits more into my socioconstructivist worldview. To ensure the ability for another researcher to attempt the same research accurate records of the data were kept and presented. This affords outside researchers the ability to inspect the data and determine if the research results make sense.

**Ethical Considerations**

Qualitative research risks ethical dilemmas in the way the data was collected and shared (Merriam, 1998). I acknowledge a longstanding history and future continuing relationship of co-worker status with the teacher participants. In addition, I acted as a participant in the research as the instructor of the professional development. Thus, the relationship among the participants and myself cannot be overlooked. It would be almost impossible for me to not allow previous experience with the teacher participants to influence the research. For this reason, I ensured opportunities for participant generated data such as the reflection journals and participant review of pertinent analysis. This ensured teacher participants were accurately portrayed and I reduced unintended researcher bias.

**Summary**

A qualitative single case study was conducted to address the research question of how professional dialogue within an Algebra 1 PLC is shifted while learning about NCTM's *Principles to Action* (2014). There were five types of data collected as documentation for this research. Data collected came from lesson plans, group discussions before the professional development sessions began and during the professional development, de-identified student artifacts, teacher reflection journals from before intervention through its conclusion, and field notes. Systematic manual coding was used to analyze the data to look for themes. Three themes emerged from the analysis of the data. These themes were professional dialogue shift, curricular pressure, and post-EOC teaching. These research findings will be discussed in the next chapter.

# CHAPTER 4: RESULTS

After iterative analysis of data collected, three main themes became apparent. The themes that emerged from the data were: shifting of professional dialogue, curricular pressure, and better teaching post standardized testing. Each theme emerged through an iterative analysis of the data. The data collected included teacher reflection journals, transcribed group discussions of professional development sessions and PLC meetings, teacher lesson plans, de-identified student artifacts, and researcher field notes. A summary of the overall findings closes this chapter.

This case study examined five Algebra 1 teachers as they participated in professional development about NCTM's learning principles. The purpose of this study was to enhance teacher understanding of student learning via professional dialogue using professional development aligned with the research based principles in the NCTM *Principles to Action* (2014) within an existing professional learning community. This chapter will focus on the findings of the data collected throughout the study. The research question guiding this investigation was: How does learning about the NCTM's *Principles to Action* (2014) shift teacher professional dialogue within an Algebra 1 professional learning community?

**Professional Dialogue Shift**

As previously discussed in Chapter 2, there were characteristics of professional development that makes it more likely to lead to teacher learning incorporated into the professional development in this research (Desimone, 2011). The characteristics of this professional development included being content focused, have active learning opportunities, have coherence, prolonged contact time, and collective participation. These characteristics were used as a framework to support the participating teachers as they were introduced to the student

learning principles through the social construction of knowledge.  During the six week research period there were a total of five professional development sessions over the course of nine PLC meetings.  Over this same period of time the participants were provided five writing prompts to respond to in their reflection journals.  The first two journals were written prior to the beginning of the professional development sessions to help establish a baseline of professional dialogue use.  See Table 5 one the following page for a summary of the PLC meeting schedule as well as the topics discussed at the professional development sessions.

The research question driving this study throughout the above meetings was:  How does learning about the NCTM's *Principles to Action* (2014) shift teacher professional dialogue within an Algebra 1 professional learning community?  The professional dialogue analysis across the research period indicated a shift in language use from participants not discussing student learning principles or vaguely referring to them to an increased specific use of, as well as more frequent use of, professional dialogue about the NCTM student learning principles (see Appendix E).  However, the shift was not consistent across time.  An analysis of the rubrics of the group discussions indicated there was a back and forth across the rubric between using specific NCTM student learning principles professional dialogue during interactions and being vague or not discussing student learning principles at all.  Further analysis of this pattern noted that on PLC days that included the professional development topics the professional dialogue was more specific and frequent about the student learning principles.  However, on days when the PLC did not include a professional development session the professional dialogue about the NCTM student learning regressed to the previously observed levels of not discussed at all or vague references to the student learning principles. The following paragraphs describe the data in chronological order of collection.

Table 5

*PLC Meetings Schedule and Professional Development Topics*

| Week | Tuesday Meeting | Thursday Meeting |
|---|---|---|
| Week 1 | | Pre-Professional Development PLC Meeting 1 and Teacher Reflection Journal 1 |
| Week 2 | Pre-Professional Development PLC Meeting 2 and Teacher Reflection Journal 2 | PLC meeting 3 with Professional Development:  Introduction of the six learning principles from NCTM's *Principles to Action* (2014) |
| Week 3 | PLC Meeting 4: Calendaring and Logistics, Planning for Teaching | PLC meeting 5 with Professional Development:  Metacognition and Feedback Reflection Journal 3 |
| Week 4 | PLC Meeting 6:  Calendaring and Logistics, Planning for Teaching | PLC meeting 7 with Professional Development:  Facilitating Mathematical Discourse, Conceptual and Procedural |
| Week 5 | NO PLC Meeting due to EOC testing Reflection Journal 4 | PLC meeting 8 with Professional Development:  Challenging Tasks, Conceptual and Procedural, and connecting learning principles to the classroom |
| Week 6 | NO PLC Meeting due to AP Testing Reflection Journal 5 | PLC meeting 9 with Professional Development:  Connecting learning principles to the classroom and looking ahead |

Using the professional dialogue rubric ratings from the PLC meetings and the teacher reflection journals, I found an average participant response.  To do this, I assigned a numerical

value for each of the columns in the professional dialogue rubric for group discussion and journal entry (see Appendix C). A score of 0 meant the participant did not discuss the student learning principles during the group discussion or journal entry. A score of 1 indicated the participant discussed the student learning tasks in vague terms, and was not included in most dialogues. A score of 2 indicated the participant inconsistently discussed the student learning principles with specific terminology, but did so infrequently. A score of 3 indicated the participant inconsistently discussed the student learning principles with specific terminology, but did discuss the student learning principles frequently. A score of 4 indicated the participant consistently discussed the student learning principles using specific terminology and the terms were used frequently in dialogue. See Table 6 for a summary of the average responses for each participant during the research period.

A pattern emerged over time that indicated the participating teachers used more specific professional dialogue during PLC meetings with professional development. However, they returned to prior levels of language usage easily during the PLC meetings with no professional development. This back and forth of professional dialogue use reminded me of a dance, more specifically, the electric slide. The participating teachers would take a step towards more specific professional dialogue only to return to their original level of professional dialogue between the professional development sessions. Just like the electric slide, this pattern repeated through PLC meeting six.

Beginning with PLC meeting number seven, there were no longer meetings that did not include the professional development sessions. This time period also coincided with the post EOC time frame. The use of specific professional dialogue maintained a higher average usage level than previously observed during the first six meetings. The teacher reflection journals

indicated an earlier increase in average use of specific professional dialogue, beginning with journal three. Journal three marked the first writing prompt directly related to the NCTM student learning principles, asking the participating teachers how they supported metacognition in their classrooms.

Table 6

*Average Rubric Response per Participant for Group Discussion and Journals*

|  | James | Anna | Diana | Sara |
|---|---|---|---|---|
| Journal 1 | 1.5 | 1 | 2 | 2.17 |
| Pre-PLC Meeting 1 | 1.17 | 1.5 | 1.67 | 1.33 |
| Journal 2 | 1.67 | 1 | 1.67 | 1 |
| Pre-PLC Meeting 2 | 1.67 | 1.17 | 1.67 | 1.33 |
| PLC Meeting 3 with Professional Development | 1.5 | 2 | 2 | 1.17 |
| Journal 3 | 2.33 | 2.3 | 2.33 | 2 |
| PLC Meeting 4 | 1.33 | 1.17 | 1.5 | 1.17 |
| PLC Meeting 5 with Professional Development | 2 | Absent | 2.5 | 2.17 |
| PLC Meeting 6 | 1.33 | 1.5 | 1.5 | 1.6 |
| PLC Meeting 7 with Professional Development | 2.17 | 1.17 | 2.67 | 1.3 |
| Journal 4 | 3.33 | 1.17 | 2.67 | 2.33 |
| PLC Meeting 8 with Professional Development | 3.5 | Absent | 2.67 | 2.83 |
| Journal 5 | 3 | 2.17 | 1.83 | 2.33 |
| PLC Meeting 9 with Professional Development | 3.17 | 3 | 4 | 3.5 |

A graph of these averages shows how the specific use of dialogue shifts back and forth during the research period. The data indicated that, even though the specific usage is inconsistent between meetings, overall each of the participants had more frequent and specific use of professional dialogue about the student learning principles by the conclusion of the data collection period (see Figure 4). The participating teachers' professional dialogue usage was increased in frequency after engaging in the professional development about the NCTM student learning principles.
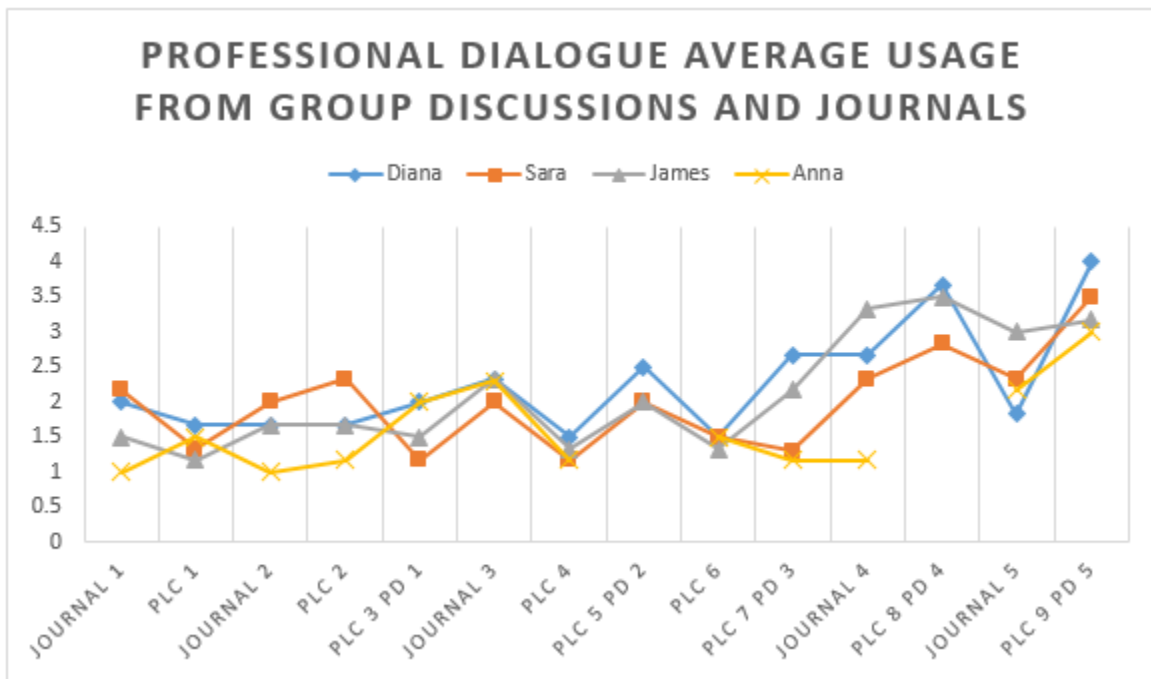


Figure 4. Professional Dialogue Average Usage

**Reflection Journal 1: Assignment selection.** The initial teacher reflection journal writing prompt asked how assignments were selected by the teachers to be included in their instruction. An analysis of the reflection journal responses indicated that the learning principles were not primary in the decision making process determining which activities to use in the classroom. Diana's response to this first writing prompt did include consistent, frequent, and specific

language related to the student learning principle of procedural and conceptual learning.  For example, Diana teaches lower achieving Algebra 1 students.  She liked for them to work on some procedural understanding first and then focus conceptual understanding so the students "can start seeing patterns and making that connection from procedures to conceptual knowledge" (Personal communication, Journal 1, lines 13-14).  Sara addressed the most student learning principles in her first reflection journal.  She included all of the student learning principles, except metacognition, in at least one vague reference.  When considering what assignments to use during instruction Sara wrote specifically about feedback stating "quick skills checks are a great way to check for understanding and give students feedback" (Personal Communication, Journal 1, lines 7-8).  James focused on wanting to make sure to include differing levels of questions for his assignments, which would fit the challenging task learning principle, but did not address the other learning principles.  James wrote he "wanted to push learning to another level and ensure mastery of the standards" (Personal Communication, Journal 1, lines 7-8) by offering a variety of different depth of knowledge level questions to challenge his students.  Anna did not mention any of the student learning principles in the first reflection response.  Anna's response indicated she chose assignments that were "aligned to the standards" (Personal Communication, Journal 1, line 1) to ensure she was providing appropriate concepts to her students.

**"You can see it's extremely basic"** (Diana, Personal Communication, PLC Meeting 1, April 10, 2018).  The first two PLC meetings I attended occurred prior to the beginning of the professional development sessions.  The purpose of observing these meetings was to determine how much professional dialogue about the student learning principles was present before the beginning of the professional development sessions.  An analysis of the group discussion rubrics for the first two PLC meetings indicated that the student learning principles were not mentioned

or only vaguely mentioned during the discussions among the Algebra 1 teachers.  The primary

foci of these meetings were content and assessment pacing, unit test construction, and review for

the upcoming EOC assessment.

As the leader of the Algebra 1 PLC, Diana leads many of the group discussions, similar

to as she would for her classes.  During these first two PLC meetings, Diana was usually at the

front of her classroom where she has her laptop setup with documents displayed on the

interactive board so everyone can see them.  Diana began the PLC meeting by asking the

teachers about content that had to be addressed prior to the high-stakes standardized EOC test.

This research took place during the final two months of the school year.  This means there were

only a few weeks left prior to the state required standardized testing, so immediate curricular

decisions had to be made regarding what content could be taught, skipped, and which content

would or would not be on unit tests.  For example, when discussing closed and recursive

sequences, a decision had to be made whether both would be taught or should only closed

sequences be taught "for the sake of time" (Anna, Personal Communication, PLC Meeting 1,

April 10, 2018).  Sara responded with "It seems likely they [the EOC] would ask more questions

about the closed [sequences]" (Personal Communication, PLC Meeting 1, April 10, 2018).

Eventually the curricular decision was to teach closed sequences and show how to use a

recursive sequence formula, but not how to write one.  Student learning and ambitious teachers'

practices were not central themes of these pre-professional development PLC meetings.

*Calendaring*.  During the PLC meetings that did not include a professional development

session, group discussions focused on logistics of teaching such as pacing and how to structure

tests.  The use of professional dialogue during these meetings was not centered on student

learning, but on calendaring.  In this context, calendaring is the process of pacing what content

needs to be "covered", on which day does the content occur, or how long to spend on the content

and is not focused on the process of student learning.  While calendaring is an important part of

teacher collaboration the Algebra 1 PLC did not include in its collaboration any deep,

meaningful conversation among colleagues about fostering student learning.  The focus of these

PLC meetings was more about what strategies will the Algebra 1 teachers use to teach and how

to write the assessment their students will take, and not about how their strategies were

supporting student learning.  As discussed previously in chapter 2, the purpose of PLC meetings

is to ensure that all students attain the highest level of learning so it is essential for the PLC

members to discuss how they are supporting student learning (Dufour et al, 2016).

     **Reflection Journal 2: Principles to Action.**  The second reflection journal writing prompt

asked the teachers what they knew about NCTM's *Principles to Action* (2014).  Diana stated she

knew the general idea of *Principles to Action* (2014) and she "pedagogically agree[s] with what

they say" (Diana Teacher Reflection Journal 2, line 8).  James initially knew the most about

*Principles to Action* (2104), because he was completing his teaching certification when the book

was published and it was included in his teacher preparation program.  In his response, James

listed the eight standards for mathematical practice and their use in the classroom.  However, he

admitted he had used the internet to refresh his memory so the language he used in his writing

prompt response may have been influenced by what he read.  The responses to this journal

prompt helped in the preparation for the first professional development session.  The analysis of

the responses indicated Diana and James both knew how teaching "should" occur, according to

NCTM *Principle's to Action* (2014), but did not indicate an understanding of why students

should learn mathematics using the eight standards for mathematical practice, which was the

focus of the professional development sessions.  Both Anna and Sara responded they were not familiar with *Principles to Action* (2014).

**"These are all the pages we skip"** (Diana, Personal Communication, PLC Meeting 3, April 19. 2018).  This PLC meeting was the first of the professional development sessions.  As the Algebra 1 teachers entered Diana's room they seemed a little bit nervous but, overall, appeared happy to be participating in the professional development.  I showed the participating teachers the recording device and where I would be placing it, in the center of their group, to ensure the recording of their responses.  I assured them they did not need to speak overly loud for the device to pick up their responses and we practiced some talking and listening to see how well the device picked up their voices.  Once they appeared less nervous, I began the first professional development session.

Based on the responses from the second reflection journal prompt indicating that the majority of the participating teachers did not have familiarity with NCTM's *Principles to Action* (2014), I introduced the student learning principles.  The participants sat in Diana's classroom in student desks as they had for every meeting prior to the beginning of the professional development.  I sat in a student desk in the front row facing the participants and used a PowerPoint presentation as a guide for the session.

The first slide of the presentation, containing a list of the eight standards for mathematical practice described by NCTM in their publication *Principles to Action* (2014), was displayed on the interactive board at the front of Diana's classroom.  As James sat down for the meeting he looked at the list and mentioned that another teacher, not in the Algebra 1 PLC, had posters of these eight best practices displayed in her classroom.   I asked the group if this list looked familiar to them.  All participants agreed the list looked familiar but were not sure from

where, so I gave the participants some context of the list, a copy of the curriculum guide from unit 1 of Algebra 1 that shows the list on the pages preceding the standards for the unit. I told them the list appeared in the Algebra 1 curriculum guides in 2015 after the publication of *Principles to Action* (2014). However, there was not an initiative in Arapahoe County to introduce the newly added standards of mathematical practice to the mathematics teachers. It was left up to the teachers to notice the addition and investigate it on their own. Diana laughingly commented "These are all the pages we skip…we don't ever really look at these things" (Personal Communication, PLC Meeting 3, April 19, 2018). In other words, the list of standards of mathematical practice was missed because the teachers using the guide were skipping the front pages of the guide and going straight to the content standards.

After the initial introduction of the student learning principles it seemed there was some uncertainty from the teachers about learning principles. The initial concern from the participants was that there was no way to incorporate each of these principles into every lesson. I assured them it isn't possible to include all the principles in every lesson and that when selecting assignments and activities they should be intentional by ensuring that their selections support the NCTM student learning principles. Nevertheless, some of the teachers felt they needed to justify why they weren't using the principles, citing varying levels of students or the need to teach too many standards in a single day to support the student learning principles.

When I began introducing the learning principle *conceptual and procedural knowledge* in particular, I felt an instant change in the response of the participants. Procedural and conceptual knowledge is important to mathematical learning because it means the student is able to use mathematics flexibly and is able to apply mathematics in novel scenarios (Fuson, Kalchman, &

Bransford, 2005; NCTM, 2014). Diana didn't feel it was possible to include conceptual

knowledge often due to the mathematical level of some of her students:

> Some of us here all teach varying levels, and I have kids that cannot – they are not
>
> at a cognitive level to develop conceptual knowledge of certain topics right now, and the
>
> only way I'm going to get them through this content standard is by here's the procedure,
>
> I'm just going to have to – you're only at this level of procedural knowledge right now, so
>
> that one is really hard, especially when you're teaching all levels (Personal
>
> Communication, PLC Meeting 3, April 19, 2018).

Anna also felt it was difficult to include conceptual understanding opportunities, but she

was more concerned with the pacing required to complete Algebra 1 prior to the EOC than the

mathematical level of her students:

> I need to teach seven topics in one day, so instead of being able to do one really awesome
>
> activity where they could really learn and retain three or four of them and discover them
>
> and apply them probably more effectively, we have to just kind of cram it all in so we can
>
> cover all the material (Personal Communication, PLC Meeting 3, April 19, 2018).

I assured Diana and Anna that I was not judging them as teachers, but trying to help them

think about their teaching and consider what they can do to ensure the learning principles are

supported in their classrooms. In order to connect the professional development to the

classroom, I gave the participants an example of a problem that supported the student learning

principles. This problem, which will be further discussed later in this chapter (See Figure 5),

only took a few minutes for the teachers to complete. However, in that short period of time, the

problem supported five of the eight student learning principles: challenging tasks that involves

active meaning making, procedural and conceptual knowledge, social construction of

knowledge, and metacognition.  This example helped spark more specific professional dialogue on procedural and conceptual knowledge as well as supporting metacognition through error analysis.

**Reflection Journal 3: Metacognition.**  The writing prompt for the third reflection journal asked teachers how they support metacognition in the classroom.  An analysis of the responses of the participating teachers indicated frequent and specific use of professional dialogue about metacognition.  The most common methods of encouraging metacognition in the classroom was through the use of error analysis and teacher questioning.  James, Sara, and Anna all mentioned error analysis specifically in their writing prompt responses.  All three also used error analysis in checking homework or as assigned classwork problems.  In addition, James used error analysis for test questions, requiring students to not only identify the mistakes, but to redo the missed problem correctly.  Teacher questioning was used by Diana, James, and Sara.  Diana had her students working in 'families', which were pairs of students working cooperatively and comparing their work.  After solving a problem, families collaborate with each other to compare answers.

In addition, all four participants wrote about using opportunities for metacognition to support social construction of knowledge.  Students must be able to "examine their own learning in order to be able to communicate with others" (Diana, Reflection Journal 3, Line 14-15).  Both Sara and Anna wrote about using metacognition opportunities to discuss with their students that their work may look different from one another's but they still came up with the same correct answer because there is often more than one way to solve a problem.  James wrote about having peers help students examine their work in order to help them arrive at the correct solution.  The participating teachers have provided opportunities for metacognition in their classroom prior to

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the professional development session.  However, after the session they were able to express how they are using metacognition in more specific language that has the same meaning to all of the members of the Algebra 1 PLC.

**"That's a higher DOK level"** (James, Personal Communication, PLC Meeting 4, April 24, 2018).  The fourth PLC meeting was the first meeting after the introduction of the student learning principles professional development.  An analysis of the group discussion rubrics for PLC meeting 4 indicated the professional dialogue had moved back to the original state vagueness with mentions of student learning principles to not mentioning the learning principles at all.  The professional dialogue level during this meeting was similar to the level of the first two PLC meetings prior to the beginning of the professional development sessions.  Instead of being focused on student learning, the language among the participating teachers was concerned with calendaring and the logistics of teaching, with the focus of discussion on what needs to be done and how to make it happen and not directly on supporting student learning.  The most specific mention of a student learning principle came from James in response to creating the test for the current unit.  The teachers were trying to decide between two questions about explicit sequences because they only need one more for the test.  James said one of them had a higher DOK (depth of knowledge) level and that would be the better choice.  Not surprisingly, just a single professional development session had not affected the professional dialogue of the participating teachers.

**Doing School.**  Professional development sessions two and three, PLC meetings five and seven, focused on supporting metacognition, feedback, conceptual and procedural knowledge, and mathematical discourse in the classroom.  However, it was difficult to support social construction of knowledge within the PLC group as I did the majority of the talking, unless I was

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prompting responses from the participants.  It was difficult to elicit responses from all the participants, except for Diana.  At the beginning of these sessions, the participating teachers would walk into Diana's room, talking to each other animatedly, choose their usual seats, sit down, and almost completely stop talking unless spoken to.  As I spoke there was a lot of head nodding as if in agreement with me, as well as smiling at me, but the interaction among me and the research participants had almost ceased.  By now, the professional development had become stilted.  The collegiality among participating teachers was present when they walked into the room, but ended as the professional development session began.  It was difficult to ascertain what, if anything, had changed with the participants.  It was as if the teachers were 'doing school', meaning they were behaving politely, listening to me as I talked, but they were not engaging in the learning process as they had in the first professional development session.  The only aspect I could control was how I delivered the professional development.  I knew a change had to be made.

A good example of the stilted conversation that was still specifically addressing student learning principles came from an exchange about an assignment given to the teachers.  The teachers had a homework assignment from the previous professional development session to provide an opportunity for their students to experience metacognition and bring the activity to the next session to discuss.  James was the only teacher who brought an example from the classroom; he had used a worksheet where pairs of students worked on error analysis on a mathematical concept called completing the square.  When asked what his process was for using the worksheet James responded he wanted pairs of students to find errors then fix and explain the errors. I prompted further with who would they explain them to, he responded partners.  Again, I prompted further with how did the students respond, did they have any a-ha moments.  James

responded with "They just kind of reported to each other" (Personal Communication, PLC Meeting 7, May 3, 2018). Trying to prompt the interaction further, I asked James if he thought the students weren't really discussing the errors with each other, to which he responded yes. I could only get one word or short statement responses from James. By this point, I felt I was putting James on the spot and allowed the interaction to stop. James seemed very relieved.

Though difficult to elicit responses from the participants during these sessions, when they did talk there was more frequent usage of specific professional dialogue regarding the student learning principles than there had been in the PLC meetings without professional development sessions,  so I knew something had sparked the interest of the participating teachers. Metacognition and social construction of knowledge were the most frequent topics of these specific professional dialogues.

While the increase in the usage of specific professional dialogue was encouraging, the lack of sustained professional dialogue was frustrating. I could hear the teachers talking to each other as they entered and left Diana's room about what they were doing in the classes, but they did not include these discussions as part of the PLC meetings. I knew a change in the professional development format had to be made.

**The professional dialogue "electric slide" continues.**  As noted previously in this chapter, the professional dialogue danced back to vague or no mentions at all of the student learning principles. After taking a step towards more specific use of professional dialogue, the participating teachers had returned to their original use of non-specific professional dialogue. This PLC meeting primarily focused on the post-EOC time frame. Teachers discussed the projects they were planning for their students to complete from after the conclusion of EOC testing until the end of the school year. Despite the topic of conversation being about hands on

projects that would support all of the student learning principles, the meeting was more focused on the calendaring and logistics of teaching, the "how" instead of the "why", with teachers discussing what materials they would use for the projects, but not how student learning was supported by the projects.

  **Reflection Journal 4:  Post-EOC projects.**  PLC meeting 6 was the inspiration for the reflection journal 4 writing prompt.  During PLC meeting 6 the teachers discussed the post-EOC projects in a logistical manner without mentioning how student learning was supported.  The writing prompt for this journal entry asked how these post-EOC projects supported student learning.  Despite the professional dialogue during PLC meeting 6 being more about calendaring and logistics, how to do the projects rather than why do the projects, the reflection journal responses were more about why the projects supported student learning.

  An analysis of the journal responses indicated specific and frequent use of professional dialogue for the student learning principles, social construction of knowledge, conceptual and procedural knowledge, and metacognition.  All four of the participating teachers responded in their journals about conceptual and procedural knowledge.  It makes sense that conceptual and procedural knowledge was mentioned by all four participants, because the students were "using real life examples to apply what they had learned about quadratic functions" (Sara, Reflection Journal 4, Lines 2-3) in a novel way.  Anna elected to have her students work on a 'Creative Critter' project to build and find the total volume for a critter using 3D figures to help prepare her students for Geometry.  For Anna, this project can be adjusted for all levels of students and gives them a "hands-on preview [that] allows them [her students] to become more comfortable with shapes, names, and formulas" (Reflection Journal 4, Lines 15-16).

Analysis of Diana, James, and Sarah's journal responses also indicated frequent and specific use of professional dialogue about metacognition and social construction of knowledge. Students had to problem solve as well as communicate with group members in order to create their catapult designs and create their quadratic equations. James said his students "were able to have great discussions about catapult designs and finding the zeros to create the functions for the catapult" (Reflection Journal 4, Lines 6-7). Diana wrote about how her students designed and then had to redesign their catapults to problem solve because their catapult was firing too high so "they use[d] conversation and discussion to come up with a good plan of action to modify" (Reflection Journal 4, Lines 15-16).

**"Something fun about math"** (James, Personal Communication, PLC Meeting 8, May 10, 2018). After the stilted conversations during professional development sessions three and four, in an effort to encourage and support sustained dialogue, I elected to change the format of the professional development. I was encouraged by the recent journal entries and sought to continue the thread of conversation already offered in those entries. In an attempt to foster social construction of knowledge, I shifted my position more to the side of the group instead of at the front of the room, still sitting with the teachers in student desks. Another change I made was no longer using a PowerPoint presentation to prompt discussion. In addition, I also brought snacks to the professional development sessions since they occurred during a time when the teachers would be eating lunch. The overall atmosphere changed to more of a professional social gathering where teachers were able to 'talk shop' rather than participation in a formal learning meeting. During these sessions, there were more sustained responses from the participants and more discussion regarding the student learning principles.

PLC Meeting 8 took place after the conclusion of the Algebra 1 EOC. It was also the first professional development session with the less formal structure. I brought pizza for the teachers to eat during the meeting. When the teachers arrived in Diana's room for the meeting they were excited to see the pizza and immediately helped themselves and settled into their regular seats. As the teachers were eating I began asking questions in a conversational manner about how their week had been going since I had not met with them the previous week due to EOC testing. After the small talk about the week and testing I broached the subject of the after EOC projects that would be beginning in the next few days. I wanted to know about this in particular because during PLC meeting 6 the discussion about these projects was more calendaring and logistics and did not include how the projects supported student learning. Compared to the previous two professional development sessions, this session contained sustained responses to posed questions as well as specific professional dialogue about the student learning principles.

Most of the teachers were present at this meeting, all except Anna. James and Diana were planning on having their students complete a project about quadratic functions using catapults, but had not yet started it. Instead they were taking the opportunity to try some activities they had never done before. James said he was doing something different before beginning the quadratic project. As opposed to the stilted, previous PLC meeting, with little prompting, James enthusiastically explained he had his students working with exponential functions by having them create stories about the spread of zombieism as well as creating tables and graphs to model their stories. He continued his explanation by including how the student learning principles social construction of knowledge as well as conceptual and procedural knowledge were supported by this activity because the students would "create [their] scenarios,

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you know, predict what's going to be happening" (Personal Communication, PLC Meeting 8, May 10, 2018).  He finished his explanation with "It's created a lot of, you know, cool math talk, discourse in the classroom" (Personal Communication, PLC Meeting 8, May 10, 2018).  This was very different than the hesitant and forced conversation experienced with James during the previous two professional development sessions.

As soon as James finished his discussion of the zombie project he was working on, Diana jumped into the conversation to tell about the project she had her students working on that day that was "super cool" (Personal Communication, PLC Meeting 8, May 10, 2018).  Diana excitedly talked about how she had her students working with a motion sensor to help them understand the concept of rate of change.  All the while Diana was relating this story she acted out how the students were moving in front of the motion sensor so we could experience what her students had experienced.  She was excited about the students getting to "play around, experiment, [and] just go figure it out" (Personal Communication, PLC Meeting 8, May 10, 2018).  Once the students understood how their movements changed the graphs they created a story and then create a graph for their story by using their movement in front of the motion sensor.  Interestingly, while relaying the story of the motion sensor activity, Diana did not specifically mention the NCTM student learning principles that were clearly evident in the activity.

Sara had begun the quadratic project the day of the professional development because she wanted them to have plenty of time for building their catapults.  Sara did not assign groups, allowing students to choose groups of up to three or work alone if they chose to do so.  After showing the students some movie clips of catapults in action, Sara put the supplies to build the catapults out on a table and told the students to build.  She did not provide plans or examples

because she wanted the students to figure it out for themselves through trial and error. Students worked at their own pace to build their catapults. Sara "was impressed that even with day one I had some who were already launching and trying to get the consistency" (Personal communication, PLC Meeting 8, May 10, 2018).

For the first time since this research study began, all six of the student learning principles were addressed by the participating teachers during a PLC meeting. The student learning principles were included in the group discussion without me directly inserting the topic into the discussion. Interestingly, when asked to brainstorm what learning principles were supported by the projects they had assigned to their students not one of the teachers mentioned procedural and conceptual knowledge. I found this interesting since they had talked specifically about it when discussing their projects, but not when asked to identify what learning principles the projects supported. When prompted by me, they had not made the connection between the student learning principles and their projects.

**Reflection Journal 5: Adjusted Lesson.** Since not all the participating Algebra 1 teachers had posted lesson plans to the PLC shared drive I needed a way to determine if professional dialogue for instructional choices had shifted during the research period. Therefore, the final reflection journal writing prompt asked if teachers had an Algebra 1 lesson that they now realized would need to be adjusted to better support the student learning principles in their classroom. An analysis of the responses indicated more specific and frequent references to each of the student learning principles as part of the adjustment of the lesson than used in response to the first reflection journal writing prompt. However, the data indicated there were still student learning principles not mentioned in this final reflection responses, even after the professional development sessions.

The most interesting response indicated by data analysis came from Diana. Her fifth journal response indicated the greatest shift right across the rubric towards the less desirable use of vague professional dialogue about the student learning principles or not indicating them at all. This shift put Diana's use of professional dialogue slightly higher than it was prior to the beginning of the professional development sessions (see Table 7). Further analysis indicated an even more interesting shift in the use of professional dialogue about procedural and conceptual knowledge. For the first time since the beginning of data collection, Diana had not mentioned procedural and conceptual knowledge. Diana usually referred to conceptual and procedural knowledge using professional dialogue that was specific and frequent. However, for this final writing prompt asking about lessons to better support student learning she did not address procedural and conceptual knowledge at all.

James had the largest shift in professional dialogue use from journal one to journal five. In his first journal response, James only mentioned the student learning principle about challenging tasks. By his final entry, James addressed the student learning principle of activating prior knowledge specifically and doubling his professional dialogue response average (see Table 7). Additionally, all of the other student learning principles were mentioned particularly, with conceptual and procedural knowledge and social construction of knowledge being addressed not only specifically, but also frequently.

Data analysis for the final reflection journal entry indicated that all the participating teachers, except Diana, increased their use of specific professional dialogue in comparison to their initial journal entries from before the professional development sessions. Diana's final journal entry was at a level similar to her pre-professional development journals.

**"They talked a lot more"** (Diana, Personal Communication, PLC Meeting 9, May 17, 2018). The responses to the journal writing prompt about adjusting lessons to better support the student learning principles resulted in responses that were lower than I expected. Therefore, one of the topics for the final professional development session was adjusting existing lessons to better support the student learning principles. Additionally, the group engaged in a discussion about what they did differently during their post-EOC projects than what they had done previously. An analysis of the group discussion rubric analysis for this PLC meeting indicated specific and frequent use of professional dialogue for most of the student learning principles. Activating prior knowledge was only referred to vaguely during the professional dialogues, but all other student learning principles were referred to specifically. In other words, during this professional development session, all six of the student learning principles were discussed by the participating teachers.

The final PLC meeting took place on the last day of school. The teachers entered Diana's room full of excitement because the final bell of the school year had just rung; it was almost summer vacation. The teachers got even more excited when they saw I had brought donuts for them for this final professional development session. As the teachers settled in their usual sitting spots and began enjoying their donuts I opened the session with a question. I asked all participating teachers whether the things we had discussed changed their thoughts as they planned lessons or as they talked with each other.

Diana immediately answered that when she had given this project in the past she would "front load at the beginning like, here's how you build a catapult, I'd get 12 of the same catapults, and this year I've got slingshots and rocket launchers and all kinds of stuff" (Personal Communication, PLC Meeting 9, May 17, 2018). This time, after explaining the grading rubric,

she stepped back from the introduction of the quadratic project and let her students "try something and figure it out" (Personal Communication, PLC Meeting 9, May 17, 2018). I asked her if she noticed anything different in the student-student behavior this year, Diana said she thought they talked a lot more because she didn't tell them how to complete the project and they had to communicate with each other to figure it out, fostering social construction of knowledge.

Sara said she also stepped back during the quadratics project and did more questioning of her students to help them to figure out the problem rather than 'rescuing' them by telling them how to fix their catapult. James said he also stepped back and put supplies on the table, like Diana, for his students to use to build their catapults. In addition he encouraged his students to bring additional supplies from home to build their catapults. James related an anecdote of one student who brought in a shelf from home because his groups' catapult would not stay on the ground. They needed a stronger base so "the next thing you know this kid is walking in with an Ikea looking shelf" (James, Personal Communication, PLC Meeting 9, May 10, 2018).

Like their students, the participating teachers talked a lot more during this final professional development session. There were sustained responses from all the teachers, the stilted discussions from before were not evident.

**Lesson Plans.**

Though the stated expectation from administration at Golden High School is that everyone turns in lesson plans on the shared drive for the PLC, not everyone has to turn in lesson plans for every PLC in which they are a member. Most mathematics teachers at Golden High School are members of more than one PLC. The teachers are only required to submit lesson plans for one of the PLC groups. Each of the four participating Algebra 1 teachers are members of two PLC groups, but only Anna does not turn in lesson plans for Algebra 1. Anna was not

able to provide lesson plans in a format usable to me for analysis.  Therefore, there will only be

an analysis of the lesson plans for James, Sara, and Diana.  I collected a total of four lessons

from the shared PLC drive to check for analysis for this research.  However, Sara did not

complete the final lesson plan.  The writing prompt response for Reflection Journal 5 will be

used as part of the analysis of lesson plans for Sara because it was written at the end of the

professional development and was related to lesson planning.

Similar to the scoring of the group discussions and journal responses, I assigned a

numerical value to each of the response categories in the lesson plan rubric (See Appendix B).  A

score of 0 meant the participant did not include the student learning principles in their lesson

plan.  A score of 1 indicated the participant planned for the student learning principles, but only

in vague terms but was not included in most of the plan.  A score of 2 indicated the participant

inconsistently planned for the student learning principles, but was still including the principles

infrequently.  A score of 3 indicated the participant inconsistently planned for student learning

principles and did so more frequently.  A score of 4 indicated the participant consistently and

frequently planned for the NCTM student learning principles.  A summary of the averages for

each participants' lesson plan can be found in Table 7.

Table 7

*Average Rubric Response per Participant for Lesson Plans*

|  |  |  | James | Anna | Diana | Sara |
|---|---|---|---|---|---|---|
| Before | PD | Lesson Plan 1 | 1.5 | 1 | 2 | 2.17 |
|  |  | Lesson Plan 2 | 1.17 | 1.5 | 1.67 | 1.33 |
| During | PD | Lesson Plan 3 | 1.67 | 1.17 | 1.67 | 1.33 |
|  |  | Lesson Plan 4 | 3.17 | 3 | 4 | 3.5 |

The first two lessons analyzed were from a period of time before the beginning of the professional development sessions. The second two lessons analyzed were collected from a time period during the professional development sessions. The data indicated that each of the three participating teachers whose lesson plans were analyzed had a shift in professional dialogue to more frequent and specific usage of the student learning principles than before the professional development. In addition to more frequent and specific professional dialogue being evident in the lesson plans there was only one instance of a student learning principle not being mentioned in a lesson plan by the final lesson plan collected.

All of the student learning principles were evident in all four of Diana's lesson plans. Even though the learning principles were mentioned, many were only mentioned vaguely. By the final lesson plan, Diana addressed all of the student learning principles using professional dialogue that was specific and frequent. Diana had not mentioned procedural and conceptual knowledge during her adjusted lesson response in journal five, however, she did specifically plan for procedural and conceptual knowledge to be part of her lesson plan. She did not connect the adjustment in the lesson to the intentional planning for procedural and conceptual knowledge evident in her lesson plan.

In the first lesson plan collected for analysis, Sara did not indicate any plans for feedback to her students. By the fourth lesson analyzed, for Sara this came from the journal 5 response, she indicated specifically that feedback was planned for her students by having them check their work using an interactive computer program. Additionally, Sara specifically planned for incorporating metacognition in her lesson plan via metacognition. Overall, Sara's initial lesson plan ranged between no mention and only vague mention of the student learning principles. The final lesson used more specific and frequent us of professional dialogue.

All three of the participants whose lesson plans were analyzed increased their use of professional dialogue in their lesson plans from what it was prior to the beginning of the professional development.  The data indicated there was a change in the professional dialogue of the participating teachers after attending the professional development sessions.

**Curricular Pressure:  "Cramming it all together"** (Anna, Personal Communication, PLC Meeting 1, April 10, 2018).

Time, or more accurately lack of time, was a recurring theme that emerged throughout data analysis, resulting the participating teachers feeling a self-imposed pressure to complete the curriculum prior to the EOC test.  I am defining this self-imposed pressure as curricular pressure as it is exhibited through the condensing and editing of the mathematics curriculum in order to ensure most of it is taught prior to the state mandated testing.  This curricular pressure became apparent right from the beginning of data collection.

In the first reflection journal, in the very first sentence of her response, Diana wrote about how she decides which assignments to use in instruction that "Time constraints are the first factor I consider" (Personal Communication, Reflection Journal 1, Line 1).  Diana went on to write that time was a consideration, especially if she needed to teach more than one concept in a class period.  If so, she would not be able to allow time for an exploration activity before providing procedural practice.  For Diana, lack of time meant student learning was not the first consideration when making instructional decisions.

An analysis of the data indicated one aspect of the time theme was a persistent thought that the student learning principles should primarily be supported using projects.  The problem with this line of thought was the participating teachers felt there was not time to complete large projects and complete content prior to standardized testing.  The concern about lack of time

emerged again during PLC meeting three, the first PLC meeting with professional development, after being given the copy of the curriculum guide with the student learning principles listed in it, Anna commented:

> I think these are the things that if we had more time or less standards, we could do a lot of the more problem-based or project-based things that we would like to do. We could integrate in pretty easily. But I always feel like a lot of them are kind of like not attended to the way that I would like to because of the pace that we have to maintain. (Personal Communication, PLC Meeting 3, April 19, 2018).

Sara, feeling the same way, extended Anna's sentiment by adding:

> And I second that. I think in Algebra 1 when we do the quadratics project at the end, after EOC, that covers a lot of these, like, the reasoning abstractly and quantitatively. You know, can they actually do their model based on their catapult and what they know about quadratics and stuff like that. (Personal Communication, PLC Meeting 3, April 19, 2018)

> This was the first discussion of a quadratics project, given to students after the

completion of the EOC, which seemed to represent the best example of best practices to these Algebra 1 teachers.  Diana noted, with irony, that the project that best combines conceptual and procedural knowledge occurs after standardized testing has concluded by saying:

> And it's a great project, but we have to wait until after the EOC to do it, because the [time] – which seems counter what the goal is, right? Like, the standards are about they need to know the standards to do well on the EOC, but the only project that we do that actually touches all of the mathematical principles is after the EOC (Personal Communication, PLC Meeting 3, April 19, 2018).

The participating Algebra 1 teachers seemed to feel like the time available for teaching content made it difficult to teach using the student learning principles. They were not connecting that the student learning principles are part of the teaching. For example, an analysis of the data indicated the teachers said the quadratics project was a good way to use best practices and the student learning principles, but took too much time to do before the EOC. In her final journal response to the prompt about revising a lesson, Anna's first response was "If I could redesign the lesson, I would start by allowing more time" (Personal Communication, Reflection Journal 5, Line 9). This theme persisted despite being offered opportunities during the professional development sessions to engage in active learning situations that supported the integration of the student learning principles into the classroom on a smaller scale. For instance, during the first professional development session, I provided an example (See Figure 5) of a quick opportunity for error analysis and metacognition in the classroom. The participating teachers were presented with the following problem and asked to find the mistake to foster social construction of knowledge.
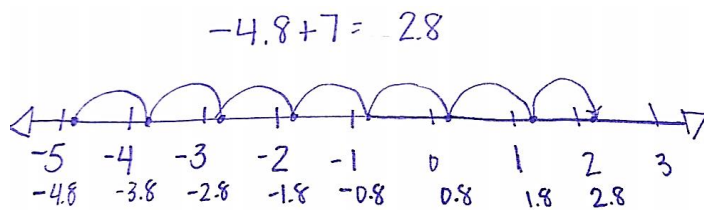


Figure 5. Example Problem from PLC 3

The participating teachers initially began to work the problem alone; I encouraged them to talk to each other. Anna had seen a similar problem and realized the answer right away, but instead of saying what the answer was she prompted the other teachers with "So when they cross zero, what happened?" (Personal Communication, PLC Meeting 3, April 19, 2018), fostering some social construction of understanding of the mistake. Further discussion about supporting

error analysis and metacognition and what it could look like in the classroom followed this activity.

Diana acknowledged how easily metacognition could be incorporated by stating "a simple demonstration like that, that took us a few minutes" (PLC Meeting 3, April 19, 2018), meaning it can only take a few minutes to incorporate opportunities for metacognition in a busy class period. However, in the final PLC meeting Diana commented on creating a semester project that could be worked on for only a few minutes a class period as a way to support the student learning principles. She was still focusing on the project aspect for using the student learning principles rather than intentionally choosing activities that would support student learning in the everyday classroom. This was interesting because, in an effort to exemplify that supporting the student learning principles did not require a big project that takes a long period of time, I had just finished saying:

> By understanding what needs to be supported, you can evaluate something you're giving them [the students] and go well, it's challenging, it provides opportunity for error analysis, like, it can provide these things that all lead to these great things even though it's still a worksheet, because we always tend to discount the worksheet of that's not best practices but it could be, are you supporting the needs of the student through these, that's what we want to look at. (PLC Meeting 9, May 17, 2018).

Another aspect of the time theme that was recurring was how the participating teachers were concerned with introducing all standards prior to standardized testing. The first instance of this concern occurred in the first PLC meeting, prior to the beginning of professional development. Diana stated "we have four weeks – less than four weeks, and we have so much left to do" (PLC Meeting 1, April 10, 2018) in reference to the amount of content that had yet to

be covered prior to the EOC.  Anna responded with "I'm kind of cramming it all together.  I'm kind of anxious about that last week" (PLC Meeting 1, April 10, 2018).

The concern about short amount of remaining time before the EOC and the amount of content that still needed to be covered was evident in each of the PLC meetings with professional development as the teachers discussed pacing and what content to include versus which content could be excluded or reduced.  For example, there was a discussion during the first PLC meeting about whether both regular interest and compound interest should be taught.  The consensus became it should be taught because it is on the formula sheet and beneficial to the student to know.  The discussion did not involve the student learning principles, but was focused on the time available to teach the content.  Diana summarized the concern about time, standardized testing, and the student learning principles the best when she said:

> I think that's where it gets lost. I think – I know for me, it's – I'm looking at all the content standards and not looking at the process standards. Like, I'm trying to hit the checklist of making sure that I get through all of the content things, so if I don't get through the process, like, that – those things, that's fine, that's fine, they can do good on the tests, the tests look good, fine. And then it's like, okay (Personal Communication, PLC Meeting 5, April 26, 2018).

Even though lack of time was a concern for the participating teachers, as discussed previously, there seemed to be a consensus that metacognition, through error analysis in particular, and social construction of knowledge were two student learning principles that could be incorporated the easiest into the classroom.  However, there still seemed to be a misconception among the participating teachers that the student learning principles are somehow separate from the teaching of mathematics.

**Post-EOC Teaching: "Post-EOC is incredible"** (Anna, Personal Communication, PLC

Meeting 9, May 17, 2018)

Somewhat related to the theme of lack of time, the second theme that emerged from data

analysis was the participating teachers indicated it was easier to use best practices and attend to

the student learning principles once standardized testing had concluded. This aligns directly with

the misconception previously mentioned about how the participating teachers viewed the use of

the student learning principles as separate from the teaching of mathematics. During the

penultimate PLC meeting while discussing how the post-EOC projects were supporting student

learning Diana had finished her story of the motion sensor project, discussed previously, with a

final statement "I would not have been able to do this before the EOC" (Personal

Communication, PLC Meeting 8, May 10, 2018). This final statement from Diana and the

exuberance in their telling I had noted from all the teachers in the discussions prompted me to

say to them "We all sound excited…we're all more excited about teaching. Before EOC, you

don't sound the same". (Personal Communication, PLC Meeting 8, May 10, 2018). Wanting to

explore this further I asked the group if they felt the pacing required to introduce all the concepts

before standardized testing makes it difficult to incorporate the student learning principles into

their teaching. Immediately James leaned forward in his seat and said:

> I think with the pace and trying to cram everything in for the EOC, it deters me from
>
> making the decision to do that [quadratic] project because of time, because I'm always
>
> worried about time, time, time, time, time. It's like, if I do that project, if I lose two or
>
> three days, where can I make those back up, where after the EOC, it's more like a
>
> laidback, let's actually do math. (Personal Communication, PLC Meeting 8, May 10,
>
> 2018).

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Diana, agreeing with James, further explained why she liked the post-EOC projects:

> What is it that you wanted to do all semester that you couldn't do because of EOCs, now
> you can do it, and so I really like this [quadratic] project in particular because I feel like it
> hits all of those things, and give it the time to breathe. Like, I've thought about, okay,
> well, I could get a day in here for this project, but when you don't let it breathe, I feel like
> you're doing a complete disservice to the kids and the project. Like, if you don't give
> yourself the time and try to put it in regular and they end up taking longer, then you're
> like, okay, it's over, the time for learning is done, it's back to worksheets or whatever the
> thing is. (Personal Communication, PLC Meeting 8, May 10, 2018).

In response to the above statements, during the final professional development session, I asked
the participating teachers if they thought it was easier to incorporate the student learning
principles during post-EOC timeframe versus the pre-EOC timeframe. Anna stated:

> I would say post-EOC is incredible as far as you finally feel like you have the freedom to
> do what you want, whatever is best for the kids, to kind of get them learning, whether it's
> letter for letter what's in the standard or if it's some kind of project-based modification of
> that, you're not worried about am I going to cover the ten standards that I need to cover in
> this particular part or is it okay that they discover or learn eight on their own plus a few
> extra ones that weren't really in there to begin with. So I definitely think it's a lot – there's
> a lot more freedom and less stress and more time for creativity and learning after the
> testing is done. (Personal Communication, PLC Meeting 9, May 17, 2018).

These responses further indicated a continued lack of connection the participants had about
integrating the student learning principles into every day mathematics instruction. The sentiment

shared by the teachers was the post-EOC time was when the student learning principles were easiest to foster.

The final professional development session ended with a commitment to teaching for the next school year. Diana suggested it would be wise to "revise out stuff that we've just become complacent with" and that it would "benefit all of us to give the why's behind it again, remember why we made it" (Personal Communication, PLC Meeting 9, May 17, 2018). Anna supported the importance of Diana's statements by pointing out it is a good idea to revisit these lessons and activities because:

> Everyone would consider themselves to be a better teacher now, hopefully, that they were five or ten years ago. But I have the same thing, I have stuff that I've used since forever, some of its good but some of it I probably need to revisit (Personal Communication, PLC Meeting 9, May 17, 2018).

Maybe by revisiting these lessons and activities and intentionally incorporating the student learning principles into the, the teachers can bring the energy they feel while teaching during the post-EOC period to the pre-EOC period.

**Summary**

Through five data sources, I found three themes emerging from the data analysis: shifting professional dialogue, lack of time, and better teaching practices after the EOC. The data indicated that there was a dialogue shift to more specific and frequent references to student learning through the student learning principles on the days participants engaged in professional development. However, the data indicated this shift to more specific and frequent use of professional dialogue was not maintained on PLC meeting days without professional development. Across participants, the data indicated that participants felt self-imposed pressure

to complete instruction prior to the EOC test and this pressure stunted their use of the student learning principles.  However, the data did indicate the participants stated they thought they would be able to imbed metacognition and social construction of knowledge into their teaching without too much difficulty through the use of error analysis and creating opportunities for student interaction.  The data also indicated, across participants, a sense of freedom to teach using the student learning principles after the conclusion of testing.  Specifically, by the final PLC meeting, the data indicated that professional dialogue about the student learning principles had shifted to be more specific and frequent with no instances of not mentioning the student learning principles during group discussions.

# 5  DISCUSSION

I began this research because I was interested in exploring the relationship between teacher learning and professional dialogue. How I was using language, in my own experience, changed as I learned more about education during my doctoral program. The more I learned, the more my professional dialogue shifted towards student learning and how it related to the act of teaching. Upon reflection, I was able to detect a change in how I planned and implemented lessons within my own classroom based on this change of understanding and use of professional dialogue.

However, I was noticing this shift in professional dialogue only when interacting with fellow teachers in my doctoral cohort. When I interacted with colleagues at work, my language shifted to be more about calendaring, as described in chapter 4. This disconnect between my two worlds became more important to me when the previous years' EOC scores were released, and they had decreased for the second year in a row. My colleagues were frustrated and unsure what more they could do to help their students improve achievement. I was inspired to help by exposing my fellow teachers to relevant research regarding student learning and why ambitious teaching was integral to student learning. This inspiration led to the idea of the professional development that was integral to this research.

It wasn't until I began to organize and code the data I had collected I realized the teacher participants experienced the same back and forth in the use of professional dialogue I had noticed in myself. My frustration in the lack of consistency in specific professional dialogue use eventually turned to understanding. Non-professional development PLC meetings included special education teachers who were not included in this study. The interaction between the special education teachers and the Algebra 1 teachers participating in the research study shifted to be

more about calendaring than about student learning.  In retrospect, the participants experienced the same disconnect I had experienced when interacting with colleagues who were not involved in the same learning opportunity.  Through these interactions, it appears that the consistent use of specific professional dialogue is more likely to occur in environments in which all members of a group are participants in the learning.  I realize that the group construction of understanding fosters the group use of professional dialogue.

**Introduction**

There was concern among the participating Algebra 1 teachers after two consecutive years of declining EOC scores.  Despite participating in twice weekly PLC meetings, EOC scores were not improving.  The participating teachers were willing to take action to make a change to their current situation in order to improve EOC scores at Golden High School.  This study documented their experiences as they learned about why and how the mathematical practices from NCTM supported student learning.  Schmoker (2004) emphasized the best way to improve instructional practices was to have teachers collaboratively examine and adjust teaching practice within the context of a PLC.  Furthermore, research indicates that teacher professional dialogue can support instructional improvements in the classroom (Fullan, 2010; Horn et al., 2017).  This research was designed to see what effects professional development has on teacher professional dialogue.  The purpose of the current case was to answer the research question: How does learning about the NCTM's *Principles to Action* (2014) shift teacher professional dialogue within an Algebra 1 professional learning community?

To find answers to this research question I carried out five professional development sessions about NCTM's student learning principles over the course of nine Algebra 1 PLC meetings.  I implemented a qualitative case study related to the NCTM learning principles

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because it afforded me the opportunity to gain thorough insight of how the professional dialogue of the participants shifted from vague or non-existent usage to specific and frequent usage. Data analyzed included group discussions during PLC meetings, teacher reflection journals, lesson plans, de-identified student artifacts, and researcher field notes. To help identify emerging themes, the data was analyzed as it was collected. Furthermore, I re-analyzed the data at the conclusion of the implementation period and used member checks to ensure I captured a complete picture of how teacher professional dialogue shifted while engaging in professional development sessions during PLC meetings. Through a rigorous analysis of the data, I drew conclusions and determined implications and recommendations for additional research.

Findings of this qualitative case study included the effect of professional development on the professional dialogue of the participating teachers. Each of the participating teachers exhibited an increase in the use of specific professional dialogue by the end of the professional development sessions. Additional findings of this research include curricular pressures and the release of curricular pressures after the conclusion of EOC testing and their effect on the ambitious teaching practices of the participating teachers. A discussion of these findings and implications for teachers and teacher professional development follows.

**Findings Related to Literature**

      **Effect of Professional Development on Professional Dialogue**. Data analysis of group discussion rubrics indicated that teacher professional dialogue shifted to specific and more consistent use of the student learning principles during professional development sessions during the research period. However, during PLC meetings that did not include professional development sessions the teacher professional dialogue reverted to no references or only vague references to the student learning principles. Despite the back and forth usage of specific

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professional dialogue about the student learning principles, each of the four participating teachers' usage of specific language about the student learning principles increased in frequency overall during the course of the research study.

The shift towards more specific professional dialogue was not maintained between the PLC meetings. One possible reason for the observed back and forth of specific professional dialogue usage may be an indication of an implementation dip as described by Fullan (2001) as "a dip in performance and confidence as one encounters an innovation that requires new skills and new understandings" (p. 52). In this case study, the implementation dip may have occurred due to not yet fully understanding the student learning principles and how to incorporate them into the PLC meetings without the support of the facilitator. During the professional development sessions I acted as a facilitator by guiding discussions. However, I did not facilitate PLC only meetings. The PLC sessions that did not also contain professional development were not supportive of the socioconstructivist epistemology. Social interactions surrounding the mathematics teachers professional dialogue were not supported during these meetings as the focus of these meetings was not creating a collaborative understanding, instead these meetings focused mostly on activities of teaching, the "how" and not the "why".

For example, the PLC meetings that occurred prior to the first professional development sessions were focused on calendaring and the logistics of teaching, as discussed in the previous chapter. In addition, the PLC meetings that did not coincide with professional development reverted to the calendaring and logistics based professional dialogue. These findings align with research that has indicated that the most common dialogue in collaboration meetings relates to calendaring, accounting for as much as 40% of the professional dialogue during the collaboration (Horn et al., 2017). Facilitation is the key to steering the dialogue to be more inclusive of

student learning by shaping the collaborative conversations to develop the teachers' shared conception and understanding in order to engage in more meaningful professional dialogues (Gibbons & Knapp, 2015; Lampert et al., 2013). By observing the first two PLC meetings I was forewarned about the structure of the meetings and the focus on calendaring and logistics rather than a focus on student learning.

In hindsight, I should have used this knowledge to support the participating teachers' learning of the student learning principles by facilitating the PLC meetings that did not include professional development. By facilitating these meetings I could have helped the participants identify the student learning principles in their lessons and help them identify ways to incorporate them into their lessons. By failing to utilize the non-professional development PLC meeting times I inadvertently slowed the participating teachers' learning.

**Curricular Pressure**. Chapter 2 reviewed research that examined both traditional teaching and the benefits of ambitious teaching (Au, 2007/2013; Battista, 1999; Clements & Battista, 1999; Gibbons & Cobb, 2017; Kohn, 1999; Lampert & Graziani, 2009); NCTM, 2014; Stigler, 2004), the professional development sessions were aimed to support why ambitious teaching helped students learn mathematics. Furthermore, the professional development was designed to incorporate characteristics, previously discussed in chapter 2, that would promote teacher learning (Darling-Hammond & Richardson, 2009; Desimone, 2011; Dufour, Dufour, & Eaker, 2008; Loucks-Horsley et al., 2010). Understanding the benefits of ambitious teaching practices and why they are effective, the participating teachers in this research study were open to engaging in ambitious teaching. However, the data indicated the participating teachers continued to view the use of ambitious teaching as a special event or for only after the completing of EOC testing due to the time it would take to implement in the classroom.

The participating teachers at Golden High School, though never explicitly instructed to do so by administration, felt a self-imposed pressure to complete the Algebra 1 curriculum as the approach of the EOC test grew closer. This self-imposed curricular pressure was exhibited through the use of more teacher-centered instruction and narrowing of curriculum through the omission of concepts deemed less important. The teachers' reaction to the impending test aligns with Au's (2007/2013) results of a metasynthesis of 49 qualitative studies about the impact of high stakes testing, such as the EOC, on curriculum. The resulting teacher pedagogy becomes more teacher centered and teacher directed, the opposite of how the participating teachers stated they want to teach their students. However, after the completion of the EOC test, participating teachers radically changed their teaching practices to a more student-centered, ambitious teaching approach that support the student learning principles.

A potential reason for reverting to teacher directed practices despite stating otherwise could be due to the "wash out" effect (Lortie, 1975). Unlike many professions, teachers have had ample opportunity to observe their profession prior to choosing it. Through these observations flawed insights into the teaching profession are developed based on a limited view of only what a teacher does in the classroom. These student-perspective observations do not take into account the link between the teacher's objectives and the teacher's actions. Students would not have been privy to the thought processes and reflections of their teachers as to why instructional decisions were made and could only imagine why their teacher chose to teach in a specific manner. Through this socialization, students may view teaching as ends-mean frame, choosing teaching practices based on personality rather than pedagogical practices. The pressure the participating teachers felt as the EOC neared may have resulted in their reverting to teaching

practices they were exposed to as students themselves, unwittingly imitating the teachers that they had observed.

**Post-EOC Teaching.** After the completion of EOC testing, the self-imposed curricular pressure dissipated for the participating teachers. The participants felt a sense of teaching freedom after they concluded the high-stakes, state required standardized testing. In contrast to the teacher centered practices prior to the EOC test, teaching practices after the completion of EOC testing were more inclusive of ambitious teaching to include the NCTM student learning principles. The participating teachers were open to, and very eager to, engage in problem based learning that supported the student learning principles as well as the standards for mathematical practice in NCTM's *Principles to Action* (2014). However, they overlooked ordinary opportunities to integrate the learning principles into everyday teaching by not connecting incorporating the student learning principles to every day mathematical instruction.

In addition to the change to include more ambitious teaching practices, the professional dialogue used during the post-EOC research period contained the highest levels of specific student learning principle language for the entire research period. It wasn't until the participating teachers were using more of the student learning principles in their classrooms that the professional dialogue reflected increased frequency and specificity. This finding establishes the link between improved teaching and professional dialogue in the mathematics classroom proposed in research finding the same link in subjects other than mathematics (Deglau et. al, 2006; Prestridge, 2009). In other words, given the opportunity to engage in the ambitious teaching in the classroom, there was an increase use of specific professional dialogue. For instance, James and Diana demonstrated the highest levels of specific professional dialogue during the two professional development sessions after the conclusion of EOC testing. In

addition, not only did James and Diana implement the problem based learning quadratic catapult project that was discussed in chapter 4, they also tried additional shorter term activities that supported many of the NCTM (2014) student learning principles because they wanted to try something new to support student learning in their classrooms.

**Implications**

Due to the important link between professional dialogue and the student learning principles established in Chapter 2, my overall intent in this research study was to examine the effect of professional development on professional dialogue. As discussed previously, research has established positive links between teachers' engagement in quality professional development and increased student achievement. Additionally, research has established positive links between teachers' use of professional dialogue and increases in student achievement. This study established a link between professional development and professional dialogue. The link of increased use of professional dialogue as a result of professional development also has positive implications on student achievement in the classroom.

**Implications for professional development.** In recent years, much of the professional development teachers experience is in the form of a one day and done workshop style, which often does not result in real change in the classroom (Gulamhussein, 2013; Wei et al., 2009). The professional development given during this research supported teacher learning by incorporating characteristics of quality professional development such as ongoing, supporting collective learning, and job-embeddedness (Dufour et al., 2008; Desimone, 2011). The implicaiton for facilitators of future professional development is that including these characteristics in the professional development planning and implementation can have a positive impact on teachers' instructional practices as well as increase student achievement (Huffman et al., 2003; Schmoker, 2004).

The six student learning principles from NCTM (2014) helps students build "mathematical knowledge from personal experiences, coupled with feedback from peers, teachers, and other adults, and themselves" (2014, p. 9). Can these principles be incorporated into mathematics teachers' ongoing, collective learning, and job-embedded professional development and applied to the mathematics teachers themselves? Inclusion of these principles into mathematics teachers' professional development may support the connection of theory to classroom practice (Darling-Hammond & Richardson, 2009; Dufour, Dufour, & Eaker, 2008; Loucks-Horsley et al., 2010).

Including these six learning principles in mathematics teachers' professional development provides an opportunity for the teachers to experience learning in a manner similar to what their students would experience, further tying the teacher learning to the classroom. For example, using all of the PLC sessions to support the "how" and "why" of teaching using the student learning principles would have been beneficial to the teachers understanding of them. How would using the six NCTM student learning principles look if they had been used with these Algebra 1 mathematics teachers instead of student learners? The participating teachers would have received descriptive and timely feedback to help build their socially constructed understanding of the student learning principles during the PLC meetings. Meaningful learning of the student learning principles would have been supported by challenging the participants to try new tasks and activities in their classroom. Preconceptions and misconceptions could have been addressed by connecting the use of the student learning principles to activities already used in their participant's classrooms by helping the participants identify how they were currently, and maybe unknowingly, using the student learning principles. The participating teachers would also be using both conceptual and procedural knowledge as they acquire new knowledge about the

student learning principles that they can then incorporate into their classrooms.  Finally, the teachers would become more aware of themselves as learners and monitor how they are using the student learning principles in their classrooms.  As stated above, students build mathematical knowledge through personal experiences, it is reasonable to think mathematics teachers would build knowledge of mathematics instruction the same way.

It is important to note that the teachers would not experience learning using the NCTM principles exactly as their students would. Adults learn differently than children.  Andragogical principles must be supported during professional development to meet the needs of adult learners.  Much like the NCTM student learning principles, andragogy supports adult learning through a process model rather than the content model of traditional educational practices (Knowles et al., 2015).  According to Knowles et al. (2015), andragogy and moderate constructivism, such as the socioconstructivist epistemology that served as the theoretical framework for this research study, parallel each other.

Most noticeably supported in this research about learning within the context of a professional learning community is the notion that "learning cannot be separated from the context in which it is used" (Knowles et al., 2015, p. 177).  Both of these frameworks support learning by stressing the importance of ownership over the learning through problem-based and experiential learning.  Learning must be tied to what the learner already knows in order for it to be retained and used, similar to the NCTM student learning principle of activating prior knowledge.  The implication for facilitators of future professional development is to be sure to incorporate andragogical principles into the development and implementation of professional development sessions to best support adult learners.

Professional development that is provided by a system insider that occurs within the bounds of a PLC is different than most professional development teachers attend, as discussed in chapter 2. Relationships are already established within a PLC, the members taking the professional development are not strangers to each other. Consequently, the approach to teaching the professional development must also be different. In this research, the more formal approach to delivering the professional development did not work well with the socioconstructivist epistemology. Once a less formal, conversational "shop talk" approach was implemented, social interaction and social construction of understanding was fostered.

**Implications for professional learning communities.** The professional development sessions taking place within the bounds of the professional learning community afforded the participating teachers the opportunity to experience ongoing learning as part of the regular workday. Professional development given during PLCs is advantageous because the structure of collaboration, focus on learning, and results orientation is presumably already a part of the structure of a PLC (Dufour et. al, 2016). Additionally, professional development provided within the PLC helps bolster the characteristics of a successful PLC's: mutually engagement in activity, engagement in joint enterprise, and having a shared repertoire (Wenger, 1998).

To better support the three characteristics of a successful PLC, all members of the group should be engaged in learning opportunities. The implication from this research is that all members of the PLC should be included in professional learning. The specific use of professional dialogue was most consistent during meetings that included the professional development. However, when participating teachers returned to PLC meetings that included non-participating teachers the professional dialogue returned to be more about calendaring despite there being opportunities to discuss student learning. This back and forth use of specific dialogue continued

until there were no longer non-professional development PLC meetings. From the end of the non-professional development meetings forward the participants maintained a higher and more specific professional dialogue usage. Including all members of the PLC group will also support teacher learning and teacher professional dialogue by providing a supportive environment in which members can try out new ideas and instructional practices (Gibbons & Knapp, 2015). It is important to note, however, that just including all of the group members does not ensure an increase use of specific professional dialogue.

An additional implication that must be considered is not all professional dialogue leads to instructional improvement. Care must be taken during PLC meetings to continue to develop professional dialogue and not revert to the meeting being solely about calendaring and the logistics of teaching, which can be mistaken for professional dialogue. Facilitation of the PLC group discussions is key. The facilitator keeps the meeting on track and moving in a productive manner. The facilitator does not always need to be the same individual. As previously discussed in chapter 2, a more knowledgeable other (MKO) can act as a facilitator to help foster the professional dialogue and support the members of the PLC, as they use professional dialogue. This facilitator would foster conversations that help teachers develop their shared vision (Gibbons & Knapp, 2015).

**Implications for classroom teachers.** Through this research, a link has been established between professional development and the increased use of specific professional dialogue. Additionally, a link has been established between the frequent use of specific professional dialogue with colleagues and improved ambitious teaching practices in the classroom. For classroom teachers, the student learning principles can be incorporated into a classroom by being more aware of how students learn mathematics and what research indicates supports the learning

of mathematics.  Ambitious teaching does not need to only be long term projects that take a lot of time.  Time is one component that cannot be easily changed in the classroom as it requires a larger cultural shift.  Teachers only have a set amount of time to provide opportunities to interact with mathematical concepts prior to state mandated testing.  However, the use of ambitious teaching practices and the student learning principles can be achieved through carefully developed activities, using both daily activities as well as long term projects that incorporate the student learning principles into the everyday classroom. By knowing and understanding the student learning principles, mathematics teachers can be more intentional in why they are selecting assignments and activities.  Supporting mathematics learning through the use of the student learning principles should improve student learning, and quite possibly standardized test scores.

**Recommendations for further research.**

In chapter 3, I wondered "can the same input always have the same output?"  As a qualitative case study using a socioconstructivist epistemology, I did not intend for this research to be generalized.  This case study involved multiple epistemological realities created through the co-construction of the interpretation of the data between me and each of the participants (Stake, 1995; Yin, 2014).  While exact replication of this research study is not possible, recommendations can be made for further research.

Further research on the topic of professional development, professional dialogue, and student learning can take many directions.  One direction further research may take is facilitating teachers professional dialogue and providing teachers professional development over the course of an entire school year within their PLC.   In addition to fostering the specific professional dialogue, participating teachers can be helped to develop or re-develop lessons that intentionally

incorporate the student learning principles into everyday teaching, tying the professional development directly to the classroom. This research should also provide a comparison of the participating teachers EOC scores from prior to the yearlong focus on student learning and after the completion of it. This research could further solidify the link between professional dialogue and professional development and their effect on student learning.

Additionally, further research should be conducted in settings different than the context of this study. In this study, I was an insider to the system where the research took place. Would the same results be found if the professional development was provided by someone who is not an insider, but a stranger to the members of the PLC? I am not sure a stranger could join a PLC group and have the same effect. The relationship among the members of the PLC is important to the social construction of knowledge. I relationship between the facilitator and the PLC members would likely need to be initiated before the professional development was to begin.

Another setting that should be explored is across grade level bands or content areas. Is the effect on student learning the same regardless of the age of the student or the content area of the teacher? Through this research, I believe professional development conducted in a similar manner would have positive effects on student learning, regardless of the age of the student or content area of the teacher. The professional development in this study was designed using characteristics developed through extensive research on what makes professional development effective (Desimone, 2011; Loucks-Horsely, et. al, 2010; Wei, et. al, 2009). If other grade band teachers or teachers of different content areas were involved in professional development that was also designed with these characteristics in mind, surely they would experience similar effects.

Settings at different socioeconomic levels and cultural contexts should be explored in future research. Can additional teacher development about student learning of mathematics help reduce the education gap that exists in traditionally underserved students such as Black children and low socioeconomic status children? I believe additional teacher development about the research-based student learning principles would help any mathematics learner. Access and equity is one of the principles explored in NCTM's *Principles to Action* (2014). The intent of the ambitious teaching practices outlined in the standards for mathematics instruction is to provide all students with the high quality teaching necessary to learn mathematics (NCTM, 2014). Access to high quality instruction has the potential to reduce the education gap.

A final recommendation for further research is to investigate the link between teacher professional development and teacher emotional support. Research has determined that teacher emotional support has a positive effect on the classroom environment as well as student achievement (Jennings & Greenberg, 2009; McLean & Connor, 2018). The participating teachers in this research were given the opportunity to engage in sustained interactions about student learning through modeling and collaboration. Can these sustained, positive teacher learning environments allow teachers to increase their sense of ownership and professional affiliation of their craft, and thus, improving student achievement?

## Limitations

This research had some limitations. One limitation of the study was the duration of the research. The timeframe of data collection was a 6 week period. The professional learning community continued to meet and work on the common goals of student learning after the data collection period ended. Additional shifting in professional dialogue may have occurred after the end of the data collection period, therefore the total effect of the professional development may

not have been observed during this research. Another limitation of the study was the participant sample. This purposeful sample was comprised of all Caucasian teachers, with only one of them being male. This sample was a microcosm of the mathematics department as a whole at Golden High School. National demographics secondary teachers in the United States indicate that about 80% of the teachers are Caucasian and approximately 60% of secondary teachers are female (Taie & Goldring, 2017). The sample largely matches the demographics of teachers nationwide, making this limitation a possible advantage as it represents the majority of teachers in the United States.

There was an existing work relationship between me, the researcher, and the teacher participants which may hamper the research. However, as a qualitative study, we have already established a relationship of trust. Another assumption is that these teachers wrote in their reflection journals and engaged in conversation in an open and honest manner. This open and honest manner was exhibited through writing and saying what they actually believed and not what they thought I would want to hear.

Another limitation to this research study was I did not facilitate the PLC meetings that did not include professional learning. I should have utilized these PLC meetings to support the further building of teacher understanding. This is especially true once I noticed the inconsistent use of specific professional dialogue between the PLC meetings.

An additional limitation to this research is I should have done a better job connecting the student learning principles to the classroom. I could have done this by having participating teachers actively identify the student learning principles in the lessons they were currently using. It wasn't until the post-EOC teaching period when the teachers had more ambitious teaching in the classroom that the most positive change in specific professional dialogue occurred. Prior to

this time, the teachers were not connecting what we were talking about during the professional development with what was occurring in their classrooms. The teachers may have been able to connect the student learning principles to their classroom quicker.

**Conclusion**

This study contributes to the fields of teacher professional development, teacher professional dialogue, and student learning. The results of this research established a link between professional development and increased use of specific professional dialogue, both of which are already positively linked with increased student learning.

The current case study aimed to examine the effect of professional development on professional dialogue of Algebra 1 teachers within a PLC. Overall, the findings indicated the increase usage of specific professional dialogue within the Algebra 1 PLC when there was facilitation of discussions. Despite a back and forth in the amount of specific professional dialogue over the course of the research period, the participating teachers used specific professional dialogue more frequently at the end of the research period than at the beginning of it. The participating teachers struggled with considering all six of the six student learning principles except in special events or during the post-EOC teaching period due to self-imposed curricular pressures. Eventually, the participating teachers committed to re-developing lessons the following school year to intentionally incorporate the student learning principles that foster student learning of mathematics.

This research study can serve as the groundwork for further research into professional development and professional dialogue. The findings in this study demonstrated there is a link between teacher professional dialogue and teacher professional development. The outcome of that link was there was more ambitious teaching practices used in the classroom as well as more

specific professional dialogue used among teachers, both of which are linked to improved

student learning.  These results have far reaching implications in secondary mathematics

education.

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# APPENDICES

**Appendix A**

**Georgia State University**
**Department of Middle and Secondary Education**
Secondary Mathematics Education Teachers Informed Consent

Title:  *Shifting Professional Dialogue:  Engaging Algebra 1 Teachers in Research-Based*

*Professional Development*

       Principle Investigator: Dr. Pier A. Junor Clarke
       Student Principle Investigator:  Jennifer K. Henderson

I.      <u>Purpose:</u>

You are invited to participate in this research study.  The purpose of this study is to develop a deeper understanding the role of professional development on teacher professional dialogue.  You are invited to join this research because you are an Algebra 1 teacher.  Your participation is voluntary but participation will assist your understanding of how students' best learn mathematics.  Recruitment consists of up to 5 Algebra 1 teachers.  Participation will require no additional time commitments outside the regular professional learning community requirements.

II.     <u>Procedures:</u>

As Algebra 1 teachers, you will take part in professional development sessions during the regularly scheduled PLC meetings.  During the professional development you will participate in audio-recorded group discussions about readings from NCTM's (2014) *Principles to Action* learning principles or other research, unidentified student classroom artifacts, and lesson plans.  In addition, you will be asked to respond to writing prompts in a journal to capture your thoughts about student learning.  All professional development sessions will be audio-recorded.  Only the journals and audio transcripts of research participants will be coded and analyzed for data collection.

III.    <u>Risks:</u>

In this study, a participant will not have any more risks than she/he would in a normal day of life.

IV.    <u>Benefits:</u>

The goal of the project and research is to advance understanding of how professional development affects teacher professional dialogue. The findings of this research study may contribute the field of education by exploring the role of teacher professional development in the development of teacher professional dialogue.  The insight obtained through this research may provide vital information addressing the need of linking professional development to teacher professional dialogue.

VI.    Voluntary Participation and Withdrawal:

Participation in research is voluntary.  You do not have to be in this study.  If you decide to be in the study and change your mind, you have the right to drop out at any time.  You may skip questions or stop participating at any time.  Whatever you decide, you will not lose any benefits to which you are otherwise entitled.

VII.    Confidentiality:

We will keep your records private to the extent allowed by law. The researchers, Dr. Pier Junor Clarke and Jennifer K. Henderson will have access to the information you provide. Information may also be shared with those who make sure the study is done correctly (GSU Institutional Review Board, the Office for Human Research Protection (OHRP) and).  A pseudonym will be used rather than your name on any study records. The information and data collected in which you participate will be stored electronically in password- and firewall-protected computers, including audio recordings and journal entries. The code sheet or the identification key that can identify the research participants will be stored separately from the data by the researcher to protect privacy. Your name and other facts that might point to you will not appear when we present this study or publish its results. In order to accurately tell your story, Jennifer will provide you with copies of all transcripts and the final version of your story after the data analysis. You will not be identified personally. The data collected will be destroyed after completion of this dissertation.

VII.    Contact Persons:

Please contact Dr. Pier A Junor Clarke at 404-413-8411 or email at pjunor@gsu.edu if you have questions, concerns, or complaints about this study. You can also call if you think you have been harmed by the study.  Call Susan Vogtner in the Georgia State University Office of Research Integrity at 404-413-3513 or svogtner1@gsu.edu if you want to talk to someone who is not part of the study team.  You can talk about questions, concerns, or suggestions about the study.  You can also call Susan Vogtner if you have questions or concerns about your rights in this study.

VIII.    Copy of Consent Form to Subject:

We will give you a copy of this consent form to keep.  If you are willing to volunteer for this research and be audio recorded, please sign below.


_____          _____

Participant                                                                              Date



_____          _____

Principal                                                                                Date



_____          _____

**Appendix B**

# RUBRIC FOR PROFESSIONAL DIALOGUE IN LESSON PLANS

Name: _____

**Rubric for Professional Dialogue in Lesson Plans**

| | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|
| **Challenging Tasks** | Consistently planned for using challenging tasks using specific terminology and included in lesson plans frequently | Inconsistently planned using challenging tasks using specific terminology, challenging tasks frequently included in lesson plans | Inconsistently planned challenging tasks using specific terminology, challenging tasks infrequently used in lesson plans | Planned for challenging tasks in vague terms, not included in most lesson plans | Did not plan for challenging tasks in lesson plans. |
| **Activating Prior Knowledge** | Consistently planned for activating prior knowledge using specific terminology and included in lesson plans frequently | Inconsistently planned for activating prior knowledge using specific terminology, activating prior knowledge frequently included in lesson plans | Inconsistently planned activating prior knowledge using specific terminology, activating prior knowledge infrequently used in lesson plans | Planned for activating prior knowledge in vague terms, not included in most lesson plans | Did not plan for activating prior knowledge in lesson plans |
| **Conceptual and Procedural Knowledge** | Consistently planned for conceptual and procedural knowledge using specific terminology and included in lesson plans frequently | Inconsistently planned conceptual and procedural knowledge using specific terminology, conceptual and procedural knowledge frequently included in lesson plans | Inconsistently planned conceptual and procedural knowledge using specific terminology, conceptual and procedural knowledge infrequently used in lesson plans | Planned for conceptual and procedural knowledge in vague terms, not included in most lesson plans | Did not plan for conceptual and procedural knowledge in lesson plans |
| **Build knowledge socially** | Consistently planned for building knowledge socially using specific terminology and included in lesson plans frequently | Inconsistently planned for building knowledge socially using specific terminology, building knowledge socially frequently included in lesson plans | Inconsistently planned building knowledge socially using specific terminology, building knowledge socially infrequently used in lesson plans | Planned for building knowledge socially in vague terms, not included in most lesson plans | Did not plan for building knowledge socially in lesson plans |
| **Feedback** | Consistently planned for feedback using specific terminology and included in lesson plans frequently | Inconsistently planned feedback using specific terminology, using feedback frequently included in lesson plans | Inconsistently planned feedback using specific terminology, feedback infrequently used in lesson plans | Planned for feedback in vague terms, not included in most lesson plans | Did not plan for providing timely and effective feedback in lesson plans |
| **Metacognition** | Consistently planned for opportunities for metacognition using specific terminology and included in lesson plans frequently | Inconsistently planned metacognition using specific terminology, opportunities for metacognition frequently included in lesson plans | Inconsistently planned for metacognition using specific terminology, opportunities for metacognition infrequently used in lesson plans | Planned for opportunities for metacognition in vague terms, not included in most lesson plans | Did not plan for opportunities for metacognition in lesson plans |

**RUBRIC FOR PROFESSIONAL DIALOGUE IN GROUP DISCUSSION/JOURNAL**

Rubric for Professional Dialogue in Group Discussion or Journal Entry (circle one)

Name: _____

| | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|
| **Challenging Tasks** | Consistently discussed challenging tasks using specific terminology and terms were used frequently in dialogue | Inconsistently discussed challenging tasks using specific terminology, challenging tasks were frequently discussed in dialogue | Inconsistently discussed challenging tasks using specific terminology, challenging tasks were infrequently discussed in dialogue | Discussed challenging tasks in vague terms, not included in most dialogues | Did not discuss challenging tasks during dialogue. |
| **Activating Prior Knowledge** | Consistently discussed activating prior knowledge using specific terminology and terms were used frequently in dialogue | Inconsistently discussed activating prior knowledge using specific terminology, activating prior knowledge was frequently discussed in dialogue | Inconsistently discussed activating prior knowledge using specific terminology, activating prior knowledge was infrequently discussed in dialogue | Discussed activating prior knowledge in vague terms, not included in most dialogues | Did not discuss activating prior knowledge during dialogue |
| **Conceptual and Procedural Knowledge** | Consistently discussed conceptual and procedural knowledge using specific terminology and terms were used frequently in dialogue | Inconsistently discussed conceptual and procedural knowledge using specific terminology, conceptual and procedural knowledge was frequently discussed in dialogue | Inconsistently discussed conceptual and procedural knowledge using specific terminology, conceptual and procedural knowledge was infrequently discussed in dialogue | Discussed conceptual and procedural knowledge in vague terms, not included in most dialogues | Did not discuss conceptual and procedural knowledge during dialogue |
| **Build knowledge socially** | Consistently discussed building knowledge socially using specific terminology and terms were used frequently in dialogue | Inconsistently discussed building knowledge socially using specific terminology, building knowledge socially was frequently discussed in dialogue | Inconsistently discussed building knowledge socially using specific terminology, building knowledge socially was infrequently discussed in dialogue | Discussed building knowledge socially in vague terms, not included in most dialogues | Did not discuss building knowledge socially during dialogue |
| **Feedback** | Consistently discussed feedback using specific terminology and terms were used frequently in dialogue | Inconsistently discussed feedback using specific terminology, feedback frequently discussed in dialogue | Inconsistently discussed feedback using specific terminology, feedback was infrequently discussed in dialogue | Discussed feedback in vague terms, not included in most dialogues | Did not discuss provide timely and effective feedback during dialogue |
| **Metacognition** | Consistently discussed metacognition using specific terminology and terms were used frequently in dialogue | Inconsistently discussed metacognition using specific terminology, metacognition was frequently discussed in dialogue | Inconsistently discussed metacognition using specific terminology, metacognition was infrequently discussed in dialogue | Discussed metacognition in vague terms, not included in most dialogues | Did not discuss metacognition during dialogue |

**SAMPLE ALGEBRA 1 LESSON PLAN**

| 10/5 | Jennifer Henderson | • Unit 1 Test Results |
| | June Sunny | • Graphing Quadratic Quiz |
| | James Wood | • Packet Updates/Edits |
| | Mona Live | |

**PLC LEARNING QUESTIONS & UNIT PLANS:**

| Date | What are students learning today? | What will students do to show that they learned it? | What am I doing for students who DID NOT learn it? | What am I doing for students who have ALREADY learned it? | Mona | Henderson/June/James |
|---|---|---|---|---|---|---|
| 9/13 | Factor and solve by GCF and Grouping | Correctly identify and factor out the GCF, write in factored form. Correctly identify the GCF from four terms and factor using grouping | | JH: Accelerated into factoring trinomials using grouping. | F10: Pull for data collection. WS: Specialized GCF and Grouping in Quadratic Book. L10: Individual conferences and summarizing of notes | F10: Review skills warmup. WS: GCF and Grouping lesson and worksheet. L10: Individual conferences and summarizing of notes |
| 9/14 | Factor and solve trinomials where a=1 | Check for GCF, Correctly identify factor pair and write in factored form for trinomials when a = 1 | JS: Remediate individually for GCF and factor by grouping | JH: Show how to factor without grouping for a = 1 | F10: Pull for data collection/ Remediation. WS: Specialized notes for book, one on one help and small group work. L10: Individual conferences and summarizing of notes | F10: Review skills warmup. WS: Factor and solve trinomials lesson and worksheet. L10: Individual conferences and summarizing of notes |
| 9/15 | Factor and solve trinomials where a > 1 | Check for GCF, correctly identify factor pair and write in factored form for trinomials when a > 1 | JH: Work with individually or in small group | JS: Extend with GCF and a>1 problems | F10: Pull for data collection/ Remediation. WS: One on One work with students who missed due to IRTOC. Specialized notes in book. L10: Individual conferences and summarizing of notes | F10: Review skills warmup. WS: Factor and solve trinomials lesson and worksheet including a>1. L10: Individual conferences and summarizing of notes |
| 9/18 | Factor and solve by factoring (mixed review) | Determine which method of factoring: GCF, Trinomial a =1, Trinomial a > 1, or grouping will be the best method and correctly factor given expressions | JS: During warm up, meet individually with students to reteach | | F10: Pull for data collection/ Remediation/ Solving Equations Remediation. WS: Specialized notes. Small Group Practice. L10: Individual conferences and summarizing of notes | F10: Review skills warmup. WS: Factor and solve by factoring mixed practice. L10: Individual conferences and summarizing of notes |
| 9/19 | Factor and solve by difference of squares | Identify perfect squares for numbers and variables, determine if expression is | | JS: Extend with GCF and DOS problems (combined) | F10: Pull for data collection/ Remediation/ Solving Equations Remediation. WS: Small Group Work at the table | F10: Review skills warmup; Factoring Organizer. WS: Mid Unit Quiz; Factor and solve by difference of squares lesson and worksheet |

**Appendix E**

**STANDARDS FOR MATHEMATICAL PRACTICE** (NCTM, 2014, p. 8)

1. Make sense of problems and persevere in solving them.

2. Reason abstractly and quantitatively.

3. Construct viable arguments and critique the reasoning of others.

4. Model with mathematics.

5. Use appropriate tools strategically.

6. Attend to precision.

7. Look for and make use of structure.

8. Look for and express regularity in repeated reasoning.