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Secondary Mathematics Teachers' Literacy Professional Learning: An Amalgamation of Adolescent Literacy, Mathematics Teaching, and Adult Learning

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SECONDARY MATHEMATICS TEACHERS' LITERACY PROFESSIONAL LEARNING: AN AMALGAMATION OF ADOLESCENT LITERACY, MATHEMATICS TEACHING, AND ADULT LEARNING

by

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SECONDARY MATHEMATICS TEACHERS' LITERACY PROFESSIONAL LEARNING: AN AMALGAMATION OF ADOLESCENT LITERACY, MATHEMATICS TEACHING, AND ADULT LEARNING

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This study uses practitioner research to examine secondary mathematics teachers' learning of literacy integration practices in the context of a district-wide literacy professional development series. The author, a secondary mathematics curriculum and instruction facilitator in a large, Midwestern suburban district, engaged in a two-year partnership with seventeen Mathematics Teacher Facilitators (MTFs) who taught literacy practices to their colleagues via a train-the-trainer model. This study provides an explicit rendering of professional development practices and ongoing, job-embedded learning vignettes of six MTF's experiences in (a) teaching literacy practices to their colleagues and (b) how they learned and enacted these practices in their classrooms. Nested in calls by the Common Core State Standards for English-Language Arts (CCSS-ELA) and Response to Intervention (RTI) process, this research is a flagship for literacy integration professional development in mathematics. The MTFs' detailed descriptions provide valuable information regarding the discipline-specific literacy practices of secondary mathematics and offer important considerations for staff developers, curriculum coordinators, including the author, literacy/instructional coaches, and administrators seeking to improve literacy integration.

Dedication

To XO, who encourages me to cherish yesterday, appreciate today, and boldly anticipate tomorrow.

Acknowledgements

My educational journey can be attributed to a great number of individuals who pushed me to see beyond my humble beginnings and embrace an optimism and insatiable hunger for learning. Grandma Gerri Fairchild fostered a sense of inquiry and built my self-esteem. Mr. Kermit McCue ignited my passion for writing and education. Peg Bay embodied the traits of a reflective practitioner as I attentively learned the art of teaching.

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Terms

ADOLESCENT LITERACY	refers to the literacy development and instructional needs of 4-12th grade students as they read, write, speak, and listen (Biancarosa & Snow, 2006).
CONSTRUCTIVIST-DEVELOPMENTAL THEORY (CDT)	focuses on an individual as an active meaning maker of experience, while considering cognitive, affective, interpersonal, and intrapersonal experiences within six hierarchical, developmental stages (Kegan, 1982; Drago-Severson, 2009).
DISCIPLINARY LITERACY (DL)	entails advanced literacy instruction which is embedded in content-area classes such as mathematics, science, and social studies (Shanahan & Shanahan, 2008). This includes "knowledge of the breadth and depth of a field of study, including knowledge of the way information is created, shared, and evaluated" (Shanahan, 2012, p. 71).
PEDAGOGICAL CONTENT KNOWLEDGE	"Pedagogical content knowledge identifies the distinctive bodies of knowledge for teaching. It represents the blending of content and pedagogy into an understanding of how particular topics, problems or issues are organized, represented, and adapted to the diverse interests and abilities of learners, and presented for instruction" (Shulman, 1987, p. 4).
POWER READING STRATEGIES	eight intermediate literacy strategies such as activating background knowledge, recognizing text features and text structures, and organizing, noting, and retrieving information (Allen, 2008) that compose Plains School District's middle school reading curriculum. These strategies were the blueprint for the literacy professional development of this research.
PROFESSIONAL DEVELOPMENT (PD)	refers to ongoing learning opportunities available to teachers and other education personnel through various modes. PD is a systematic attempt to bring about changes in instructional practices, beliefs, and student outcomes and generally occurs outside of instructional time when teachers are released from their classroom duties.
SOCIAL CONSTRUCTIVIST THEORY	is a sociological theory of constructing knowledge in social settings in which members interact and collaborate within a small culture of shared experiences, artifacts, and meanings.

CHAPTER ONE: INTRODUCTION

Educators agree that learning mathematics requires specific skills to comprehend mathematics texts; however, professional development (PD) for teachers to learn these literacy skills and how to teach them effectively to students is negligible (Davis, 1994; Moje, 2007; Shanahan & Shanahan, 2008). Content-Area literacy and "Reading Across the Content Areas" professional development initiatives, in isolation, are antiquated approaches to meeting the demands of the Common Core State Standards for English-Language Arts, Social Studies, Science, and Technical Subjects (CCSS-ELA), workplace competencies (Daggett & Hasselbring, 2007), and post-secondary expectations. Revived literacy integration professional development is proliferating in response to the CCSSELA and an increased emphasis on teaching mathematics for conceptual understanding (CCSSM, 2010; NCTM, 2000). However, much of this PD fails to address mathematics literacy in a way that supports the integration of the Common Core State Standards for Mathematical Practice, which require *doing* mathematics.

For many years, mathematics teachers have been overlooked within literacy PD (Davis, 1994; Draper, Smith, Hall, & Siebert, 2005). Instructional approaches including using picture books, biographies of mathematicians, and vocabulary graphic organizers are the norm within literacy PD, yet are tenuously tied to actually *doing* mathematics. These strategies do not attend to the situated literacy required to learn and do mathematics in secondary settings. Feeling torn between teaching mathematics content and utilizing such literacy strategies, many teachers believe they are being forced to choose, often sacrificing the implementation of such strategies for increased mathematical content coverage (O'Brien, Stewart, & Moje, 1995); thus, such approaches

have fortified a "dualism" for math teachers (Draper, Smith, Hall, & Siebert, 2005). Adopting a disciplinary literacy perspective abates this dualism and concretizes the practices and habits of mind that are central to knowing in mathematics. Waning student achievement in both mathematics and literacy (ACT, 2006; TIMSS, 1995) alongside emerging disciplinary literacy research are causes to re-examine the professional learning of teachers and associated instructional practices in secondary schools, with a focus squarely on literacy integration professional development for mathematics teachers.

Mathematics Disciplinary Literacy

Discipline-specific literacy skills. A disciplinary literacy perspective suggests situated literacy habits that are non-transferrable to other content areas. Shanahan and Shanahan (2008) developed a pyramid model beginning with basic reading skill instruction in elementary school followed by intermediate and disciplinary literacy instruction in middle and high school (Figure 1.1). This model recognizes the importance of decoding and sight word mastery and the progression to "reading for understanding" through intermediate literacy skills (Graves, 2000). Intermediate reading skills incorporate comprehension strategies such as making connections to what is read through connecting with self, other texts, and the world as well as increasing one's fluency with content-rich texts. Such strategies may be applied in any discipline with virtually any text. What's unique to this model is the third tier: disciplinary literacy (DL). These skills are integral to learning in each content area, yet are rarely taught in pre-service courses or emphasized in professional learning (Donahue, 2003). Disciplinary literacy "involves the use of reading, reasoning, investigating, speaking, and writing required to learn and form complex content knowledge appropriate to a particular discipline" (McConachie &

Petrosky, 2010, p. 16). This requires instruction that is anchored to specific literacy skills in each discipline, which can extend students' achievement by providing scaffolds for critical thinking; however, these skills do not necessarily compensate for lack of vocabulary or conceptual knowledge (Juel et al., 2010). This suggests students require all three tiers of literacy instruction, with the top two tiers *collectively* being critical to secondary students. Faggella-Luby et al. (2012) concur noting "although disciplinary literacy is a potentially powerful idea, [it] cannot replace general strategy instruction for all adolescent learners" (p. 69). Intermediate and disciplinary literacy skills comprised the content of the literacy integration professional development of this study.

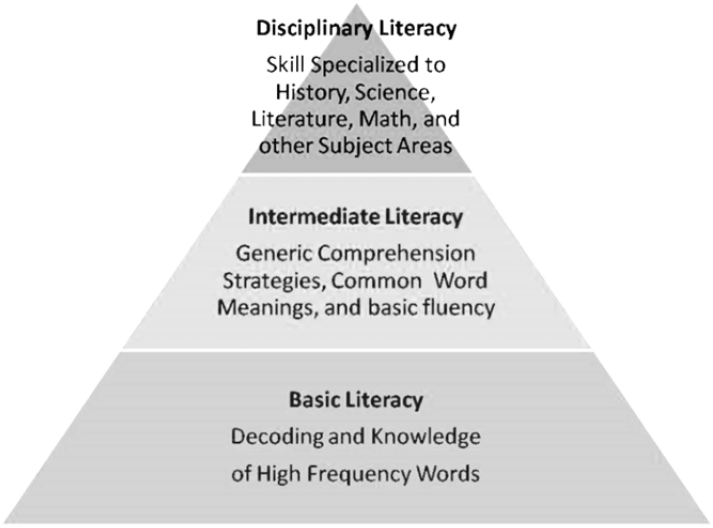


Figure 1.1: Types of literacy.

Tier II: Intermediate literacy skills. Generic comprehension strategies can be learned to understand nonfiction texts. These strategies fall within a content-area reading perspective, which typically emphasizes the use of graphic organizers to assist learners in constructing meaning of text. An intermediate literacy strategy approach (Shanahan & Shanahan, 2008) reflects how the research site structured the PD during the research

period (see Figure 1.2). Plains School District used the 8 Power Reading Strategies from the district-adopted middle school reading curriculum to structure each professional development session, reflecting the second tier of Shanahan and Shanahan's model (see Table 1.3).

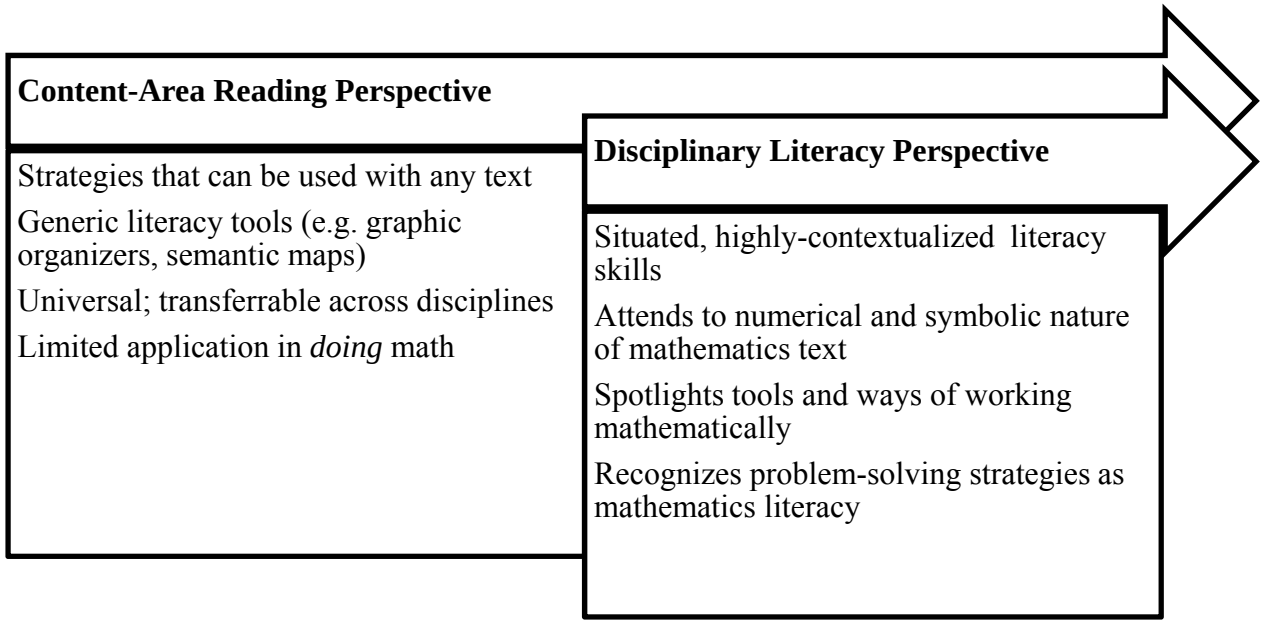


Figure 1.2: Literacy perspectives.

Power Strategy	Learning Objectives: The student …
Content/ Specialized Vocabulary	Uses a variety of strategies to identify content-specific, specialized vocabulary words; chooses and uses appropriate content-specific, specialized vocabulary words to enrich nonfiction writing.
Text Features	Identifies and uses text features to support comprehension and develop nonfiction pieces of writing that are considerate to readers.
Text Structures	Recognizes organization features of expository and informational text structures: compare/contrast, question/answer, problem/solution, cause/effect, sequence/chronology, description; recognizes and uses cue words writers use to alert readers to organization structure; uses knowledge to support comprehension and as potential organizational tools for writing.
Monitoring Understanding	Recognizes importance of monitoring understanding during reading; uses a variety of strategies to support comprehension before, during, and after reading (metacognition).
Previewing Text	Uses a variety of strategies to establish purpose for reading; plans for reading; previews text; determines possible supports and challenges of text.
Activating Background Knowledge	Uses strategies to assess current level of background knowledge; determines amount of background knowledge needed to access the text; uses features of text to connect current background knowledge to information that will be gained during reading.
Questioning	Questions the text, the author, and self as a way to focus, connect, predict, infer, analyze, and synthesize the text; asks important questions to focus reading for information; uses questioning to anticipate readers' questions when writing.
Noting, Organizing, and Retrieving Information	Uses strategies to note important information; organizes information based on learning styles and purpose for use; retrieves information to use for demonstrating learning and other writing purposes.

Table 1.3: Power reading strategies for literacy integration PD.

Plains School District relied on the District Literacy Team, comprised of secondary administrators, curriculum and instruction facilitators, and a representative sampling of teachers to develop an implementation plan for each of the above strategies (see Table 1.4).

2010-11	2011-12	2012-13	2013-14	2014-15
District Academic Vocabulary List (Middle School only)	Pre-reading and the Reading Process	Note, Retrieve, and Organize Information	Text Structures and Text Features *(integrating writing)*	Text Structures and Text Features
	Academic Vocabulary	Develop Questions About What Is Read	Monitoring One's Own Understanding	Putting It All Together
	Activating and Building Background Knowledge			

Table 1.4: Plains School District literacy professional development plan (March, 2010).

Over time, this plan was adjusted both in scope and approach based on the input of research participants and literacy team members. These modifications are described in Chapters Three and Four.

Tier III: Specialized mathematics literacy skills. Disciplinary Literacy (DL) is grounded in sociocultural theory (Cazden, 1988; Gee, 1992) and services content-area learning through knowing, doing, and communicating within a discipline (Moje, 2008). This perspective moves beyond the ideology of "every teacher is a teacher of reading" and literacy as an "add-on" used to improve reading and writing skills. Rather, it situates literacy as a fundamental part of content (Moje, 2008) so that "literacy within the discipline becomes the goal of disciplinary literacy." (Zygouris-Coe, 2012, p. 4). In mathematics, this requires actually *doing* mathematics through applying and adapting a range of problem-solving strategies that are employed by mathematicians such as working backwards, guessing and checking, or trying a special case. The distinguishing characteristic of such literacies is which mathematics texts are used and how they are applied within problem-solving contexts.

Mathematics comprehension requires understanding variable text structures and identifying the salient ways in which numbers and symbols are positioned in problems (Fang & Schleppegrell, 2010). Deciphering text is often mediated through multiple exposures accompanied by experts describing how to approach problems and reinforcing terminology (Stigler & Hiebert, 1999). Because this mediation is orchestrated by a teacher, educators must develop fluency with mathematics texts and become adept at providing effective literacy skill instruction. Even so, many secondary teachers contend that learning such skills should occur in the elementary setting while their role is transmitting content knowledge (e.g. Greenleaf, Schoenbach, Cziko, & Mueller, 2001); however, emerging reading research suggests this stance will not result in positive achievement gains. Educators have learned strong early reading skills do not automatically transform into more complex skills, those which are necessary for students to navigate science, history, and mathematics texts (Fang & Schleppegrell, 2010; Perle et al., 2005), thus, secondary educators cannot depend on their primary counterparts to provide all of the literacy instruction a child needs to be successful. Adolescents require explicit literacy skill instruction to successfully comprehend content-area texts and build disciplinary knowledge, particularly in mathematics (Osterholm, 2005); however, constraints on time to collaborate, participate in professional development, and learn the knowledge-producing practices of mathematics are persistent challenges to developing literacy integration practices (Moje, 2008; Wilson, 2011). How can literacy professional development be structured and supported to overcome such obstacles? This case study offers drivers for surmounting these challenges.

Characterizing mathematics text. Secondary students experience a great diversity in texts. For example, historical texts often require readers to recognize a cause-and-effect pattern of writing whereas math texts include a large amount of nonverbal material, such as symbols, that must be decoded accurately to solve problems. In mathematics, numerical, symbolic, and standard language interact simultaneously resulting in complex cognitive demands (Fang & Schleppegrell, 2010). To compound these challenges, academic vocabulary and the use of specialized terms require adolescents to learn in different "vernaculars" each hour of their school day. Due to these uses and conceptions of text, literacies performed in each area differ (Wilson, 2011). Accordingly, educators must conceptualize literacy broadly and explore the various uses, forms, and characteristics of text in the discipline. What constitutes *text* and *literacy* within mathematics?

Text stretches beyond print materials, as math teachers infuse a multitude of nontraditional texts into daily instruction. Siebert and Hendrickson (2010) argue, "Students cannot engage in authentic mathematical activities unless they are able to read and write the many different types of texts that are used…[including] equations, graphs, diagrams, proofs, justifications, displays of manipulatives, calculator readouts, verbal mathematical discussions, and written descriptions of problems" (p. 41). Mathematics practitioners are the first to agree that these texts are central to mathematics, but may not classify them as such (Draper, 2008). The ability for practitioners to identify and describe mathematical texts may be the first step to conceptualizing disciplinary literacy.

Literacy involves more than speaking, listening, reading, and writing. From a disciplinary perspective, "literacy is the ability to negotiate (e.g., read, view, listen, taste,

smell, critique) and create (e.g., write, produce, sing, act, speak) texts in discipline-appropriate ways or that other members of a discipline (e.g., mathematicians) would recognize as 'correct' or 'viable'" (Siebert & Hendrickson, 2010, p. 30). For example, adolescent mathematicians must learn to read and apply slope-intercept form and construct viable arguments for their problem-solving approach, perhaps communicating solutions with multiple representations. In this lens, several questions arise. How do mathematicians critique one another's approaches to solving problems? What academic discourse occurs? When mathematics teachers design lessons that uncover discipline-specific literacy habits such as these, student achievement improves (Draper & Siebert, 2004). Yet, how do mathematics teachers learn and describe their professional development for such literacy habits? This is an important question as Shanahan and Shanahan's (2008) research indicates these literacy habits are not particularly easy to learn. Disciplinary literacy skills are difficult because "they are not likely to have many parallels in oral language use and they have to be applied to difficult texts" (p. 45), yet these skills buttress learning mathematics. For example, students completing calculus learn how to determine limits of a function as *x* approaches a constant (see Figure 1.5). The applicable skills do not have oral counterparts and are cognitively challenging, therefore, mathematics practitioners must provide instruction to uncover ways of negotiating such problems.

$$\text{Compute } \lim_{x \to 3} \frac{5x^2 - 8x - 13}{x^2 - 5}.$$

Figure 1.5: Sample calculus problem.

Professional Development

At the epicenter of learning is a scholarly practitioner who orchestrates his or her classroom to maximize each individual's potential. A teacher's preparation and continued professional development influences his teaching expertise and, consequently, what his students learn (Adler, Ball, Krainer, Lin & Novotna, 2005; Alexander & Fives, 2000); therefore, professional development plays an important role in educational systems. Professional development (PD) drives changes in teachers' instructional practices, attitudes, and beliefs as well as students' learning outcomes (Guskey, 2002). Effective PD encompasses "systematic efforts to bring about change" and transformative rather than additive changes to teacher practice (Correnti, 2007). In other words, teachers who grow expertise through PD delve into the core of their practice and transform how they think about teaching and learning rather than adding more instructional strategies to their repertoire. Relatedly, Shepard et al. (2005) note, teachers who learn the theory and research (the *why*) behind a new skill or instructional strategy are more likely to transfer the learning into their classrooms, suggesting PD must stretch beyond teaching isolated instructional strategies for teachers to implement and include the theoretical underpinnings of the pedagogy under investigation.

Plains School District's literacy PD goal (see Figure 1.6) focused on improved student achievement through applying reading comprehension strategies. It attempted to merge the Response to Instruction and Intervention process designed to provide structured, tiered support to all students via interventions with reading in the content areas professional development, reflecting a technical implementation of instructional strategies. This reflects the PD approach of many U.S. school districts in which a broad

goal is developed and parceled into nuggets of in-service sessions to be consumed by practitioners (Reeves, 2010). My study demonstrates, tangentially, how PD can evolve beyond this approach. I discuss these alternative approaches in Chapters Four and Five.

> Secondary staff will understand and apply RtI+I Tier I: Best Learning Practices with a specific focus on reading comprehension strategies. Staff will understand and apply reading comprehension strategies to help students read to learn and therefore improve student achievement in the content areas. (Goal Statement, adopted Spring, 2010).

Figure 1.6: Literacy professional development initiative goal.

Adult Learning

Effective educator professional development must adhere to basic tenets of adult learning to be transformative. First, learning is nested in pedagogical experiences that stretch beyond absorbing new information. Content alone cannot serve as the single motivator; rather, teachers need to process and reconsider how their existing knowledge informs and provides purpose within new learning. Shell et al. (2010) describe effective adult learning requires participants to draw upon background experiences to build new knowledge and make connections. When learners engage in this process, the topics spiral from one another versus seeming disjointed. Because teachers come with myriad experiences, they crave these connections (Lawler, 2003); hence, PD should activate learners' background knowledge and connect to past experiences. Secondly, teachers grow expertise when they engage with a topic, fully attend to the ideas, and practice in a safe environment (Shell et al., 2010). Learning exponentially increases when practice is coupled with collaboration (Lave & Wenger, 2001; Lawler, 2003) and practitioners exercise self-direction (Knowles, 1990; Ross-Gordon, 2003). Conversely, mandating implementation is ineffective (Duke, 1990). Loughran (2008) indicates teachers must respond to the local context and make intuitive decisions rather than following a plan

after learning teaching strategies. Thus, effort, responsible risk-taking, and practice are fundamental to teacher learning. If PD surrounds technical implementation without occasion to adapt instructional strategies, teacher growth will wane.

Goals of this Study

I serve as the secondary mathematics curriculum and instruction facilitator in Plains School District, where all secondary teachers engaged in a multi-year professional development (PD) initiative aimed to increase explicit reading comprehension strategy instruction in every discipline to improve student achievement (see Figure 1.6). Each PD session was structured around eight "power" reading strategies. I inquired into how this PD was described by Mathematics Teacher Facilitators (MTFs). The MTFs were 6^{th}-12^{th} grade mathematics teachers who agreed to serve as trainers for their colleagues in addition to their regular classroom duties. Plains School district teachers (non-MTFs) experienced a hybrid of typical content-area reading PD (e.g., graphic organizers and vocabulary devices such as the Frayer Model, a well-researched process for vocabulary building) and a peppering of disciplinary literacy PD (e.g. using specific questioning practices to support students' ability to construct viable mathematics arguments and critique the reasoning of others; CCSSM, 2010). How did MTFs describe their PD experiences? How did they depict mathematics *literacy* and *text*? What can be learned from their narratives? Through a qualitative, emergent design involving interviews, observations, and artifact analyses, my research centered on the following research question: How do secondary Mathematics Teacher Facilitators (MTFs) describe their professional development in literacy integration and their enactment of it in their instruction? My research provides insights into (a) the characteristics of effective literacy

integration PD for math teachers; and (b) how math teachers integrate literacy practices. This study was designed to better understand how secondary mathematics teachers in this district described literacy professional learning and made sense of such learning using a framework that regards knowledge development as socially constructed and culturally mediated (Fosnot, 2005) throughout an individual's lifetime (Kegan, 1982).

Conclusion

Equipping students with the necessary literacy learning experiences to negotiate and understand informational text, including the symbolic, almost cryptic language of mathematics, is paramount to achieving 21st century literacy and academic demands. Given the focus on adolescent literacy and mathematics achievement illustrated by 46 states' adoption of the Common Core State Standards for English Language Arts (CCSSELA) and Common Core State Standards for Mathematics (CCSSM) among other factors, it was crucial to investigate secondary mathematics teachers' professional learning related to disciplinary literacy (Shanahan & Shanahan, 2012; Zygouris-Coe, 2012). How mathematics teachers construct understanding, describe learning experiences, and enact practices reflecting literacy integration continue to grow a rich research base, all of which are needed to inform the ongoing intersections of theory, educational policy, and practice.

CHAPTER 2: A REVIEW OF THE RESEARCH LITERATURE

Several constructs from educational research provide this study's foundation: literacy integration (Moje, 2007; Shanahan & Shanahan, 2008), pedagogical content knowledge (Shulman, 1986), adult learning (Kegan, 1982, 1994; Lave & Wenger, 1991, Shell et al., 2010), and teaching expertise (e.g. Alexander & Fives, 2000; Bullough & Baughman, 2008; Guskey, 1986). Each element informs the descriptions mathematics teachers provided concerning literacy integration PD (see Figure 2.1).

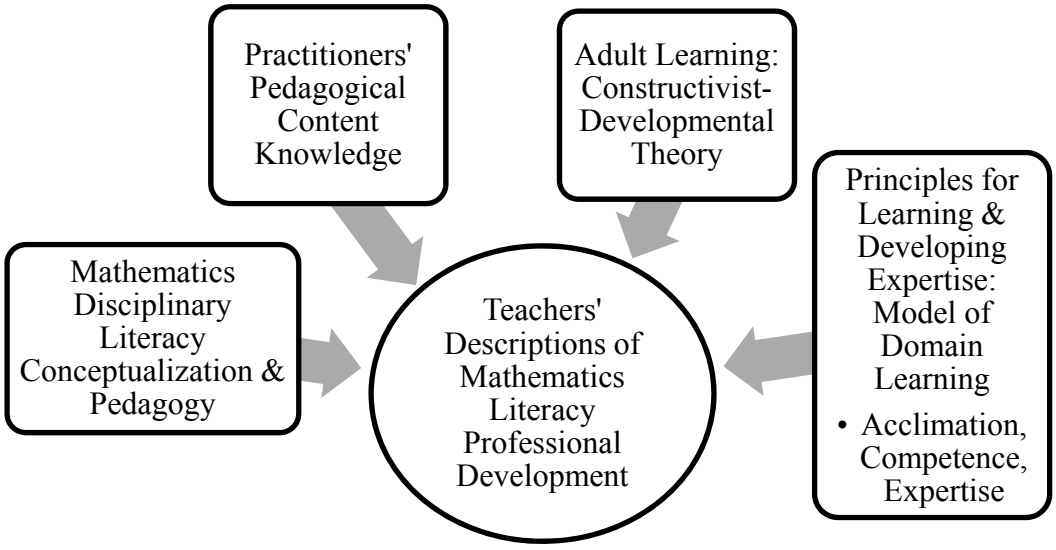


Figure 2.1: Study constructs.

A larger body of literacy research including (a) content-area reading strategy PD, (b) the readability of mathematics texts, (c) pre-service teachers' content literacy preparation and (d) literacy coaches' work with mathematics practitioners (see Figure 2.2) shaped my study. Additionally, adult learning theory and professional development research served as linchpins to understanding MTFs' descriptions.

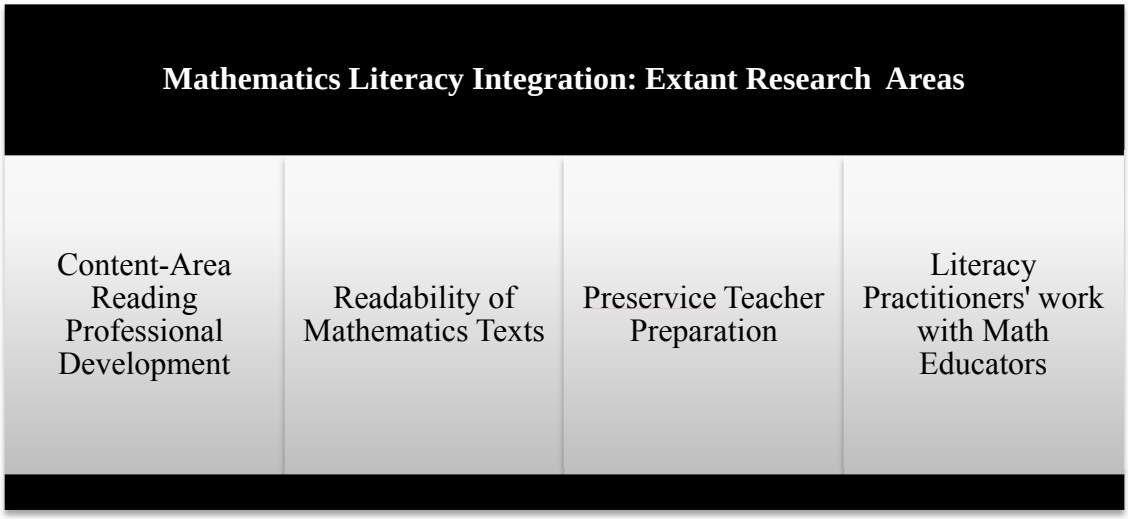


Figure 2.2: Extant literacy integration research.

Content-Area Reading Professional Development

Curriculum for content-area reading PD has been based on the assumption that knowledge can be "objectified, verified, and disseminated via compartmentalized disciplines" (O'Brien, Stewart, & Moje, 1995, p. 448). This view encompasses a positivist pedagogy (VanManen, 1990) and results in technical, efficient, packaged instructional strategies such as SQ3R (Survey, Question, Read, Recite, Review), REAP (Read, Encode, Annotate, Ponder), and ReQuest (Students read a selection and develop discussion questions directed toward the teacher), which are often applied to the expository texts of science and social studies (Schumm & Saumell, 1994). This technical application fails to address the literacies required in mathematics (Borasi, Siegel, Fonzi, & Smith, 1998) and offers little relevance for mathematics educators (Davis & Gerber, 1994; Draper, 2008).

Siebert and Draper (2008) researched how professional learning resources such as content-area methods textbooks and research reports about content literacy impact

secondary math teachers. In review, math teachers seemed to believe these generic messages about literacy (a) ignore what constitutes mathematics text, reading, and writing and (b) discredit the notion that meaning-making is situated in particular disciplinary contexts and interactions between students and teachers. To remedy, Siebert and Draper (2008) suggest math teachers need professional learning that equips them to read, speak and write mathematically—in the form of diagrams, tables, discussions, and equations; however, due to the incongruence between math teachers' perceptions and current literacy PD, Ross and McDaniel (2004) found that math teachers were more likely to implement literacy instructional strategies that required low preparation time than enact disciplinary pedagogies.

Borasi and Siegel's longitudinal research study, Reading to Learn Mathematics for Critical Thinking (RLM), is one of the few inquiries into reading and learning mathematics through literacy. Their work concerns mathematics epistemology and how *what* counts as knowing mathematics influences the literacies of classrooms (Borasi & Siegel, 2000; Borasi, Siegel, Fonzi, & Smith, 1998; Siegel, Borasi, & Fonzi, 1998). These studies are grounded in Rosenblatt's (1978) Transactional/Reader Response theory, which conceives reading as a unique experience to each individual. Every reader possesses funds of knowledge that influence what he/she interprets during the reading process, thus generating different reading responses. One RLM study investigated the potential of four cognitive reading strategies in mathematics instruction. Findings demonstrate that encouraging students to read, write, talk, draw, and enact texts provide ways to construct and negotiate interpretations of mathematics texts, thereby facilitating conceptual understanding and comprehension. Their findings (1) expanded "text" to

include student-generated writing, charts and graphs, and traditional textbooks and notes and (2) conceptualized the notion of reading and thinking like a mathematician, a disciplinary literacy perspective, though little research exists in this vein (Moje, 2007).

Conversely, Fisher and Frey's (2008) work shines light on the power of using the same instructional strategies across content areas such as SQ3R and graphic organizers, thereby promoting student transfer of learning tools across disciplines. Fisher and Frey (2008) contend "Content area teachers…need to understand the strategy…[and] how it can be effectively applied to each content area" (pp. 258-259). Wilson, Grisham, and Smetana (2009) agree, noting "effective strategy instruction…requires teachers to demonstrate the metacognitive actions required to effectively implement the strategy through modeling the process for their students" (p. 710). In short, this approach focuses on cognitive comprehension strategy instruction, which entails teachers understanding how, when, and why one would use particular strategies and reifies the notion that intermediate literacy skills are adequate for secondary disciplines. This dissonance in research illuminates the current paradox of literacy integration PD for mathematics teachers.

Readability of Mathematics Texts

Textbooks are a staple in American high schools, with as much as 75% of classroom time and 90% of homework time involving them (Ciborowski, 1992; Jobrack, 2011). They serve as repositories for exorbitant amounts of information, are overloaded with processes, theorems, and formulas, and introduce academic vocabulary at an alarming rate (Daniels & Zemelman, 2004; Lee & Spratley, 2010). Through analysis, Barton and Hiedema (2002) found mathematics textbooks have the highest content load per sentence

of all secondary textbooks, illustrating that students cannot skim a math text and understand. In mathematics,

> "Every word matters. Rereading is essential…students often attempt to read mathematics texts for the gist or general idea, but this kind of text cannot be appropriately understood without close reading. Math reading requires a precision of meaning, and each word must be understood specifically in service to that particular meaning" (pp. 49-51).

Close reading is required as symbols, numbers, letters, and words interact, producing multisemiotic texts (Fang & Schleppegrell, 2010). Very few texts include explicit and direct ways of navigating the mathematics language contained within (Phillips et al., 2009, Usiskin, 1996), which is particularly troublesome for adolescent readers (MacGregor, 1990). Furthermore, Bosse and Faulconer (2008) note, "the natural layout of mathematics textbooks—numerous pages of discussion, examples, more discussion, and more examples all followed by a few pages of compacted homework exercises—may be an inherent inhibitor to students reading the text" (p. 14). To further compound the challenges of reading mathematics text, Siebert and Draper (2012) assert, "the difficulty in reading many mathematics-related texts may not be facility with print, but facility with the underlying mathematical ideas" (p. 175). For example, calculating the cost of products which advertise "buy one, get one half off" causes many students to think that they are getting a product for half price, without recognizing they are paying 150% of the original price for two products. Semantically, this is not difficult text to read; however, through the lens of conceptual understanding, percentages and discounts are difficult. Thus, literacy and math are inextricably woven in the conceptual development process.

How do mathematics teachers support students in reading their textbooks? How do they teach "reading" mathematics? These questions are discussed throughout this study.

Preservice Teacher Preparation

Secondary content-area teachers often complete methods courses that involve the use of content literacy texts. Johnson, Watson, Delahunty, McSwiggen, and Smith (2011) found content area literacy textbooks often consider the same tools appropriate regardless of discipline, reflecting a narrow scope of literacy instructional strategies. One of the few texts devoted specifically to reading in mathematics promotes think-alouds, graphic organizers, utilization of root words and affixes to teach academic vocabulary and small-group discussion and practice (Barton and Heidema, 2002). While effective, these literacy strategies alone do not promote *doing* mathematics. Furthermore, substantial research suggests much of the coursework in content-reading strategy instruction is left behind when secondary teachers begin their careers (Alger, 2009; Korthagen & Kessel, 1999; O'Brien & Stewart, 1990), indicating an apparent lack of applicability in mathematics or modeling by cooperating teachers. These studies portray the current emphasis on applying intermediate literacy strategies, often lacking a disciplinary literacy focus, resulting in little transfer to secondary contexts.

Literacy Practitioners' Work with Mathematics Educators

A number of researchers have studied literacy practitioners' collaboration with math teachers (e.g. Alvermann, Friese, Beckmann, & Rezak, 2011; Cantrell-Chambers & Hughes, 2008; Draper et al., 2005; Draper, 2008; Draper & Siebert, 2004; Phillips, Bardsley, Bach, & Gibb-Brown, 2009). Some document the inconsistency between instructional strategies suggested by literacy coaches and the norms of mathematics

(Draper, 2002; Draper & Siebert, 2004), whereby a coach may suggest students read biographies of famous mathematicians and complete reports in lieu of doing mathematics. Interestingly, Draper et al. (2005) contend such suggestions produce a "dualism", in which teachers are positioned to choose either content or literacy rather than approach teaching through a literacy integration lens. To settle this "dual," researchers propose explicit, direct instruction of texts with an emphasis on how they are used and produced by mathematicians (Moje, 2007; Siebert & Draper, 2005). For example, teachers may think-aloud to describe the relationship between a table of values, graph, and equation while determining the best price for pizza.

Developing Teaching Expertise through Professional Development

Teaching expertise rests on what teachers know, do, and believe. Professional development (PD) is seen as a major contributor to instructional improvement and developing teachers' beliefs (Guskey, 2002). PD historically comes in the form of a full day or half-day workshops in which a large group of teachers listen as a speaker instructs them on new ideas, methods, or materials (Vogt & Shearer, 2007). The majority of teachers struggle to change, modify, or implement new strategies provided through such workshops (Costa & Garmston, 1991; Hull, Balka, & Miles, 2009). Why? Change in pedagogical approaches is complex, multifaceted, and involves myriad factors. Individual teachers possess unique background knowledge and experiences and react in their own ways to change. Consequently, PD should address specific teacher's needs (Kise, 2006; Kise 2009; Shanklin, 2006).

Kennedy (1998) conducted a seminal analysis of math and science professional development programs and their impact on student outcomes. PD showed larger

influences on student learning when it focused on pedagogical content knowledge or on how students learn the subject, which buttresses literacy integration. Clewell et al. (2004) conducted a similar evaluation of 18 PD science and math studies using student achievement outcomes as effectiveness measures. The major conclusions included: A minimum of 80 contact hours is needed to effect changes in teachers' instructional behaviors and a minimum of 160 contact hours is needed to effect changes in the classroom environment. To meet these requirements, educator professional development is moving away from "one-hit wonders" and isolated trainings focused on the transmission of knowledge to practitioner-focused, sustained, job-embedded PD that centers on collaboration, inquiry, and knowledge construction (Belzer & St. Clair, 2003; Cochran-Smith & Lytle, 2009; Guskey, 2002; Reeves, 2008). This paradigm shift distinguishes informational training from transformational professional development (see Figure 2.3).

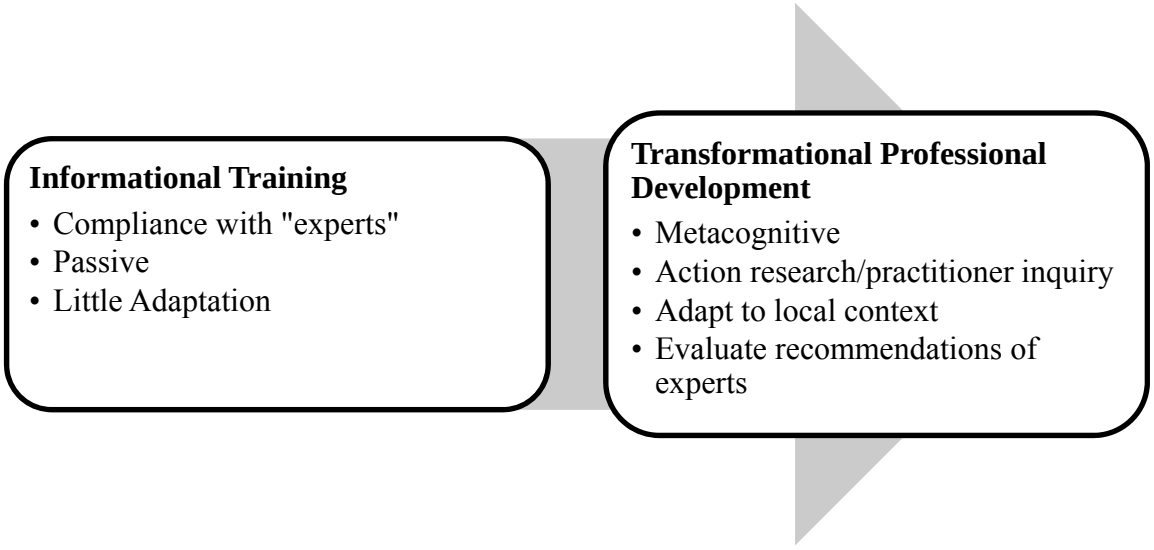


Figure 2.3: Shifting from informational training to transformational professional development.

Informational training carries a connotation of "passive assimilation of knowledge and compliance with experts' recommendations" with little ability for teachers to own information or adapt strategies to fit their instructional contexts (Duffy, 2005, p. 300). In contrast, metacognitive, or transformational, professional development fosters an environment in which teachers actively seek solutions to problems and "mediate the recommendations of experts" (p. 305). Transformational PD emphasizes conscious, reflective, mindful teaching rather than technical compliance and focuses on how a person comes to understand. Drago–Severson (2009) writes, "with transformational learning, a qualitative shift occurs in how a person actively interprets, organizes, understands, and makes sense of his or her experience" (p.11), which counters top-down initiatives that do not connect with teachers' philosophical stances or gain authentic commitment from teachers (Fullan, 1997). Coburn (2003) also notes "the more challenging a reform is to teachers' existing beliefs and practices, or the more aspects of classroom practice or levels of the system it engages, the more it may need well-elaborated materials and sustained, ongoing professional development to achieve depth" (p. 9).

Mathematics practitioners have struggled to break away from didactic instruction, in which a teacher models a problem, students engage in guided practice of similar problems, and then students complete independent practice, often in isolation (see Stigler & Hiebert, 1999). Disciplinary literacy and its associated instructional implications, including the Common Core State Standards for Mathematical Practice (see Figure 2.4), counter the observed pedagogies many teachers experienced as students. In today's classrooms, students are expected to construct arguments, listen to others' and critique

their reasoning and work within problem-solving groups. Students must monitor their comprehension of tasks, model problems with appropriate tools and attend to precision. To reify this pedagogical shift, which inherently involves literacy integration, teachers must engage as adult learners and seekers of "expert" mathematics teaching.

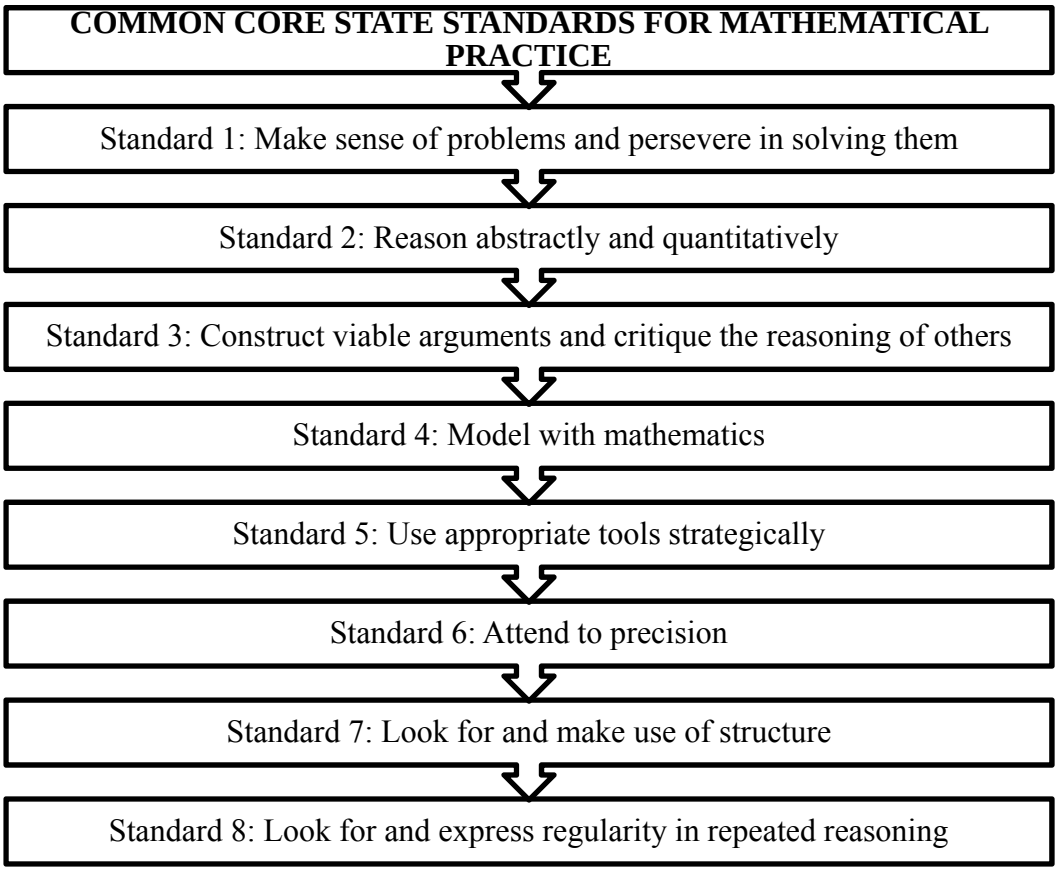


Figure 2.4: Common core state standards for mathematical practice.

In summary, teacher change and expertise blossom when professional development:

- is school-based or job-embedded (National Foundation for the Improvement of Education, 1996),

- relates to classroom instruction and student learning (American Educational Research Association, 2005; Loucks-Horsley, Stiles, Love, Mundry, & Hewson, 2010),
- actively involves teachers in the professional development activity (Desimone, Porter, Garet, Yoon, & Birman, 2002),
- is supported by district and school administration (Darling-Hammond, 1995)
- is sustained over time (Birman, Desimone, Porter, & Garet, 2000; Guskey, 2006).

Effective literacy professional development for math teachers. Cohen and Hill (2001) found content-aligned professional development impacts mathematics teachers' practice and produces high levels of reform-oriented practice with an emphasis on higher-order thinking. Unfortunately, much literacy professional development overlooks the nuances of or misrepresents mathematics, which causes resistance (Draper, 2010). The divergence between content-aligned PD that cultivates teacher change and traditional intermediate literacy PD is vast. As Alvermann et al. (2011) describe "one cannot assume that simply establishing a set of structures that emphasize the use of mathematical domain knowledge in content area reading pedagogy will lead to desired outcomes" (p. 216). In other words, mandating "reading across the curriculum" in mathematics will most likely result in little change. Rather, mathematics practitioners must be supported to (a) exercise their pedagogical content knowledge, (b) conceptualize mathematics literacies, (c) devise ways in which students can develop mathematics understanding through literacy integration, and (d) explore a range of mathematics texts through collaborative inquiry. Draper (2010) suggests as mathematics teachers integrate literacy

strategies that lend themselves to authentic mathematics tasks, they are likely to find they are already helping their students learn how to negotiate disciplinary text. In the next section, I describe the theoretical framework of my study.

Theoretical Framework

This study is grounded in social constructivism and interpreted primarily through the lens of Kegan's Constructivist-Developmental Theory (CDT), with underpinnings from Guskey's (1986) model of professional development and Alexander and Fives' (2000) Model of Domain Learning. Below, I describe the framework, emphasizing how it was applied to my study (see Figure 2.5).

Constructivist-developmental theory. Constructivism is a theory of learning that emphasizes *active* construction of knowledge (Gunning, 2010), whereby learners integrate new knowledge with existing knowledge. From this perspective, professional learning entails teachers' understanding concepts, interpreting and building meaning, and use resources to inform their instructional behaviors (Schoenfeld, 2011; Shell et al., 2010). Models specific to adult learners, such as CDT, are essential to understanding *how* teachers integrate knowledge into their practice and shape beliefs.

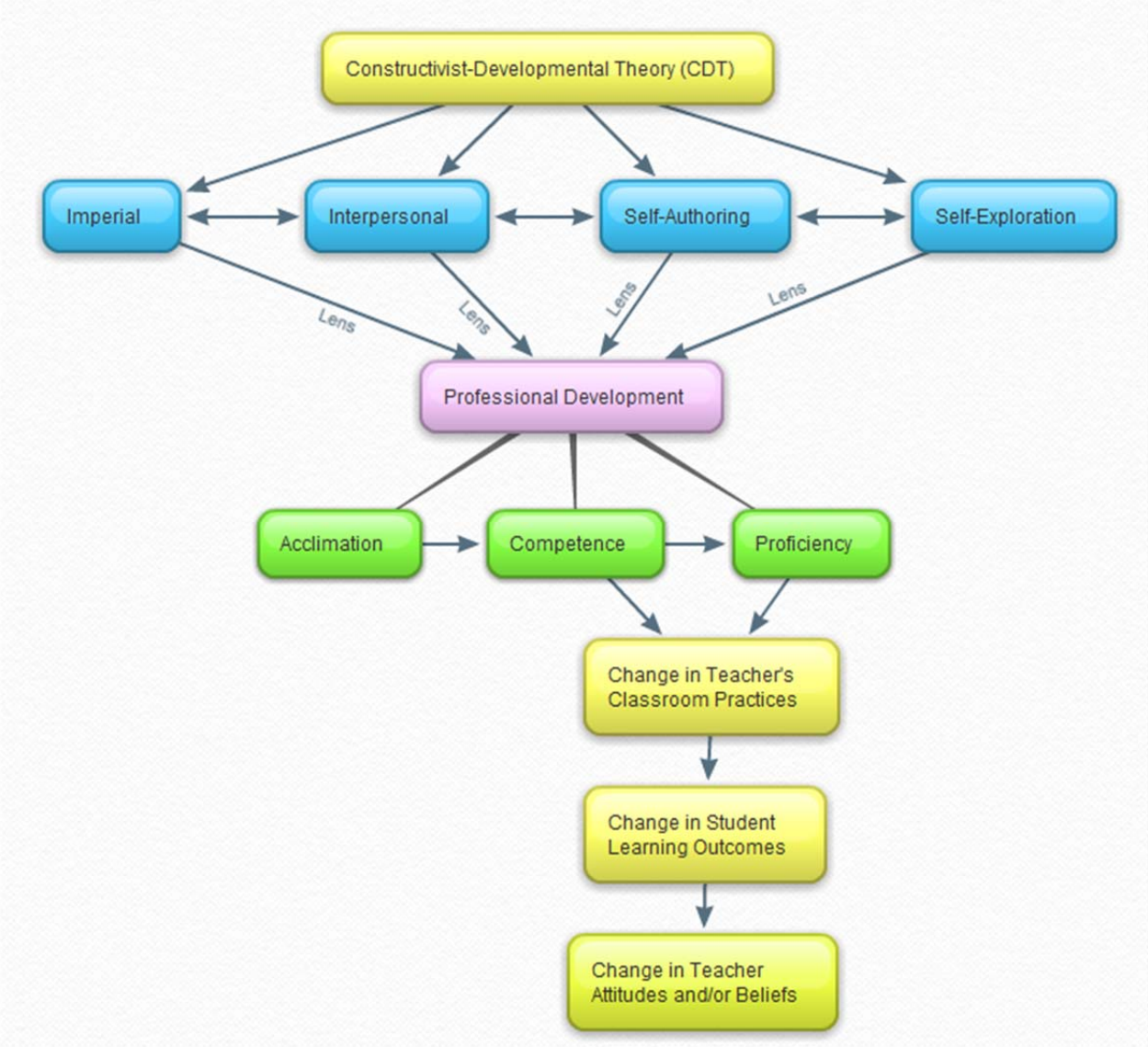


Figure 2.5: Theoretical framework.

Constructivist-Developmental Theory served as the theoretical lens for several reasons. First, CDT illustrates how differences in our behaviors, dispositions, beliefs, and thinking are often related to differences in how we construct our experience. Second, it explains why even as adults we have different needs and capacities for growth. Third, CDT asserts strongly that development is not intelligence, thereby approaching learning through a growth, or incremental, rather than fixed, or entity, mindset (Dweck, 2006). For

these reasons, CDT was used to interpret MTFs' descriptions and enactment of literacy integration.

CDT involves five orders of mind that are qualitatively different systems of thought (Kegan, 1982). Drago-Severson (2009) conceptualizes these orders into six "ways of knowing" that were the basis for data analysis. These ways of knowing include: incorporative, impulsive, imperial, interpersonal, institutional, and inter-individual (see Figure 2.6). The systems of thought rest on the relationship between the self and other or Subject and Object. In Kegan's theory, the self is the Subject as we are embedded in it. Kegan asserts that aspects of our meaning construction that are Subject are unseen because they are held internally and unquestioned, which include one's beliefs and assumptions about the world. The Object, however, can be organized and reflected upon by the self. Object are "those elements of our knowing or organizing that we can reflect on, handle, look at, be responsible for, relate to each other, take control of, internalize, assimilate, or otherwise operate upon" (p. 32). In my study, Object was PD while Self was each MTF. The first two stages, incorporative and impulsive, generally occur early in a person's life. As such, I analyzed data through the final four stages.

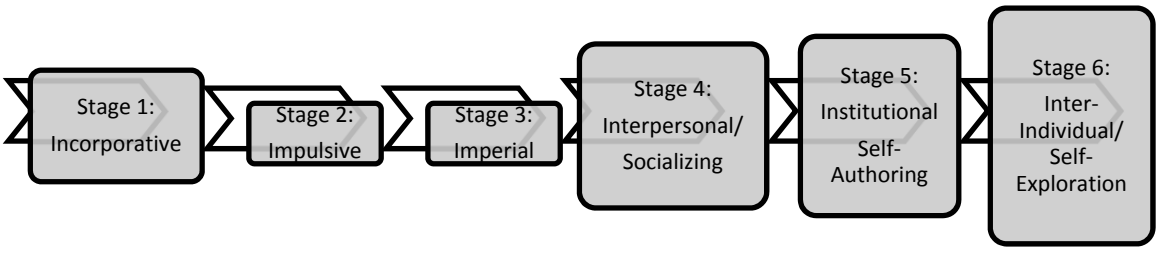


Figure 2.6: Kegan's constructivist developmental theory stages.

- **Stage 3:** The imperial self is concerned with self-interests and purposes, and has a need for concrete examples. These adults often ask the question, what is in it for me? These rule-based individuals require learning experiences that offer multiple perspectives that go beyond “right” and “wrong.”
- **Stage 4:** The interpersonal or socializing self is other–oriented, feeling responsible for others and holds others responsible. This learner centers on whether actions will be perceived positively, often seeks approval, and wants to be recognized as a good worker.
- **Stage 5:** In the institutional or self–authoring stage, learners are focused on their own values and seek to uphold their personal integrity, standards, and values. Adults in this stage are concerned with their own competence and performance and view conflict as natural and healthy. This often manifests itself in the form of deep reflection. Adult learners reflect on their multiple roles as instructional leaders, teachers, citizens, and parents, drawing upon the intersections of each.
- **Stage 6:** In self–exploration, adults want to gain insight from others and embrace others’ thinking to construct their own understanding of concepts.

Kegan's (1994) analysis of the rate of people demonstrating each CDT stage demonstrates that most adult learners will construct meaning using at least two systems of thought. However, only 18% of adults demonstrated an institutional or self-authoring system of thought. This indicates that most adults fall within the imperial and interpersonal stages, while some engage in more complex stages. According to Kegan,

people tend to engage in the same way of knowing within different roles and across different contexts. In short, teachers may engage in the same making-meaning patterns as adult learners in professional development as they do as parents. Kegan and Lahey's 2001 study, *How the Way We Talk Can Change the Way We Work*, offers support for Kegan's assertion that individuals stay within the same stage. The study suggests hidden assumptions bolster our fear of change and potential resistance to change. These hidden assumptions work to sustain our present behaviors rather than embracing new ones.

Within professional development, collaborators should understand an adult's current way of knowing and support changes in the person's meaning-making system through (1) embodying a pedagogy of relation, (2) identifying a teacher's CDT stage, and (3) adjusting instruction to promote growth. As the curriculum and instruction facilitator, I identified each MTF's CDT stage(s) to support change. Each MTF's CDT stage(s) influenced their descriptions and enactment of literacy integration, which are reported in Chapter Four.

Congruent with CDT, the National Research Council's study, *How People Learn: Brain, Mind, Experience and School* (2000) highlights three key activities that must occur to ensure a deep understanding of content. These include: (1) identifying preconceptions, (2) relating new factual information to a conceptual framework, and (3) monitoring and assessing learning. The first activity involves how an individual's experiences and prior knowledge influence current learning. This serves as Kegan's theoretical foundation. Each developmental movement from one stage to the next rests on some form of philosophical crisis or re-thinking of what has taken place previously, which leads to the second and third activities in which teachers establish connections and exercise

metacognition. This is crucial when considering extant research documenting mathematics practitioners' resistance to integrating literacy practices (see Dupuis, Askov, & Lee, 1979; O'Brien, Stewart, & Moje, 1995).

Alexander and Fives (2000) describe the progression of teacher development through the Model of Domain Learning (MDL). The MDL includes three stages, each marked by particular challenges (see Figure 2.7). During *acclimation*, teachers are orienting themselves to new, unfamiliar domains. For many mathematics practitioners, literacy integration fits within this stage as teachers begin to conceptualize text and literacy in ways that counter existing understandings. Consider the notion of calculator graphs constituting mathematics text. Teachers acclimate themselves to this new conception of *text* and begin to shift toward competence. The *competence* stage begins once learners have acquired a foundational basis of knowledge in a domain. Learners' knowledge is more cohesive and based on disciplinary principles in this stage. Math teachers may demonstrate this through describing how literacy supports mathematics learning or through utilizing graphic organizers. Once competent, learners engage in deep-processing strategies to identify problem areas and develop new knowledge relative to what is being learned. It is during this transition that *proficiency* and growing expertise are evident. Math teachers who integrated literacy while building mathematics conceptual understanding demonstrated proficiency and serve as models for others.

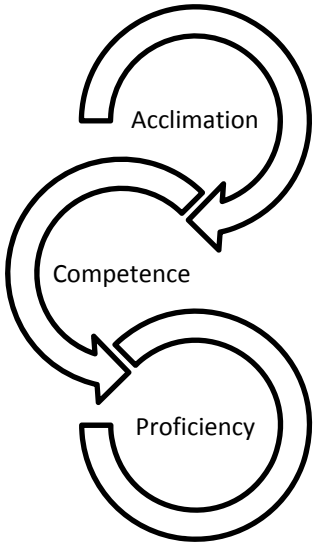


Figure 2.7: Model of Domain Learning (MDL)

The knowing-doing gap: Moving beyond acclimation and competence to proficiency. In their work, *The Teaching Gap*, Stigler and Hiebert (1999) identify the knowing-doing gap. Essentially, the effect of professional development does not rest on what educators *know*; rather, the power rests in what educators *do*. Expertise requires proficient, metacognitive use of what one has learned, which has been supported through coaching or ongoing study (Bush, 1984, Joyce & Showers' 1995, 2002). Only 10% of teachers transfer instructional strategies from PD workshops to their classrooms (Figure 2.8). This concept is substantiated in Cantrell and Hughes' (2008) yearlong professional development study of content-literacy implementation, which found extended teacher institutes that included modeled lessons and self-reflection to be effective. From these studies, one can interpolate the necessity of modeling, collaboration, and, perhaps, instructional coaching (Knight, 2007) to foster practitioner growth.

Learning Progression	Type of Training Provided	Impact on Conceptual Understanding	Impact on Skill Development	Impact on Accurate Use in the Classroom
	Theory	85%	15%	5-10%
	Theory + Modeling	85%	18%	5-10%
	Theory + Modeling + Practice	85%	80%	10-15%
	Theory + Modeling + Practice+ Coaching	90%	90%	80-90%

Figure 2.8: Joyce and Showers' (1995, 2002) relationship between type of training and instructional impact.

Teacher change. Change is an incremental process that occurs at different rates. Guskey's (1986) model suggests that teachers begin to change by first adapting their instruction, frequently monitoring the adaptations. As they progress, teachers then establish revised student learning goals. Teachers' attitudes and beliefs, per Guskey's model, may change because of increased achievement as they reconsider existing beliefs.

Conclusion. Teacher development and growing expertise are multifaceted, continuous processes focused on enhancing instructional practices and increasing student achievement relative to teachers' beliefs (e.g. Guskey, 2002; Reeves, 2008). Immersing teachers in learning that requires self-regulation and transformation pushes them toward proficiency and self-exploration behaviors (Alexander & Fives, 2000; Drago-Severson, 2009; Duffy, 2005; Kegan, 1982). This is evidenced by changes in teachers' practices, student learning outcomes, and teachers' beliefs (Guskey, 1986). Therefore, this study investigated how secondary math teachers described their professional development in literacy integration and their enactment, seeking to better understand how literacy intersects mathematics and practitioner growth in such contexts.

CHAPTER 3: METHODOLOGY, PROCEDURES, AND STUDY CONTEXT

This research is a case of how secondary Mathematics Teacher Facilitators (MTFs), who agreed to serve as peer trainers for an ongoing literacy professional development (PD) series, described their experiences. MTFs depicted how they taught literacy approaches to colleagues and integrated literacy in 6^{th}-12^{th} grade mathematics instruction. Specifically, my research examined: (a) the participants' narratives of PD sessions in which they learned literacy strategies under the direction of a national literacy consultant, (b) their experiences as presenters, teaching literacy content to mathematics colleagues via a train-the-trainer model of professional learning, and (c) their enactment of literacy integration.

Primary research question:

How do secondary Mathematics Teacher Facilitators (MTFs) describe their professional development in literacy integration and their enactment of it in their instruction?

Subsidiary questions:

- How do MTFs describe literacy in mathematics?
- What, if any, tensions exist between literacy and mathematics as cited by the MTFs?

Study Design

Research approach. Case study is an in-depth description and analysis of a bounded system and an appropriate design for practical situations emerging in everyday practice (Merriam, 2009). Qualitative case study is well-suited to situations where it is impossible to parse out the phenomenon's variables from their context (Yin, 2008). This case is bounded by location and time. I researched within a single suburban school

district and the participants' classrooms. Interviews and observations were conducted during the first two years of the PD series. Plains School District's literacy professional development was the bounded system from which I developed understanding of mathematics teachers' literacy learning.

Merriam (2009) notes qualitative research "…focused on discovery, insight, and understanding from the perspectives of those being studied offers the greatest promise of making a difference in people's lives" (p. 1). This approach allows researchers to record their own observations and uncover the meanings participants bring to their life experiences. I engaged in qualitative case study research because there is not a testable theory concerning how mathematics teachers describe literacy integration professional development or choose to hybridize literacy instructional practices. Quantitative literacy integration research would lack rich, thick descriptions (Geertz, 1973) of teacher narratives and instructional vignettes of literacy integration in mathematics.

Extant research indicates there are too few math examples of literacy, so math teachers disregard content literacy professional development (e.g., Davis & Gerber, 1994; O'Brien & Stewart, 1990). As the secondary mathematics curriculum facilitator in Plains School District, I embodied a practitioner researcher role, collected data to illuminate how math teachers describe literacy PD, and exposed effective literacy integration practices in mathematics, thereby informing my practice and the field writ large.

Practitioner research. My inquiry can be categorized as teacher research or practitioner inquiry in which research and practice inform one another and occur in tandem. Practitioner research grows from the desire to marry research and practice in the field of education (Mills, 2007), is largely defined by an insider perspective (Merriam,

2009), and is based on a teacher's praxis. It is a systematic study focused on problems of practice (Baumann & Duffy, 2001) and is situated in teachers' experiences; thus, the findings are useful in education (Lytle & Cochran-Smith, 1992). My inquiry involved an iterative search for understanding how secondary mathematics teachers describe literacy professional development and enact literacy instructional practices. My position aided in this inquiry, allowing for organic, rich data that may not have been obtained by outside researchers. I leveraged adult learning opportunities to support teacher development and varied approaches based on the individual MTF and instructional context (Bullough et al., 1997; Robinson & Darling-Hammond, 1994). Being a catalyst for adult learning is critical to improving teachers' effectiveness; thus, practitioner research can serve as a lever for educational progress (Cochran-Smith & Lytle, 2009). For example, interview data provided inroads for action, pushing me to advocate on MTFs' behalf. Even with these strengths, practitioner research has limitations.

Practitioner inquiry can be characterized as too specific to one context and not generalizable (Wilson, Floden, & Ferrini-Mundy, 2001). My intent was to gain personal knowledge about literacy integration PD to inform my practice and offer a series of vignettes that may assist other practitioners. For example, the number of literacy coaches working with math teachers is growing in response to the CCSSELA. These practitioners will benefit from the data and analysis reported in Chapters Four and Five. Some scholars contend the dual roles of a practitioner researcher cause the research to be egocentric (Bullough & Pinnegar, 2001). They argue that practitioners will err with their daily role, supporting teaching and learning; thus, sacrifice the research's validity (Cochran-Smith & Lytle, 2009). Being an insider dwarfs these concerns. The data I gathered as a

practitioner researcher captured the nuances of MTFs' descriptions and instructional practices that would be missed by an outsider.

Participant Selection. I employed purposeful sampling in which participants were defined by a set of operational criteria (Yin, 2008). A unique pool of the 2011-12 and 2012-13 Mathematics Teacher Facilitators (MTFs) were invited to participate in this study (see Appendix A-1). This approach ensured participants were highly involved in the literacy PD series, completing approximately 90 PD hours compared to non-MTFs who participated in 16.5 PD hours (Table 3.1). Desimone (2009) suggests, "[Professional development] research has not indicated an exact 'tipping point' for duration but shows support for activities that are spread over a semester…and include 20 hours or more of contact time" (p. 184). Because of the difference in PD hours, MTFs were essential participants to investigate the research questions.

Secondary Mathematics Teachers' Professional Development Experience: Contact Hours		
	Math Teacher Facilitator (MTF)	Non-Facilitator (Secondary Math Teacher)
2011-12	32 literacy consultant PD hours 8 preparation hours (off-contract) 10 presentation hours	10 required hours (3 PD sessions)
Total	50 hours	10 hours
2012-13	24 literacy consultant PD hours 6 preparation hours (off-contract) 4 preparation hours (with curriculum facilitator) 6.5 presentation hours	6.5 required hours
Total	40.5 hours	6.5 hours
Grand Total	90.5 hours	16.5 hours

Table 3.1: Study participant professional development contact hours.

There were 12 MTFs in 2011-12, with five new MTFs beginning in 2012-13 due to teacher attrition, resulting in 17 potential participants. Eight agreed to participate in the study. These MTFs taught mathematics in six of the ten secondary schools in Plains School district. Because they facilitated mixed groups of teachers from all ten sites, some secondary buildings were not represented by an MTF while others had multiple MTFs. I interviewed and observed six of the eight participants, identifying three middle school MTFs and three high school MTFs. Table 3.2 depicts characteristics of the research participants and is followed by a narrative description of each MTF.

MTF	Teaching Experience	Courses Taught (Current and *Past*)	Teaching Certification Area(s)	MTF Experience
Bailey	6 years	Math 6 Challenge Math 6 *English 6, Reading 6*	Elementary K-8 Middle Grades, 4-9 Math and English K-12 Administration	Year 1 Year 2
Brynne	6 years	Pre-Algebra Algebra I Geometry 6^{th}-8^{th} Math Intervention *Math 7, Reading 7*	4-9 Math and Social Studies	Year 1 Year 2
Claire	11 years	Math 7 English 7 *3^{rd} Grade, 5^{th} Grade, English 6, Reading, 6, Social Studies 6*	Elementary K-8 Middle Grades, 4-9 Math and English	Year 2
Pedro	8 years	Algebra II College Prep Math Foundations teacher *Geometry*	7-12 Mathematics	Year 2
Alice	11 years	Algebra II Math Studies-International Baccalaureate course College Prep Math *Algebra I, Foundations, ELO Reteaching, Geometry*	7-12 Mathematics 7-12 Administration Coaching	Year 1 Year 2
Sue	3 years	Honors Geometry Geometry Algebra I	7-12 Mathematics	Year 1

Table 3.2: Study participant characteristics and teaching experience.

Bailey

Bailey taught sixth-grade mathematics courses at Middle School A, a fairly affluent school serving approximately 1,100 sixth-eighth grade students. She taught grade-level Math 6 and Challenge Math 6, which is the typical seventh-grade math

course. Students who complete Challenge Math 6 are on a one-year advanced sequence of math courses. When I asked Bailey to describe her teaching career, she recollected teaching her siblings math as a middle-school student and her disdain for how high school math was taught. She recalled, "I wanted to be a math teacher because it [high school math] wasn't fun. I was good at it, but it wasn't fun. It wasn't exciting. We never did activities." (Interview #1, 11-20-12). Once she identified her goals, Bailey began a rigorous path by earning her Bachelor's degree and two Master's degrees. She aspired to be a middle school administrator and continually sought leadership opportunities including district curriculum writing committees and book studies during the research period. Her passion and persistence positioned her as an MTF candidate who was recommended by her building Curriculum and Instruction assistant principal.

When Bailey was approached to serve as an MTF during the Spring 2011, she agreed immediately. The primary experiences that supported her decision were previous professional development, mentoring, and co-teaching (Personal Communication, 1-21-13). She described, "If I'm going to have a choice to be in that step-ahead group, I'm going to be there…for me to work effectively and for me to be engaged, I need to have a role." (Interview #1, 11-20-12). Bailey was committed to the MTF role, presenting the sixth PD session during her maternity leave. Why? She explained, "I find it so important to be there…to be consistent during this process. Since I am one of the few math presenters that has been there since the beginning, I feel I would be letting the whole department down by not doing this again," (Personal Communication, 1-23-13). She is one of three MTFs who served during the entire research period.

Brynne

Brynne taught 6th, 7th, and 8th grade students at Middle School B, one of the most socioeconomically diverse schools in Plains School District. She had a varied teaching assignment, instructing sixth-grade Prealgebra, seventh-grade Algebra, and eighth-grade Geometry students in addition to providing interventions to struggling students. Math intervention is the articulated process to support students who are not meeting grade-level mathematics standards. Brynne's department is small, with only eight staff members.

Brynne served as an MTF during a transitive time in her career. She began at Middle School A, with Bailey as a colleague, teaching seventh-grade Math and Reading. She became an MTF after the first PD session because the middle school groups were overcrowded. An additional middle school section was created to decrease the non-MTF size to 20-22 teachers. I invited Brynne to the MTF team, as she had experience with the power strategies, exuded a positive attitude, and was an experienced staff development facilitator. She agreed. Her experience as a reading teacher became critical throughout the research period as Brynne had substantial background knowledge in teaching the eight power strategies in a reading instructional setting. During her second year as an MTF, she moved to Middle School B. Negotiating a change of grade levels as well as schools, Brynne reflected on the literacy integration PD in two instructional contexts with two different math departments, which was a needed perspective for this study.

Claire

Claire taught 7th grade mathematics and English on a middle-school team of 75 students at Middle School C, a prosperous neighborhood school serving over 1,000 students. Middle School C students are highly successful on state mathematics exams and

involved in many academic and extracurricular activities. Collaborative practice and improving instruction were linchpins to Claire's math department, with three of the eleven staff members on the MTF team. Claire was a voracious educator, often seeking additional PD opportunities. Consistently reflecting, she deliberately engaged in learning with and through others and assumed a stance of inquiry (Cochran-Smith & Lytle, 2009). For example, she shared "I love listening to other teachers and figuring out if and when I can use what they are sharing in my classroom," (Personal Communication, 1-23-13), illuminating her belief in reciprocity, that is, each learning interaction is an opportunity for everyone to learn (Knight, 2011). This disposition provided recognition from and built rapport with non-MTFs.

Claire was a prime MTF candidate to fill a vacancy on the middle school team after the first year. With eleven years teaching experience, a background in working with elementary and English-Language Learners, and experience as a English-Language Arts teacher, Claire added significant value to the MTF team. During the first year, Claire participated in the literacy PD sessions as a non-MTF and described how the sessions prompted her to return to previous practices. Specifically, she described the importance of activating background knowledge and building vocabulary during mathematics lessons. Because of her positive experiences as a participant, unique teaching position, and tenacity for growth, she was approached by her building administrator and myself to serve as an MTF during the 2012-13 school year. She continued during the third year.

Alice

Alice served as the mathematics department chair at High School A, a fairly affluent high school. She taught Honors Algebra II, Standard Level International

Baccalaureate Mathematical Studies, and College Preparatory Mathematics. Her school offers a traditional seven-period day, with additional opportunities during "zero" and "eighth" hour. Math is a part of the culture at Alice's school, with the student math club receiving multiple awards and students scoring significantly higher on state and district mathematics exams than students attending other schools. Most of Alice's colleagues were in the midst of their careers during the research period, with five to fifteen years' experience.

Alice was the most veteran MTF, having over 10 years teaching experience. As an active leader and learner, she served as one of two building staff development facilitators and participated as a member of several other committees including the District Literacy Team, which allowed her "to see the big picture" of the literacy integration PD (Personal Communication, 2013). As an aspiring administrator, Alice accepted the invitation to serve as an MTF during the first year and continued into the second. Why? "I feel like I buy into it more when I'm the presenter rather than the receiver. I like to be involved. I learn more…when I'm getting it first-hand," she said (Interview #2, 12-18-12). She was "open to change" and reflected critically on her practice, often submitting instructional improvement articles to the Office of Staff Development. She was the only high school research participant who served as an MTF for the entire research period. Upon this study's conclusion, Alice accepted a middle school assistant principal position

Pedro

Pedro taught in a diverse school, High School B, with 2,200 students who had a wide range of socioeconomic and ethnic backgrounds. His classes ranged from 24 to 30

students, were typically 90 minutes in length, and followed an alternating block schedule. Pedro taught Honors Algebra II, College Preparatory Mathematics, Algebra I, and one section of a "foundations" level course. Students who need additional support to complete Algebra I, Geometry, and Algebra II can opt to complete foundations courses over four years in lieu of the traditional three-year sequence. High School B's math staff was experienced, with five staff members near retirement and several others with over fifteen years teaching experience. When Sue (see below) was unable to continue as an MTF during the second year, I immediately thought of Pedro. He had only taught in Plains School District for a year; however, he had eight years teaching experience and displayed an insatiable appetite for professional development. Serving on district committees such as the Math Topics Vertical Team, actively participating in meetings, and effective classroom instruction were several of the characteristics that positioned Pedro as an MTF. He also brought a unique perspective from his time teaching mathematics through inquiry previously. The tagline on his email summarized this perspective: "You can teach a student a lesson for a day; but if you can teach him to learn by creating curiosity, he will continue the learning process as long as he lives. ~Clay P. Bedford." After consulting with his administrator, Pedro joined the MTF team. Planning with other MTFs and "personal classroom experiences/experiments" were the primary reasons for becoming an MTF (Personal Communication, 4-8-13).

Sue

Sue taught Geometry, Honors Geometry and Algebra I in a High School B with Pedro. Approximately 50% of eleventh-grade students meet state standards on the required summative assessment; contrast this with nearly 70% who meet standards at

Alice's school. School improvement is a constant focus at Sue and Pedro's school; thus, district administrators felt strongly that they be involved in the literacy integration PD.

Sue grew up in Plains School District and attended an in-state university. After three years teaching and beginning her master's in Educational Leadership, Sue wanted to "get her feet wet." She served on many building and district committees, while maintaining close relationships with students and fellow staff members. Sue's personal mission statement during the research period was: "To connect with purpose, inspire through passion, and believe in the power of dreams." She purposefully sought leadership opportunities and led a book study in addition to her MTF duties.

The primary experience the positioned Sue to serve as an MTF was facilitating Small-Group Instruction in Secondary Mathematics, a PD session. When I recommended Sue, her assistant principal was supportive and felt it may move the entire department forward. Many of Sue's colleagues had over fifteen years teaching experience and were steeped in traditional pedagogies, which countered some of the literacy integration strategies. After presenting three PD sessions, Sue wanted to continue as an MTF, but was unable to attend a train-the-trainer session due to her Master's program; thus, Pedro was selected as a replacement. Because she transitioned from an MTF to a non-MTF participant, her descriptions provided distinctions between the two groups. She resumed her MTF role at the end of the research period.

Researcher role. I began building relationships with many of the participants through serving as their curriculum facilitator during the 2010-11, 2011-12, and 2012-13 school years. My position was beneficial because case study research requires continuous attention and an insider's viewpoint to fully capture descriptive data. As the primary data

collection instrument, I was able to offer specific details of the data and offer knowledge embedded in context (Merriam, 2009). Furthermore, qualitative case studies are focused on deep understanding of complex social situations and incorporate rich descriptions to convey findings (Merriam, 2009); therefore, having a researcher who is active in the environment being studied is a strength of case study research (Stake, 1995). While not a practicing mathematics teacher, I was an instructional asset to MTFs. For example, I assisted MTFs in PD planning, offering specific suggestions about the content and how non-MTFs would complete the learning activities. At other times, I listened to the MTFs interact, prompting further reflection through asking questions. I am not an evaluator; therefore, MTFs did not see me as "above them" (Bailey Interview #1; Sue, Interview #1). I also assumed a researcher role, removing myself from the process, and took field note data.

Research site. Research was conducted in a large Midwestern suburban district serving approximately 23,000 students at 25 elementary schools, 6 middle schools, and 4 high schools. I selected this site due to the literacy integration PD and my position in the district. I accessed this site as a practicing secondary mathematics curriculum facilitator. An institutional approval letter for conducting the research was granted through the district's Department of Assessment, Research, and Evaluation. The following table shows the race and ethnicity demographics of Plains School district:

Years	American Indian/ Alaskan Native	Asian	Black or African American	Hispanic	Native Hawaiian or Other Pacific Islander	White	Two or More Races
20102011	88	1,023	651	1,395	63	18,987	577
20112012	85	1,067	660	1,485	58	19,067	653

Table 3.3: Plains School District demographics.

The district's student demographic is predominantly white, with some minority populations. Student performance is measured through district and state assessments in mathematics, reading, writing, and science. Demographic and contextual information for each MTF's school site is provided below. As indicated in the participant descriptions, there were three middle school and two high school sites that did not have a participating MTF.

MTF	School	Number of Math Teachers (at School Site)	Students Receiving Free and/or Reduced Lunch	Student Mobility Rate	Students Proficient on State Mathematics Exam (2011-12 School Year)
Bailey	Middle School A	10	8.45%	6.57%	81.21%
Brynne	Middle School B	8	26.12%	11.91%	66.62%
Claire	Middle School C	11	*11.44%*	8.15%	81.54%
Alice	High School A	18	13.1%	6.95%	68.15%
Pedro	High School B	22	*27.08%*	9.70%	49.41%
Sue	High School B	22	*27.08%*	9.70%	49.41%

Table 3.4: MTFs' school sites contextual information.

Data Collection

Data were collected through: (a) field notes from classroom observations and professional development sessions (see Appendix A-2 for Field Notes protocol); (b) transcripts and retrospective notes from interviews (see Appendix A-3 for Interview Protocols); (c) artifacts obtained during observations and interviews, including audio recordings; (d) a research journal; and (e) a quantitative survey, *Disciplinary Literacy in Mathematics Teacher Self-Report Survey* (see Appendix A-4). Data were collected from April 2010 through June 2013. Table 3.4 shows the relationship between research activities, research questions, and the type of data collected.

Activity	Related Research Questions	Type of Data
Research Journal	How do MTFs describe literacy in mathematics? How do secondary Mathematics Teacher Facilitators (MTFs) describe their professional development in literacy integration-and their enactment of it in their instruction? What, if any, tensions exist between literacy and mathematics as cited by the MTFs?	Journal
Professional Development Session #1	How do MTFs describe literacy in mathematics?	PD Observation 1 Field notes and Presentation Artifacts
Interview #1	How do secondary Mathematics Teacher Facilitators (MTFs) describe their professional development in literacy integration-and their enactment of it in their instruction? What, if any, tensions exist between literacy and mathematics as cited by the MTFs?	Audio recordings and transcriptions
Classroom Observation #1	Which literacy tools and strategies transfer to daily classroom practice in MTFs classrooms?	Observation 1 Field notes and Instructional Artifacts
Interview #2	How do secondary Mathematics Teacher Facilitators (MTFs) describe their professional development in literacy integration-and their enactment of it in their instruction? How do MTFs describe literacy in mathematics? What, if any, tensions exist between literacy and mathematics as cited by the MTFs?	Audio recordings and transcriptions
Classroom Observation #2	How do MTFs describe literacy in mathematics?	Observation 2 Field notes; instructional artifacts
Professional Development Session #2	How do MTFs describe literacy in mathematics?	PD Observation 2 Field notes and Presentation Artifacts

Table 3.4: Relationship between research activities and questions.

The following table provides the approximate data collected for each participant. The amount of data varied slightly depending on each MTF's instructional context, MTF

experience, and professional responsibilities. Interviews and observations were the primary data sources and were informed by the quantitative survey instrument *Disciplinary Literacy in Mathematics Teacher Self-Report Survey.* The table below delineates the data collection timeline for each MTF, which will be referenced in Chapter 4. Several PD observations occurred on the same day, which provided a variety of data that is discussed further in Chapters Four and Five. Each data source is described below.

Approximate Data per Participant	
Data Source	**Quantity**
Observations-Classroom	3, 60-minute duration
Observations-Professional Development Sessions	2, 120-minute duration
Interviews	2, 60-minute duration
Interview Transcriptions	*Approximately 35 pages per interview; total of 70 pages per participant*
Artifacts	*Approximately 500 pages*
Disciplinary Literacy Teacher Self-Report Survey	*Four, 10-question surveys producing numerical values of 1-100*

Table 3.5: Quantity of Research Data

Data Collection Timeline per MTF			
	Interviews	**Classroom Observations**	**Professional Development Observations**
Bailey, 6th Grade Math teacher	November 20, 2012 December 13, 2012	November 28, 2012 February 19, 2013 March 21, 2013	January 22, 2013
Brynne, 6th-8th Grade Math teacher	November 20, 2012 December 14, 2012	December 12, 2012 February 26, 2013 February 28, 2013 March 27, 2013 March 28, 2013	March 12, 2013
Claire, 7th Grade Math and English teacher	September 12, 2012 October 17, 2012	August 28. 2012 October 3, 2012 March 29, 2013	January 22, 2013
Pedro, High School Algebra II and Foundations teacher	December 21, 2012 February 12, 2013	February 19, 2013 March 4, 2013 March 27, 2013	January 22, 2013
Alice, High School Algebra II and International Baccalaureate teacher	November 30, 2012 December 18, 2012	January 25, 2013 March 20, 2013 April 10, 2013	January 21, 2012 February 9, 2012
Sue, High School Geometry teacher	August 30, 2012 September 20, 2012	August 24, 2012 September 14, 2012 October 12, 2012	January 21, 2012 February 9, 2012

Table 3.6: Data collection for each MTF.

Field notes. I engaged in participant observation (Angrosino, 2005) to generate field notes, which served as my primary data collection technique. Field notes documented detailed observations within the participants' classrooms relative to the eight power reading strategies used to structure each PD session (Table 3.7) and captured the PD sessions in which MTFs were presenting literacy content to non-MTFs.

Power Reading Strategies-Mathematics Disciplinary Literacy Instructional Examples
CONTENT / SPECIALIZED VOCABULARY
Environmental print Graphic organizers New vocabulary words are “front-loaded” Multiple, meaningful exposures
TEXT FEATURES
Teachers describes features Suggestions are made for which text features might be most helpful
TEXT STRUCTURES
Organizational pattern is identified Attention is drawn to structure clues
MONITORING UNDERSTANDING
Chunking of content Pauses and/or reflection time Frequent checks for understanding Think-alouds
PREVIEWING TEXT
Identified purpose Students identify unfamiliar vocabulary words Sample problems Connection to “real world”
ACTIVATING BACKGROUND KNOWLEDGE
Activity to activate Connections Teacher prompts reflection w/questions Similes, metaphors, analogies and comparisons Builds interest around topic
QUESTIONING
Predictions High-level questions Student-generated questions Talk moves
NOTING, ORGANIZING AND RETRIEVING INFORMATION
Visual images Ongoing summarization Note-taking options Graphic organizers Words and images

Table 3.7: Eight power reading strategies and observable instructional practices.

I documented: (a) the physical layout, (b) the students or non-MTFs, their roles and interactions with one another and the MTF, (c) routine actions (see Guba, 1978, "recurring regularities"), (d) unusual occurrences, either to me or to others present, and (e) other observations relative to the research questions.

Interviews. I conducted interviews until the data reached redundancy, including two; sixty-minute interviews with each participant to better understand several constructs related to the literacy integration PD (see Appendix A-3). These constructs included teacher beliefs and efficacy, decision-making, literacy conceptualization and enactment, and developing expertise through professional development. Each protocol contained 5-9 broad questions with probes designed to gain holistic descriptions. Since my relationship with the MTFs was complex, social dynamics informed and shaped the accounts and replies during interviews. I conducted each interview at a participant-selected site to secure a setting where the MTF was more apt to engage in honest conversation. Oftentimes, interviews occurred in their classrooms or at their school building in a planning area. I continued my job-embedded role, an advocate and partner, using the interview results to address issues raised by MTFs throughout the data collection process.

Artifacts. Artifacts, or other written documentation, are sources of data that may or may not be influenced by the researcher (Merriam, 1998). In my study, artifacts included but were not limited to: written communication with MTFs, PD documents, meeting minutes, and any other documents that I gathered related to the participating MTFs' descriptions.

There were several groups who met during the research period producing artifacts, including the District Literacy Team, Core Planning Team, and MTFs.

Presentation materials. PowerPoint presentations, handouts, and other materials used for PD sessions were collected from June 2011-August 2013. Several versions of each presentation's materials were available based on the audience and presenter (see Table 3.7). For example, each high school MTF team developed their own session materials depending on the non-MTFs attending. If their groups had a large portion of Geometry teachers, they might include more Geometry and less Algebra or Calculus examples, which varied from the literacy consultant's train-the-trainer materials.

Audience	Presenter
6-12 Literacy PD Presenters (*all disciplines* Train-the-Trainer session)	Literacy Consultant, Shelly
Non-MTFs (Grades 6-8)	Middle School MTFs, Bailey, Brynne, and Claire
Non-MTFs (Grades 9-12)	High School MTF Group 1, Alice High School MTF Group 2, Pedro High School MTF Group 3, Sue

Table 3.7: Literacy PD sessions where data were collected.

The presentations held during the research period explicitly focused on six of the eight power strategies. Figure 3.8 shows the timeline of sessions where artifacts were collected.

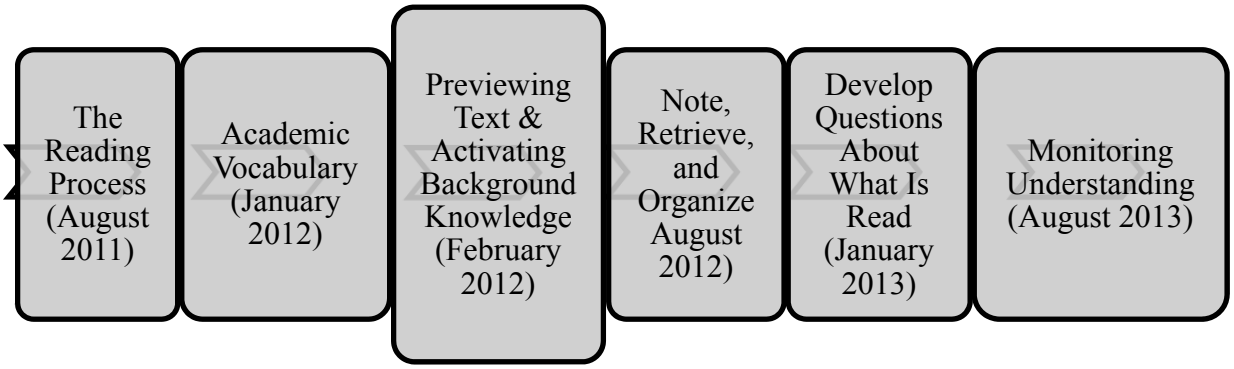


Figure 3.8: Professional Development sessions where presentation materials were collected.

Research Journal and Personal Communication. I kept a research journal of personal thoughts or tensions related to the study from April 2010-June 2013. Through processing interactions I had with the MTFs during interviews, PD sessions, and classroom observations, I was able to interpret and come to understand their experiences more fully. After meetings, I generated reflections and documented content decisions, which assisted in understanding MTFs' descriptions. E-mail messages and memos were also collected during the research period.

Disciplinary Literacy in Mathematics Teacher Self-Report Survey. A quantitative, 10-question instrument (see Appendix A-4) provided dispositional data about participants relative to the eight power strategies. MTFs self-assessed their current instructional practices and dispositions surrounding the goals of the literacy integration PD on a continuum of 1-100, with 1 representing strongly disagree and 100 indicating strongly agree, at four points during the data collection period (see Table 3.9 for the administration schedule). Prompts measured their views and practice about: (a) vocabulary, (b) building and/or activating background knowledge, and (c) previewing text. I utilized these data informally to focus my classroom observations and interviews.

Survey	Administration Window
Administration 1	September 1-8, 2012
Administration 2	September 27, 2012-October 4, 2012
Administration 3	October 19-26, 2012
Administration 4	May 29, 2013-June 5, 2013

Table 3.9: Administration schedule for teacher self-report survey.

Data Analysis

Data were analyzed through de-contextualization and re-contextualization (Tesch, 1990). De-contextualization simply means that I took the collected data and segmented it into smaller units to examine the specific pieces. I established a coding system, classifying data relative to extant research. The system included categories such as reading in mathematics, academic vocabulary, activating and building background knowledge, and dispositions toward professional development. Several themes and the relationships among them soon emerged as central, which became the focus of data analysis. I re-contextualized these data through establishing themes through constant comparative methods (Glaser & Strauss, 1967). Multiple iterations of the above process aided in constructing working hypotheses for the research questions (Cronbach, 1975) and rendering a holistic representation of MTFs' literacy professional development. Below, I offer an elaborated description of the data analysis procedures.

Interviews. I transcribed and labeled each interview with the participant's pseudonym, interview number, date, time, and location. Merriam (2009) supports this practice, "transcribing interviews is another means of generating insights and hunches about what's going on in your data" (p. 174), thereby promoting a deeper understanding of the phenomenon being studied. I supplemented the transcription with a descriptive narrative of the interview's context. MTFs engaged in member checks, where each participant provided feedback on the raw interview transcript and informed the data by best reflecting their intent. Maxwell (2005) reasons "[member checks are] the single most important way of ruling out the possibility of misrepresenting the meaning of what participants say and do and the perspective they have on what is going on, as well as

being an important way of identifying your own biases and misunderstandings of what you observed" (p. 111). Each MTF had one week to review the transcript. Upon return, I discussed any changes with the MTF until consensus was reached.

After member checks, I reread the transcript and reviewed the research questions. During a third reading, I applied open coding to identify in-vivo codes, which documented low-level inferences and the language of participants (Creswell, 1998). Each code was a short verbatim quote or phrase that adequately captured the construct or potential theme. This process served two purposes: (1) participants' language was used, thus a more accurate description of themes emerged; and (2) the potential theme was descriptive enough to reveal the identified construct outside of the interview itself, reflecting Tesch's (1990) de-contextualizing approach. The codes were then recorded and examined separately from the transcript using analytic coding, which requires higher-level inferences about the data and reveals category schemes (Merriam, 2009). Following analytic coding, I wrote memos to move data analysis forward. I utilized these memos to synthesize and revisit data, thereby serving dual purposes of analysis and further collection. The memos were shared with my advisor for peer debriefing, allowing me to probe for biases, search for deeper understanding, generate alternate hypotheses, and engage in reflective discourse (Creswell, 1994).

Field Notes. I took field notes *in situ* and elaborated within 24 hours of each observation via retrospective notes, writing about my observations and experiences. I applied the same analytic process to field notes as interviews, beginning with MTF member checks. I then coded the data and searched for category schemes, while synthesizing field note, interview, and artifact data to develop narrative analyses.

Artifacts. Documents and artifacts were analyzed using several guiding questions (Guba & Lincoln, 1981, pp. 238-239):

- What is the history of the document?
- How did it come into my hands?
- If the document is genuine, under what circumstances and for what purposes was it produced?
- Who was/is the author? What was the author trying to accomplish? For whom was the document intended?
- Do other documents exist that might shed additional light on the same story, event, project, program, context? If so, are they available, accessible? Who holds them?

These questions probed into each artifact's underlying meaning. Artifact data were also analyzed through accretion, whereby the quantity of a particular phrase or approach is assessed (Webb, Campbell, Schwartz, and Sechrest, 2000). For example, instructional materials collected during classroom observations were analyzed to determine the degree of literacy integration.

Individual and collective analysis. Each data source shaped emerging themes for each MTF. Then, all data was analyzed to establish comprehensive themes across all participants. Congruent with a grounded theory approach, I developed a diagram illustrating how the codes and categories interacted, which went through multiple iterations (Creswell, 1998). This diagram is presented and discussed in Chapter Five.

Data Validation

Because I collected and analyzed my own data, the interpretations of reality were accessed directly through my observations. Thus, I was closer to reality than if various data collection instruments were interposed between me and the MTFs. Due to the high level of interpretation and proximity involved in this methodology, it was important to engage in reflexivity as a researcher. Merriam (2009) supports, "Critical self-reflection by the researcher regarding assumptions, worldview, biases, theoretical orientation, and relationship to the study may affect the investigation" (p. 229); thus, explicitly engaging in reflexivity was crucial to the methodological and analytic aspects of my case study.

Reflexivity is documented through the use of a researcher journal and peer debriefing sessions. In addition to documenting my attempts to recognize biases and assumptions, the use of a research journal established an audit trail for the study. Peer debriefing and member checks bolstered consistency and trustworthiness in the research process. Further, multiple sources and types of data (Yin, 2008) were discussed with my advisor, during which questions and alternative ways of viewing the data were offered, allowing me to categorize data, find disconfirming evidence, and construct alternative hypotheses. Dependability and consistency were corroborated through member checks, during which MTFs reviewed narrative analyses, analytic memos, and interpretive commentary. Rich, thick descriptive accounts are used in Chapter 4 to demonstrate adequate engagement with the participants and saturation in the data (Geertz, 1973; Lincoln & Guba, 1985; Merriam, 2009). Additionally, these accounts contextualize the study such that readers can make connections and draw parallels between the current case study and their context (Merriam, 2009). In summary, human behavior is never static, so I continually assessed whether the emerging results were consistent with the data to

ensure dependability and consistency; consequently, de-contextualizing and re-contextualizing the data prior to reporting the findings (Lincoln & Guba, 1985; Tesch, 1990).

In the following chapter, I report the results of my study.

CHAPTER 4: RESULTS

I organized this chapter into three parts correlating with the primary and subsidiary research questions. Qualitative results of observations, interviews, and artifacts provide rich, thick descriptions. These results are rendered through individual MTFs and synthesized relative to the research questions. To begin, I provide MTFs' conceptualization of literacy in mathematics and perspectives of the literacy integration PD goal and planned implementation. Then, I organize their experiences in sequential order: before, during, and after the train-the-trainer PD sessions. Finally, I share MTFs' literacy integration enactment and report tensions between literacy and mathematics.

How do MTFs describe literacy in mathematics?

MTFs articulated multiple perspectives of *literacy* in mathematics. While some limited literacy to reading mathematics textbooks, others viewed it as constructing meaning of content resulting in a continuum. Below, I synthesize their descriptions from interviews and artifacts around the research question: How do MTFs describe literacy in mathematics?

At the end of the data collection period, MTFs communicated the most important things they learned through the literacy integration PD. Most began with the realization that literacy exists in mathematics, seeming to debunk previous dispositions (See Table 4.1). Some MTFs began the series wondering if literacy integration was "fitting a square peg into a round hole" (Pedro, Interview #1) and how they could facilitate a meaningful PD session with non-MTFs (Bailey, Interview #1). During interviews, MTFs described how literacy surfaces in mathematics. "You have to be able to read and understand in everything you do," Brynne explained as she associated literacy integration with student

achievement (Interview #1, 11-20-12). As the veteran MTF, Alice integrated reading *and* writing in her view: "It's [mathematics] a language in itself. Whether you're reading math or reading about math or reading directions, there's a lot of reading and writing and it's not just problem solving" (Interview #1, 11-30-12). Reading word problems, applying academic vocabulary, and the symbiotic relationship between words and numbers emerged in MTFs' literacy descriptions and enactment.

MTF	**What I learned about literacy…**
Bailey, 6th Grade Math teacher	There is reading in math.
Brynne, 6th-8th Grade Math teacher	Math does involve reading.
Claire, 7th Grade Math and English teacher	Graphic organizers start great conversations.
Pedro, High School Algebra II and Foundations teacher	It's possible.
Alice, High School Algebra II and International Baccalaureate teacher	It's possible!
Sue, High School Geometry teacher	Reading actually exists in math class!

Table 4.1: Top things I learned about literacy in mathematics.

Middle school MTFs perspectives. Bailey conceptualized literacy as *reading* numbers juxtaposed with words. "In a math classroom…literacy is reading numbers…[and] understanding how to read problems and to have comprehension of how to work out the problems. It's a completely different type of literacy," (Interview #2, 12-13-12). She expounded that reading skills are not parallel in every discipline, noting students may excel in English-Language Arts, but struggle in reading mathematics. This difference caused her to converse with parents, students, and colleagues about how to read mathematics textbooks. Bailey suggested deeper levels of understanding come through reading mathematics textbooks, not rote computation, which paralleled Brynne's conceptualization of literacy (Personal Communication, 1-13). Brynne traced the change from district math testing, consisting of computation exercises, to state testing, which

contains contextualized problems, marinated in mathematics terminology. She explained, "a lot of it [state test] is understanding word problems…so the kids have to be able to read it, to understand it, to use different strategies…students just freak out in math with words." Students' ability to read and solve word problems was paramount to MTFs' literacy descriptions and enactment.

Claire offered a unique description, tying reading to the linear, repetitive nature of mathematics; therefore, "…activating their background knowledge and knowing how to read a problem is crucial," (Interview #1, 9-12-12). She described how math is learning to relearn. Teaching students how to use their textbook, find example problems that match the current problem, and make connections between the two were linchpins to literacy in Claire's view. She explained, "What I'm trying to do and I'm not directly, but indirectly trying to teach my students is, 'you've learned this before.'[…] read this, open your book to this page, read a couple pages, now try the examples" (Interview #2, 10-17-12). Later, she offered writing and content vocabulary as inherent literacy integration tools for mathematics learning. Claire was the only MTF who explicitly tied the power strategy language, such as "Activate Background Knowledge" or "Content/Specialized Vocabulary" to her descriptions. Overall, middle school MTFs characterized literacy as reading and comprehending word problems.

High school MTFs perspectives. Pedro's conceptualization evolved. He explained, "At first it kind of seemed as though, are we trying to fit a square peg into a round hole?" Continuing, "I didn't consider it [the PD] literacy because my mentality is literacy is reading….making Geometry students read *Flatland*" (Interview #1, 12-21-12). Over time he developed an understanding that literacy is about making connections and

purported that literacy bolsters mathematical conceptual understanding. “If you isolate the two and say literacy is just for Language Arts and Social Studies or whatever, then math learning will be harder, if you tend to only focus on the numbers,” (Interview #1). He described the importance of textual descriptions, which provides context and relevancy for algorithms. For example, “If I gave a formula and let’s plug in, let’s plug in, let’s plug in, there’s no context or connection as to why or what we’re plugging in or what the use of that formula is,” which troubled Pedro. Learning mathematical processes in isolation led, in Pedro’s view, to limited applicability.

Alice suggested the language of mathematics is text. Equations, graphs, symbols, and charts are texts that can be understood with explicit literacy strategies, which separated Alice from others. She reflected, “Some people believe it [literacy in math] doesn’t exist…there is a sort of literacy to math instead of just being math problems…I think people are more aware that there is a form to literacy in terms of vocabulary and we’ve always taught vocabulary, but I don’t think they ever referred to that as literacy” (Interview #1, 11-30-12). She embodied this broad description throughout PD sessions and instructionally.

With Alice’s idea that math language is text and comes in multiple forms, Pedro reasoned why math teachers struggle with literacy integration: “We weren’t taught that way…Fifty-year teachers weren’t taught that way, but understanding that we need to tie in vocab…through word walls was something I never saw as a student. Using foldables to define or to group terms…I never saw as a student,” (Interview #2). Pedro professed the need for students to see, hear, experience, and apply mathematics in multiple ways in lieu of guided examples and independent practice; thus, literacy integration makes for a

more meaningful student experience (Pedro, Personal Communication, 1-13). Alice added, “Kids accept the different structure of the math classroom if you start it from day 1” (Personal Communication, 1-13) seeming to indicate that literacy integration requires student-centered instruction.

High school MTFs agreed mathematics is “like learning a foreign language,” requiring explicit instruction and strategies to comprehend. During a classroom observation, Sue said, “Math people are lazy…they like to symbolize everything” (8-24-12) and demonstrated how to mark diagrams with hash marks to show congruency, arrows to mark parallel lines, and use congruent () and unequal () symbols. Symbolism emerged again when Sue taught conditional statements, using the abbreviation “iff” for “If and only if” with a potpourri of other symbols (9-14-12). Before the literacy PD, Sue described how she was unaware of the exorbitant amount of vocabulary and how frequently symbols are used to summarize mathematical processes. She attributed her growing awareness to train-the-trainer sessions and articles she read as an MTF. From Sue’s perspective, literacy in mathematics surfaces through vocabulary and symbolic texts.

To summarize, high school MTFs described literacy in mathematics as a language in itself, accentuating the use of symbols to summarize and technical vocabulary to communicate. Middle school MTFs explained how literacy surfaces in all disciplines, pinpointing the importance of intermediate literacy skills that mediate comprehension of story problems and math textbooks in their courses. Students’ ability to replicate processes from textbook examples centered their descriptions. Next, I report tensions between MTFs’ descriptions of literacy and their views about math textbooks.

MTFs agreed students should acquire textbook reading skills, but most felt others were responsible for teaching students these skills. As a sixth-grade teacher, Bailey thought explicit comprehension instruction with math textbooks should begin in elementary school, as early as first grade. She described how students struggle when asked to read the textbook and how this skill would improve mathematics learning. Brynne, Sue, and Claire agreed. As a high-school teacher, Alice said, "Some kids just don't know how to use it…It seems silly that a 15-year old doesn't know how to use an index, but they don't, so we have to teach them," (Interview #1, 11-30-12). Alice was the only MTF who assumed an onus for teaching intermediate reading skills. Yet, she offered an insight that illustrates the paradox of teaching students to read mathematics textbooks:

> "I bet you could take a math textbook and take out every single page except for the practice problems and I bet 90% of your teachers would never miss the other pages, nor would the kids, because I think the books are used for the problems and nothing else. That's it." (Interview #1, 11-30-12)

Pedro shared eerily similar descriptions, indicating math texts are "disgustingly hard to read" and as a student, "…we only looked at it to get the homework problems, we didn't even read the text," (Interview #2). While MTFs wanted reading instruction to occur, they also discussed the inherent impediments of some textbooks during the fifth train-the-trainer session, stating some chapters are too dense and lack coherence. Brynne indicated this was her rationale for not distributing Pre-Algebra books, while Sue questioned the need for paper textbooks. This discussion prompted MTFs to describe characteristics of math textbooks.

"We're just digging for words in math books," Brynne shared as she highlighted how that students lack experience and struggle to read graphs, symbols, and tables. Text features, like tables, were explored in the third literacy integration session. Claire, Brynne, and Bailey attempted to implement their learning, identifying these features during lessons. Bailey explained how she taught a student to read his text. She began with how to find example problems, use headings and subheadings, and understand highlighted or boldfaced vocabulary terms. She reiterated the importance of vocabulary, stating "Without it, reading becomes more difficult," (Interview #1, 11-20-12). Alice shared this view and suggested limited vocabulary comprehension can impede doing mathematics, "If they can't understand what leads up to the math problem [vocabulary], there's your issue, not the math." (Interview #2, 12-18-12). This reinforced Pedro and Sue's view that vocabulary is prerequisite to doing mathematics; thus, substantiated mathematics as a language and the importance of reading textbooks.

In sum, every MTF indicated that reading the textbook is integral to literacy in mathematics. MTFs described textbooks as prime real estate for mathematics learning and suggested textbook reading should occur earlier in students' math courses. MTFs also noted distinguishing characteristics of math textbooks, citing instructional implications.

With these conceptualizations of literacy, I offer next MTFs' descriptions of literacy integration professional development to address the first portion of the research question: "How do secondary Mathematics Teacher Facilitators (MTFs) describe their professional development in literacy integration and their enactment of it in their instruction?" This question directly relates to data collected during train-the-trainer

sessions and the five sessions MTFs facilitated for non-MTFs. The data covered in this section comes from interviews, field notes, and artifacts. MTFs' descriptions are grounded in their perspectives of the PD goal and then organized into activities that occurred before, during, and after each train-the-trainer session. Interwoven with these descriptions, I provide evidence of tensions between literacy PD and mathematics. These data address the research question: What, if any, tensions exist between literacy and mathematics as cited by MTFs?

How do secondary Mathematics Teacher Facilitators (MTFs) describe their professional development in literacy integration?

The literacy PD series goal was "Secondary staff will understand and apply RtI+I Tier I: Best Learning Practices with a specific focus on reading comprehension strategies. Staff will understand and apply reading comprehension strategies to help students read to learn and therefore improve student achievement in the content areas" (Goal Statement, Spring 2010). This goal and an implementation timeline were distributed at each train-the-trainer session. MTFs articulated varied descriptions of this goal. From a high school perspective, Alice shared, "The goal is…being intentional about gathering the background information, working through that process of kids understanding text better…I think it's our job to teach them how to read a math book…so when they go to college, they can do it on their own. I don't think we've always done that…definitely not in math," (Interview #1, 11-30-12). Pedro suggested the goal was for students to recognize which literacy tools, such as a vocabulary graphic organizer, were most helpful to learning math. He felt he should provide opportunities for students to select tools and use them (Interview #1, 12-21-12). From a middle school perspective, Brynne proposed

the goal was "putting it all together," indicating that teachers who completed the literacy series would incorporate reading strategies to increase student achievement. She explained, "Our state math test, I think, is a reading test and then a math test, so I think what we're learning right now with the eight power strategies is important because the kids have to use those while they are taking the [state test]" (Interview #1, 11-20-12). Bailey concurred and expressed how literacy integration would support student learning through more textbook reading (Interview #1, 11-20-12). Overall, MTFs identified (a) students reading math textbooks, (b) teachers applying literacy tools, and (c) improved student achievement on the state math test as indicators of achieving the goal. The following section delineates the MTFs descriptions of literacy professional development into (a) activities that occurred before MTFs presented to their colleagues including train-the-trainer sessions and off-contract collaboration meetings (b) MTFs' facilitation experiences with non-MTFs; and (c) MTFs' reflections of literacy integration PD.

Before the literacy PD session: Preparing for non-MTFs

The MTFs offered varied perspectives of their training professional development. Each revealed tensions between the train-the-trainer sessions and mathematics. I synthesize their descriptions and report their experiences before presenting to groups of secondary math teachers.

After the fourth literacy integration session, Bailey remarked, "I love the fact that it's not coming from a district person saying 'here's what you have to do'…I like that we're in small groups and we do have that work time" (Interview #2, 12-13-12). Alice agreed that having the latitude to modify materials provided a greater sense of ownership.

She appreciated being able to structure the examples and sequence, hoping that a variety of ideas would result in literacy integration. MTFs did not always feel this autonomy.

For the first three sessions, MTFs received non-negotiable slides and pacing guidelines for each section of the presentation, such as "Slides 1-7, 10 minutes." They were required to deliver this information to non-MTFs. Bailey described these sessions as "prescribed" and "not fun" (E-mail, May 2011). Sue said the prefabricated presentations were "a waste of time to present to anybody that teaches math," so the ability to emphasize "what pertains to math" needed to occur (Interview #1, 8-30-12). Guidelines were eliminated beginning with the fourth session, allowing MTFs to make significant adaptations to each session's content.

Pedro reiterated the importance of modifying the presentation for math teachers. After the fifth train-the-trainer session, I conducted my first interview with Pedro. He shared, "We didn't use anything that she [Shelly, Literacy Consultant] brought…this last time, which had the potential to be the one where math could have been like 'Haaaaah! Finally!' I felt like it was a complete…did we just spend eight hours here? Did that just happen? It was a huge let down," (Interview #1, 12-21-12). Pedro described the inconsistencies with some of the approaches Shelly shared during the train-the-trainer session and mathematics. For example, Question-Answer-Relationships and the idea of "On Your Own" questions troubled the MTFs. Pedro said, "In math, I want students to work within the problem, find evidence, and be able to explain it. I'm not interested in their opinion from their experience. They need to do math and explain their thinking." Alice agreed: "I don't want my kids doing the easy questions. I want them to think out of the box…the 'in your own words'? I shouldn't be able to just point and find the

answers…I'm not a fan of that. I didn't like it," (Interview #1, 11-30-12). This sentiment was not limited to high school MTFs.

Brynne agreed that the training session was fruitless; however, she said, "I like our [non-MTF] presentation because we tweaked it a lot…I feel like we, with your help too, put our knowledge into it and it wasn't anything from Shelly. It was the main concept of questioning," (Interview #2, 12-14-12). MTFs noted that the adapted presentation aligned more closely with doing mathematics (Alice, Interview #1, 11-30-12) and would help non-MTFs adapt questioning practices (Bailey, Interview #2, 12-13-12).

Given Pedro's discontent with the session content, I asked him whether he thought train-the-trainer was an appropriate approach for secondary math teachers' literacy integration PD. He remarked,

> "Well, seeing how math teachers can be *(smiles)*, I wouldn't have anyone but a math teacher teaching math teachers because then the whole room would be like 'you don't know what we do. You can't apply this.' So at least with a math teacher teaching a math teacher there has to be some, 'we've dug 24 feet and we've found this coal that we can somehow turn into a diamond.' Imagine an English teacher teaching math teachers…I don't think math teachers would be receptive to what they are saying, because they'd be thinking 'Obviously you know how to apply this [8 power strategies], you have 18,000 textbooks that you go through every semester.' You know?" (Interview #2, 2-12-13).

In Pedro's view, math educators tend to believe that others would be unable to teach the salient ways of reading, writing, and communicating mathematically.

MTFs offered additional reasons to retain the train-the-trainer structure. Literacy integration seemed impossible without math teachers assisting their colleagues. Even so, middle school MTFs questioned whether an outside presenter would elicit more engagement and attention. Brynne described the challenges of peer-led professional development and struggled with balancing collegiality and leadership (Interview #2, 12-14-12). Sue noted providing "real examples that we might carry over" was far more beneficial than having one literacy presenter for all disciplines. She agreed with other MTFs that strong exemplars were crucial to successful integration. However, time to generate relevant examples was a hurdle.

After the fourth train-the-trainer session, Bailey said, "I really wish that…we could have more time to talk about 'How can we make it math?' It's a great idea, but it doesn't work for math, so how can we adjust it?" Bailey was on the cusp of crafting disciplinary literacy instructional examples for her peers, but felt stifled by time. Limited time also frustrated Claire (Research Journal, 9-13-12). She wanted to develop "new, creative ideas" and felt it was impossible. During the third train-the-trainer session, Sue explained how many of the literacy tools just "don't work for math" or are a "stretch" and expressed a desire to develop useful examples. Aside from vocabulary organizers, she felt the adapted literacy tools were contrived, lacking applicability in high-school mathematics: "It can always be a little tough with math [to adapt the intermediate literacy tools]. I always think, 'Gosh, this one would be great if I taught history. This would be great if I taught English,'" and noted that math examples I provided in subsequent training sessions were helpful (Interview #1, 8-30-12). Beginning with the fourth train-the-trainer session, I previewed Shelly's tools and generated math examples. Alice

agreed, “I have found that the ones you give us are easier to use simply because I have seen the use for them in math. Instead of me seeing a blank one from Shelly to ‘make fit my content area’, I like to see one with an idea to twist off of to create something on my own that works for my courses,” (Interview #1, 11-3-12).

Given her Math/English teaching position, Claire’s reflections were unique. In her words, “While Shelly was presenting her ideas, my brain was in overdrive trying to figure out where her strategies would work best in my day--English or math,” (Personal Communication, 5-20-13). During sessions, Claire took notes and cited ways to modify tools to support students’ mathematical understanding (Research Journal, 6-5-12; 6-4-13). For example, Claire suggested using the “Chain Reaction” graphic organizer to model order of operations. Then, students could use the organizer to explain how to find the value of an expression (see Figure 4.3). She presented this during the fourth literacy PD session. After, she used the organizer for cause-and-effect writing in her English class, demonstrating two uses of the same literacy tool.

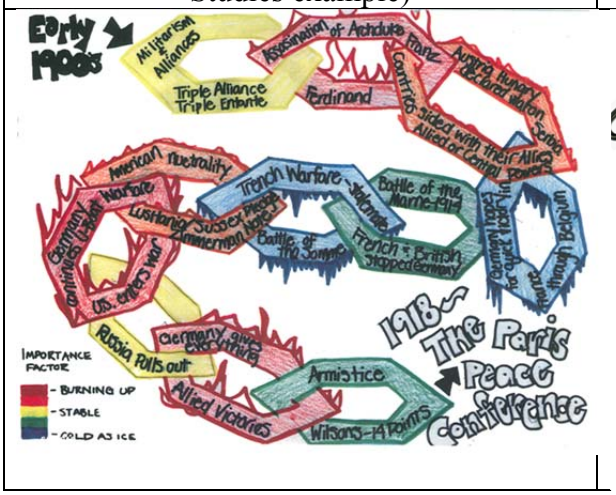
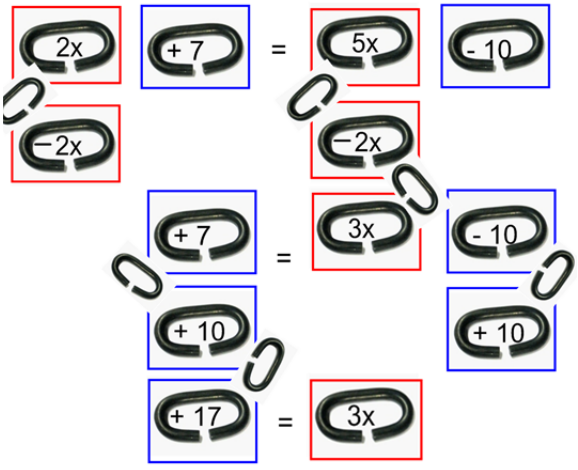
“Chain Reaction” Example (from Train-the-Trainer session; Social Studies example)	**“Chain Reaction” Math Adaptation**
	

Figure 4.3: Intermediate literacy tool adaptation-“Chain Reaction.”

To summarize, MTFs described autonomy to modify PD materials, providing math examples and retaining math facilitators as important aspects of train-the-trainer literacy integration PD. They reported tensions between the train-the-trainer session content and mathematics. In the following section, I expand on their descriptions before presenting to other math teachers through reporting interview and field note data concerning time MTFs collaborated with one another.

Collaborating with other MTFs. MTFs finalized their presentation materials each afternoon of train-the-trainer sessions. In Sue's words, this time was spent "tweaking it [training presentation] to fit math." The six middle school MTFs developed common materials while high school MTFs modified the presentation materials for their specific group of 25 colleagues. Middle school MTFs were strategic, developing roles and responsibilities. For example, Brynne modified the electronic presentation file, Bailey developed the processing agenda, and Claire researched, collected handouts and found videos. High school MTFs' collaboration was more informal. For example, Pedro and his partner shared a Lotus chart, a concept organizer (6-5-12). Alice appreciated this collaboration, "When Pedro made the chart…that's really going to help people see what types of questions you ask and how frequently," (Interview #1, 11-30-12). MTFs offered perspectives of this collaboration time, which are described below through (a) facilitation techniques and (b) developing PD materials.

Facilitation. MTFs' transition from delivering a canned message during the first year to a more autonomous role resulted in several reflections. Bailey shared, "the less you put on the screen, the better it's going to be" (Interview #2, 12-13-12). Opportunities for organic, serendipitous conversations were important to Bailey as she recommended

using quotations and pictures instead of text. During the fourth session, Bailey suggested, "Let's just put that list in the processing agenda with a checkmark on the screen. They can reflect on their own and then…maybe like a think, pair, share?" Sue took a similar approach. During the sixth session, she said, "That can go in the processing agenda. Let's find a picture for the types of learners and then we can write our notes in the power point. Get the words off the screen!" (Research Journal, 6-4-13). Comparing the first set of presentation materials to the sixth, MTFs used more graphics to elicit discussion and opportunities for non-MTFs to share literacy integration ideas. In addition, MTFs fourth and fifth session materials contain less than 30% of the original train-the-trainer presentation's slides. The first three sessions' materials closely mirror the original presentation because of the non-negotiable slides and pacing guidelines (see Train-the-Trainer: "I love that it's not coming from a district person.").

Bailey said, "The more scripted that you make a presentation, the more people are going to feel like they are being talked at," (Interview #2, 12-13-12). She explained that less scripted presentations allow for "true, real conversations rather than forced ones" and gave an example. In session four, "We started talking about note-taking, different styles of notes and I had thrown the idea out there that I wanted to do notebooks…four people came up during our break and were like, 'This is what I do. These are some things that I've tried. I don't like doing it this way, but I do it this way'…we had a very rich conversation that wasn't scripted." Bailey led others to more facilitation rather than presentation. When MTFs prepared the fifth session's materials (11-15-12), she suggested, "let's just use this example of the two tasks [Figure 4.4] and then have them

talk about it…" Her suggestion produced the sought-after result. As Bailey and Claire facilitated, non-MTFs gave examples of how they transform tasks.

TASK 1: Martha was recarpeting her bedroom which was 15 feet long and 10 feet wide. How many square feet of carpeting will she need to purchase?
TASK 2: Ms. Brown's class will raise rabbits for their spring science fair. They have 24 feet of fencing with which to build a rectangular rabbit pen in which to keep the rabbits. 1. If Ms. Brown's students want their rabbits to have as much room as possible, how long would each of the sides of the pen be? 2. How long would each of the sides of the pen be if they had only 16 feet of fencing? 3. How would you go about determining the pen with the most room for any amount of fencing? Organize your work so that someone else who reads it will understand it. *Stein, Smith, Henningsen, & Silver, 2000, p. 1-2*

Figure 4.4: Sample math tasks from fifth literacy session.

Which literacy integration materials? MTFs felt they should generate examples for their colleagues. Many expressed a disposition that effective professional development equips teachers with ideas, tools, or instructional strategies that they can put into practice the next day. Sue shared "I always want something I can use in the classroom tomorrow" (Interview #2, 9-20-12). Bailey echoed, "I think if a teacher can walk away feeling confident in something they have used [or] can have something created where they can use it the very next day in their classroom, that's success" (Interview #1, 11-20-12). She relied on three or four graphic organizers and communicated the importance of variety to ensure students would be familiar, but not disengaged. At her school, all teachers were required to use a Reading Assignment Plan (RAP) during the fall semester after the first session. From her perspective, "it was overkill" and lacked transfer to mathematics. RAPs set a reading purpose, highlight key vocabulary, text features, and critical information, and offer reading tips and will be discussed in subsequent sections. Aside from the RAP, two resources were intended to

support literacy integration: the *Adolescent Literacy Action Tool* and *Reading across the Content Areas Action Tool* (ASCD). Each resource includes approximately 100 graphic organizers with teaching notes to support implementation. "The binders" received mixed reviews from MTFs.

The vetting process for selecting literacy integration tools was arduous. Two reasons emerged. First, the adaptation of graphic organizers from other content areas conflicted with learning math, as Brynne, Sue, and Alice explained. "You can stretch it and stretch it and stretch it, but then it just becomes more of a, 'I'm going to waste my time explaining how to fill out the graphic organizer and we're losing the whole concept of what we're learning'…rather than being helpful," (Brynne, Interview #1, 11-20-12). She explained her attempt to use the "Chain Reaction" organizer with her Geometry students as they started two-column proofs. She distributed the organizer and attempted to guide students through an example. Her students were confused and asked, "Where does that go?" and "How do I know the order of the steps?" She felt the traditional format would have been more effective. During the second train-the-trainer session, Alice seemed to support Brynne, "We need to pick ones that don't distract from the content itself…that one is way too confusing. No one would ever use that-I wouldn't." Secondly, there were a limited number of math examples in the binders, with a total of 9 math-specific graphic organizers out of 188. The nine organizers were templates for problem solving and vocabulary instruction. Brynne laughed as she said, "we look at the binders [and] tools that support the power strategy and really, you should just be able to take those tools and show up the next day to use them in class somehow," yet the applicability seemed limited (Interview #1, 11-20-12).

Brynne and Bailey felt the pool of available tools was shallow, producing redundancy. Brynne illustrated this through working with new MTFs in the fourth train-the-trainer session. “We were looking through the binders and people were like, ‘Oh, I like this one. I like this one!’ And Bailey and I had been presenting and we were like, ‘we used that one.’ They were like, ‘are you sure?’” (Interview #1, 11-20-12). Even the new MTFs, who showed interest in literacy integration, didn’t remember the tools. Brynne concluded non-MTFs were not transferring their learning and felt frustrated. Did MTFs transfer their learning? While this is explored further in MTFs’ enactment, MTFs discussed their literacy integration while planning; therefore, some data is reported here as it relates to their collaboration time.

Bailey described how often she integrated literacy tools. “I don’t use them once a week, probably once every two weeks, but I know I’m way ahead of where a lot of teachers are at. I know a lot of them aren’t even using any at all,” (11-20-12). When I asked her to speculate why others weren’t using the tools, she was able to quickly cite the following obstacles, which other MTFs supported:

1. Time-Teachers lacked time to process how tools best support math learning and how to teach with them. Alice noted, “With such busy schedules…teachers don't want to use their time flipping through binders looking at ideas that may not apply. It may be helpful to cut down the binders to the examples that seem to fit best with math. ” (Personal Communication, 3-1-12).
2. Instructional materials- New math textbooks were purchased in 2008; hence, many teachers already had established lessons that seemed effective. Bailey thought literacy integration would be more likely during a textbook adoption. She

described, “If it’s [literacy] still pushed, when the new text comes…people are more likely to implement and change when that happens, rather than I’ve got this, this, this [and] I’m going to use the same stuff I used last year” (Interview #1, 11-20-12).

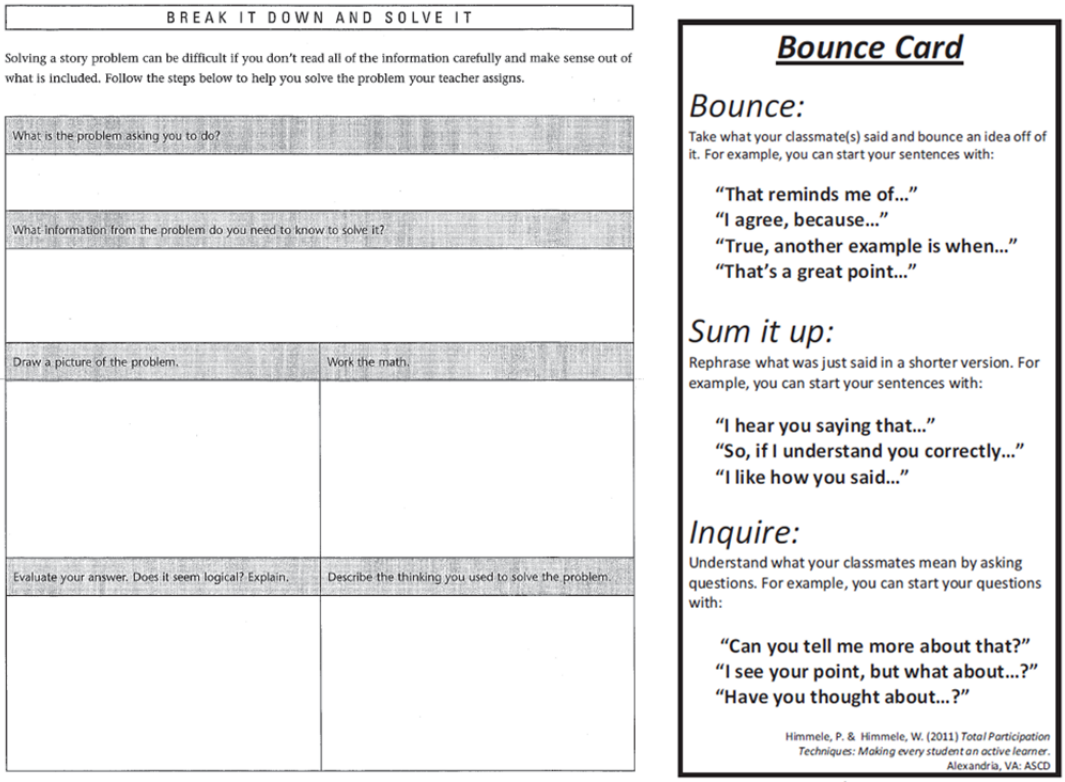
3. Timing of instruction-Brynne noted that sometimes a literacy tool from PD would “fit” a math concept, but the instructional unit it “matched” would be six months away. Because of this gap, Brynne reported that her colleagues struggled to integrate literacy.
4. Professional Learning Communities (PLCs)-Consistency between teachers in pedagogy, scope, and sequence of instruction barricaded literacy integration. Claire articulated challenges as PLC members said literacy integration was “her style,” while Bailey felt frustrated that her efforts were not reciprocated. She felt PLC members should share in developing and implementing the tools.

Bailey indicated “the people that you constantly work with are going to be the ones that I know are using things. The people that sit in their room and never want to be involved in any type of staff development, which makes up 75% of our math staff…they are the ones that aren’t going to use it,” (Interview #1, 11-20-12). This seemed to reflect a dichotomy of teachers who were willing to integrate literacy tools and those who were not.

Beyond the binder: Edging toward disciplinary literacy. MTFs promoted constructive struggle and opportunities to build mathematics conceptual understanding through literacy integration. Claire described ways to concretize students’ understanding. She explained how different senses need to be activated while learning mathematics and how sketching and writing are comprehension catalysts. Middle school MTFs also used

student work samples, classroom video clips, and photographs to illustrate literacy integration.

High school MTFs developed problems to complement existing organizers such as "Break It Down and Solve It" and used "Bounce Cards" (refer to Figure 4.5) to reinforce mathematics discourse, demonstrating the necessity to go "beyond the binder." Sue envisioned facilitation during the sixth train-the-trainer session: "Let's have them get into groups. We will have each problem on a different colored sheet of paper. They can choose which problem they solve, but we will explain how we want them to use the Talk Moves that Janet shared with us…as they explain their problem, we will ask the other teachers to use the Bounce Cards to ask questions and critique the reasoning of their peers. The speaker will have to…construct viable arguments to explain their thinking," (Research Journal, 6-6-13). Talk Moves (Chapin, O'Connor, & Anderson, 2009) include: (a) revoicing what has been stated, (b) asking students to restate or apply someone else's reasoning, (c) adding on to what has been discussed, and (d) using wait time. I facilitated teachers' investigation of these and the Mathematical Practice Standards (CCSSM, 2010), including "construct viable arguments," during the second year of literacy integration PD. Sue's description is a prime example of how intermediate and disciplinary literacy strategies buttress *doing* mathematics. "Break It Down and Solve It" served as a problem solving map and mathematical discourse was supported by the Bounce Card and Mathematical Practice Standards.



BREAK IT DOWN AND SOLVE IT

Solving a story problem can be difficult if you don't read all of the information carefully and make sense out of what is included. Follow the steps below to help you solve the problem your teacher assigns.

What is the problem asking you to do?	
What information from the problem do you need to know to solve it?	
Draw a picture of the problem.	Work the math.
Evaluate your answer. Does it seem logical? Explain.	Describe the thinking you used to solve the problem.

Bounce Card

Bounce:

Take what your classmate(s) said and bounce an idea off of it. For example, you can start your sentences with:

"That reminds me of..."
"I agree, because..."
"True, another example is when..."
"That's a great point..."

Sum it up:

Rephrase what was just said in a shorter version. For example, you can start your sentences with:

"I hear you saying that..."
"So, if I understand you correctly..."
"I like how you said..."

Inquire:

Understand what your classmates mean by asking questions. For example, you can start your questions with:

"Can you tell me more about that?"
"I see your point, but what about...?"
"Have you thought about...?"

Himmele, P. & Himmele, W. (2011) *Total Participation Techniques: Making every student an active learner.* Alexandria, VA: ASCD

Figure 4.5: Break It Down and Solve It organizer and Bounce Card.

MTFs reported a sense of responsibility to implement the power strategies and tools in their classrooms so they could articulate how they could be applicable in math before presenting to peers. Brynne shared, "as presenters, we have to buy into it." Bailey, Alice, Pedro and Claire shared similar feelings. Claire said, "[after train-the-trainer] I go straight back to my class and try to figure out how to work the strategies into my lessons," (Interview #1). By using the strategies, Claire shared "what works" with MTFs and suggested some tools be eliminated before non-MTF literacy sessions. Other MTFs took a similar approach. Pedro reflected, "I had tried a lot of these things [note-taking tools] in my class last spring, so that gave me personal research for the August session. Had I not done that, I don't know what I would have done. It would have been more data-driven stuff, but I was able to bring in my own experiences and that helped a lot"

(Interview #2, 2-12-13). Allowing tools to percolate in their classroom contexts (a) produced richer examples of literacy integration and (b) eradicated less effective examples. After finalizing materials, I asked MTFs how they prepared for non-MTF literacy sessions.

Preparing to present. After finalizing materials, each MTF took a distinctive approach to preparation. Each described his/her approach and elaborated on the collaborative relationship among MTFs during interviews. These data illuminate MTFs descriptions of literacy integration PD. I begin with middle school MTFs, Bailey, Brynne, and Claire and conclude with high school MTFs, Alice, Sue, and Pedro.

Bailey. Bailey was self-assured, laughing as she said, "I am embarrassed to say this. When I put something together, I feel pretty good about it ...I might glance over it the night before, but I'm pretty good at just kind of going along as things go," (Interview #2, 12-13-12). Her confidence emanated during sessions as her MTF partners, Claire and Matt, went from being very tense to relaxed as they facilitated sessions with middle school math teachers (Research Journal, 8-2012; 1-2013). Before sessions, Bailey did not delineate responsibility for each presentation slide, equating this approach with co-teaching. She described, "As we come up to a slide, we talk about it…It works and we play off of each other…It's more of a relaxed conversation," similar to Brynne and Larry's approach described below. As Bailey's partner and a first-time professional development facilitator, Claire prepared strategically and thoroughly.

Claire. With ten years teaching experience, yet limited MTF experience, Claire described her "full presence" during planning sessions, offering specific examples of writing integration to share with middle school math teachers. This allowed her to build

confidence as a presenter and play an integral role in each session's instructional materials. After developing the presentation, she rehearsed her explanations and reviewed the scope and sequence of content. The morning of sessions, she arrived early, asked Bailey questions, and reviewed handouts to ensure the presentation would "flow." She took her role seriously as she implemented instructional strategies and provided transparent reflections to middle school math teachers as to how effective the approaches were in her context.

Brynne. Like Bailey, Brynne presented with two different MTFs during the research period. I prompted her to describe how she and Larry, her second partner, prepared for the fifth session. She described, "We walk through [the presentation] because it's been a couple months since we've seen it…We don't really go, 'who's going to do what slide?' If I stop talking during the presentation, he'll chime in or I'll chime in. It just feels really laid back, not scripted, not holding something with words printed out from PowerPoint and reading" (Interview #2, 11-20-12). She noted the value of having compatible "personalities." She explained, "I like presenting with my current presenter because it's more natural, but when I've been with others presenters, they were like, 'you do slides 1-10 and I'll do this'...I didn't like that." She noted how Larry was masterful at building rapport during sessions by saying, "I thought this would never work and I tried it and the kids liked it," (Interview #2, 12-14-12). Their partnership produced confidence so they were able to "diffuse situations together." Brynne then described the morning of a literacy PD session.

"It's *really* nerve-racking. When I've presented before, I was passionate. I knew the presentation was great, knew people were going to learn from it, but [with literacy

integration PD] it's driving there and being like, ‘Ok, I know we're not going to start at 8 o'clock because people are purposely going to be late because they don't care.’ They know who is presenting.” As she continued, she said, “It's nerve-racking when you see everybody in there and you can already hear people [saying] ‘I hope we get out early. Do we get a lot of work time? Do we get to use our computers?’ ‘Here we go again.’" When I asked her how she copes with her nerves, she stated, “Getting there early. Getting the room set-up. I like presenting at [Plains High School C] because they have tables,” producing a conducive environment for discussion (Interview #2, 11-20-12). She expressed how Larry reassured her, while her previous MTF partner made her feel isolated and responsible for “doing all of it.”

Alice. Alice, the veteran high-school MTF, presented literacy integration sessions to high school math teachers with two different MTF partners; thus, completed most of her preparation during the afternoons of train-the-trainer days. She expressed, “I feel like I do most of it then [because] when I had someone in my building, it was much easier. We kind of put everything aside and then we would come back to it a week before the presentation” (Interview #2, 12-18-12). I asked her to describe the differences between having an MTF partner at the same versus different high schools. She reported, “[My partner] is fantastic and we work very well together. It’s just hard sometimes to touch base with each other, so sometimes I’ll call her at home [and] talk about the transitions so it looks more like we know when we’re switching in and out…we try to help each other…support each other’s ideas and answer each other’s questions, but yet we still have an idea of who is doing what…so it looks like we’re more prepared.” Alice wanted two MTFs per high school for the ease of planning, attending to the local context, and the

ability to ask, “Why don’t you stop by? I’m trying this today.” Having a partner outside of her school site required additional phone conversations and fortified the divide-and-conquer approach within the high school MTF teams, defining who would be responsible for each section of the presentation in lieu of the middle school MTFs, who opted for co-facilitated sessions.

Alice described the morning of presentations and chuckled, “Nothing’s different for me. I don’t like doing things the morning of presentations, so I get there early, make sure everything is set up,” like Brynne. Alice was also similar to Bailey: “I don’t feel like I need to flip through it another time or look through my notes another time because I feel like I’ve already done that. So morning of for me is just like walking into another day of teaching.” I observed this multiple times as Alice greeted non-MTF colleagues, laughing and sharing personal stories (Research Journal, 1-12; 8-12). She exuded confidence and preparedness. Her colleagues, Sue and Pedro, had a unique situation, as each worked with the same MTF partner in separate years. Sue partnered with Lance during the first year, while Pedro worked with him during the second year.

Sue. Sue, with two years teaching experience, began by describing the importance of collaboration and her relationship with other MTFs. “…it’s been nice, with [the literacy PD] to work with other secondary math teachers and bounce ideas off of each other and see how we apply it to math because I think that’s the hardest part of a lot of the PD. A lot of it can be difficult to apply to a math classroom,” (Interview #1, 8-30-12). As Lance and Sue prepared, “We just divided up slides and topics and said, you do this, I’ll do this and we didn’t really check in with each other to make sure it was ok.” When I asked her to explain, Sue expressed, “I trust his work, he trusts mine.” They did not share

materials ahead of time, yet she knew the literacy session would go well because they had "personalized" it. For example, "I think one time we had talked quite extensively about the Khan Academy and that was something that Lance contributed. That was great because…it got people's minds going a little bit [to] bring in real-world experiences and other ideas for them." She continued by explaining how the original presentation materials would be ineffective, "because Shelly's was not really relevant to math" and how she strategized with Lance to elicit participation. "We had the same audience each time and we kind of got to know, who is going to participate, [asking herself] 'Who do I need to get to chime in?' Because I know they are good teachers and have good ideas." Pedro offered similar descriptions of his preparation with Lance.

Pedro. Pedro, with diverse teaching experiences and no prior MTF experience**,** made significant modifications to the presentation the night before the fourth session. Why? Pedro said, "Two years into this with every other, well maybe not every other, but some teachers not wanting to be there, we said, 'You know? We need to make this entertaining. Not entertaining, we need to make this meaningful.'" Because of this unique change, I asked Pedro to describe his preparation. He said, "The day of, we were just kind of trying to pump each other up like 'we're going to get through this. We're going to do this.' I know that Lance and I made it our own and we were comfortable." While "comfortable," Pedro also divulged a level of concern that administrators or district leadership may frown upon the changes. Even so, he felt prepared and confident that they had developed a meaningful session. Pedro depicted a trusting relationship with Lance, expressing "I think we both respect what each other has to say. We don't impose what we do on each other and I think we flow great together. I don't think there is any

competition. We're alike in a lot of ways, which could be bad, but it's not in our case" (Interview #2, 2-12-13). Collectively, it seems Lance was a strong MTF colleague for both Sue and Pedro.

Clearly, MTFs collaborated with one another to critically investigate literacy integration in mathematics, prepared to present to colleagues in various ways, offered insights to the train-the-trainer sessions facilitated by the literacy consultant and assessed the applicability of training session materials in mathematics. In the following section, I report interview and field note data surrounding MTFs' facilitation with groups of secondary math teachers to further illustrate the literacy integration PD.

During the literacy PD session: Presenting

MTFs presented to their colleagues at Plains High School C on staff development release days. Table 4.7 shows the number of sessions each MTF facilitated during the research period. I conducted observations and solicited MTFs' descriptions of these sessions to address the first portion of the research question: How do secondary Mathematics Teacher Facilitators (MTFs) describe their professional development in literacy integration and their enactment of it in their instruction? Data reveals how MTFs presented strategies to colleagues.

MTF	Number of Sessions Facilitated
Bailey	5
Brynne	4
Claire	2
Alice	5
Sue	3
Pedro	2

Table 4.7: Number of sessions each MTF facilitated.

Non-MTFs were in the same groups across sessions, which allowed participants to build rapport and reflect on previous sessions (Bailey, Interview #2, 12-13-12; Claire Interview #1, 9-12-12; PD Evaluation Analysis 9-1-12). As teachers entered the fifth session, several shared foldable note-taking devices they had used since the fourth session. One teacher explained how the tool summarized over ten pages of the math textbook, which focused her students' attention. High school MTFs noted curricular benefits to having the same subgroups of high school teachers for each session. Sue shared, "It has been helpful to know what is taught after Geometry…making connections between literacy and the curriculum with the same people," (Interview #2, 9-21-12). Many high school teachers focus on one course, such as Geometry or Algebra, and do not always teach the preceding or subsequent course. Mixed groups allowed teachers to share how literacy could support instruction; consequently, teachers provided snapshots of specific course content.

Sessions began with MTFs sharing the session's power strategy, reviewing previous strategies, and stating the session objective. How did Brynne feel during this time? **"**You're getting the daggers or the 'UGH.'" She expressed that "getting through the first ten minutes" was important so "now everybody knows we're still doing literacy...and we can get rolling," (Interview #2, 11-20-12). I observed other MTFs and often sensed a sink-or-swim feeling that upheld Brynne's description. For example, the fifth literacy session began at 8:09 a.m. with Bailey saying, "Everyone excited to see us today? No response? Ok, we are going to get started. We are going to use your time wisely today…hopefully you're not sick of seeing us," (Field Notes, 1-21-13). Pedro's comment about "pump[ing] each other up" offers further support. Brynne reported that non-MTFs

were fidgety and "after 45 minutes of talking about literacy, they [non-MTFs] are done with it," (Interview #2, 11-20-12). While MTFs provided these descriptions, I illustrate another perspective through field note data.

After Bailey began the fifth session, Claire facilitated a discussion surrounding non-MTFs' literacy integration. First, Claire described how she ferretted out issues with note-booking in her classes and shared a statistics foldable (see Figure 4.7). In her example, students generated multiple forms of graphs and annotated the graphs with observations and questions. She explained how her students began to edge upon future power strategies including monitoring understanding and questioning by making predictions and assessing the reasonableness of their answers. Claire described, "all of these strategies go with one another and just because we do one today doesn't mean the others are not important" (Field Notes, 1-21-13). This seemed to concretize the rationale of ongoing literacy integration PD for some math teachers.

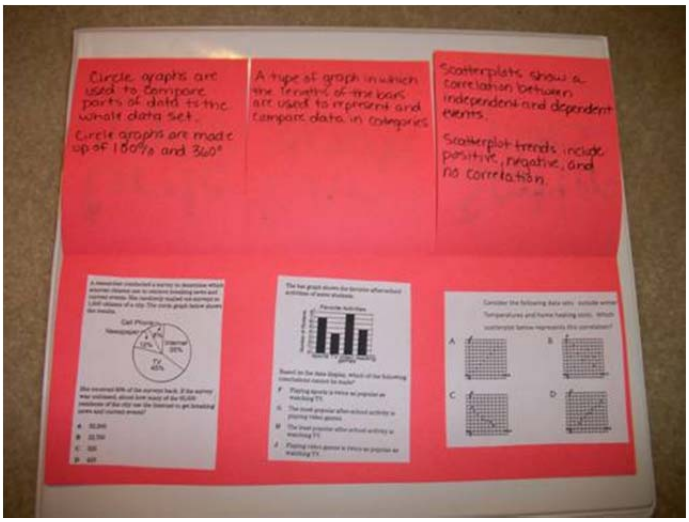


Figure 4.7: Sample statistics foldable.

"Something I am working on, but need to improve, are notebooks" (Field Notes, 1-21-13). Interactive notebooks documented students' thinking and provided a history of

learning in Claire's classes. Each day, students completed a warm-up activity and developed notes. During an observation, Claire reinforced the purpose of taking notes: "You need to remember the rules for simplifying integers. If you need to go back into your binder to review, take that initiative to do that!" (Field Notes, 10-3-12). Often, notes were open-ended rather than guided; thus, required students to decipher which information was important (Field Notes, 8-28-12, 10-3-12, 3-29-13). When non-MTFs inquired how she supported students who copy information verbatim, Claire stressed teaching different strategies over time such as outlining, highlighting, and sketching.

The discussion then shifted to other pedagogies that non-MTFs were investigating such as "flipped classrooms," which Bailey implemented during the research period. This involves "flipping" the traditional instructional sequence to homework in class, while students receive direct instruction through video at home. Claire and Bailey emphasized the relationship between the power strategies, Note, Retrieve, and Organize and Questioning, and flipped instruction.

At this point, Bailey restated the session focus, develop questions, and shared, "All day, every day, before I went through the Shelly session, I kept asking, 'So, what do I do next?' Now, I'm trying to get my kids to elaborate more about their thinking and ask questions to get them to dig deeper into their understanding," (Field Notes, 1-21-13). Bailey presented characteristics of high-quality math questions. These questions:

- Help students make sense of mathematics
- Are open-ended
- Unravel misconceptions

- Require students to make connections/generalizations, not just application of fact/procedures
- Are accessible to all students
- Lead students to wonder more about a topic

(Schuster & Anderson, 2005)

Non-MTFs then generated examples of high-quality math questions. One group developed the following list:

1. How did you get that?
2. What did you do first? What did you do next? Why?
3. How would you explain it to your grandma?
4. What do the directions say?
5. What resources do you have that will get you to your outcome?

These questions illustrated several power strategies, including: Note, Retrieve, and Organize (#2, #4, #5) and Monitoring Understanding (#1, #2, #3) within mathematics. Then, Bailey emphasized shifting questioning practices from IRE, in which a teacher *Initiates* a question, awaits a *Response* from a student, and then *Evaluate*s the answer for correctness with a short (one to two word) acknowledgement (Cazden, 2001), to creating an environment where students are asking and answering their own questions. Claire reinforced, "At some point, I want them to know what type of questions they should be asking themselves. They take assessments and need to know what to do when they get stuck," (Field Notes, 1-21-13). This exchange reinforced the collaborative approach of middle-school MTF teams and their perspective of the literacy PD goal-increasing student achievement on state exams.

Claire asked teachers to examine the Task Analysis Guide (Figure 4.8) and determine the task type (e.g. memorization, procedures with connections) of two problems. This guide demonstrated the integral nature of mathematics and literacy as more complex problems lead to more robust thinking and application of comprehension strategies. Non-MTFs discussed the different quadrants of the guide. Claire and Bailey listened as a non-MTF described how students know the mechanics of math (i.e. how to add or subtract integers), but they don't know how to score a golf game. He described how students can manipulate numbers but cannot apply procedures in context. Claire shared, "That's why I had my students play golf, so they could actually understand it and see how it fits in the world." After table discussions, Claire facilitated a whole-group discussion, where teachers offered experiential lesson ideas involving recipes, football fields, and basketball courts. After hearing these examples, Bailey said, "I have to keep in mind, when we look at the state test, there are very few problems like that *(points to ½ + ¾).* The kids need to see it's a real-life application. You're building a house. You're going to have a pool. Moving up to that level, it's hard, but it's beneficial." At this point, I moved to Pedro and Lance's session.

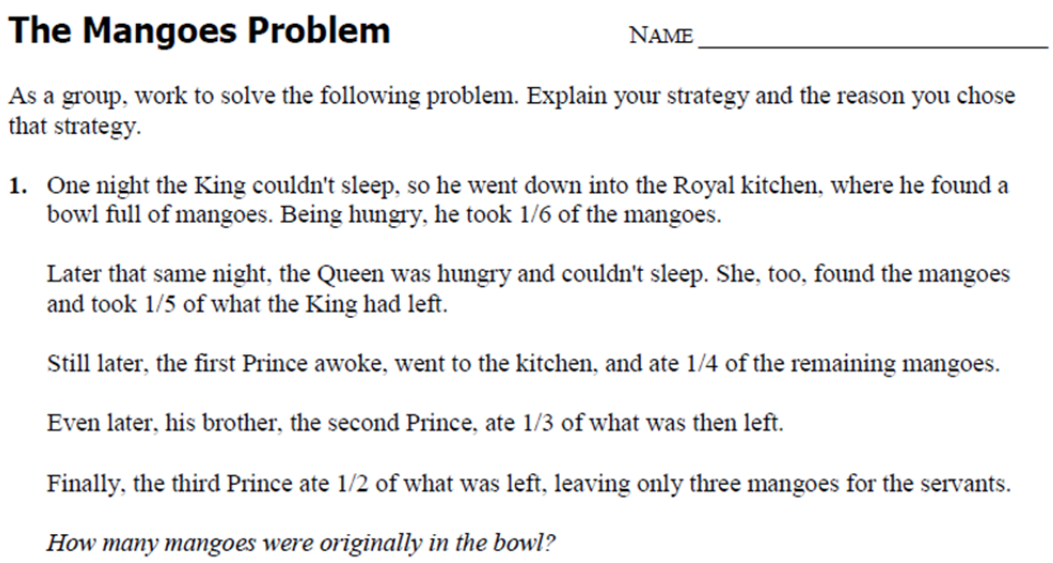
THE TASK ANALYSIS GUIDE

Lower-Level Demands	***Higher-Level Demands***
Memorization Tasks • Reproducing previously learned facts • Committing facts to memory • No procedure needed to find the answer because it is memorized • Exact reproduction of previously seen material • No connection to the underlining meaning	Procedures with Connections Tasks • Focus on the use of procedures to develop deeper levels of understanding • General procedures that have close connections to underlying conceptual ideas • Represented in multiple ways (visual diagrams, symbols, problem situations) • Require some cognitive effort. May be procedural, but cannot be followed mindlessly.
Procedures without Connections Tasks • Step-by-step procedure that is the obvious process to use • Require little thinking to complete successfully • No connection to the underlining concept for the procedure • Focused on producing correct answers • Require no explanation or explanation is describing the procedure itself.	Doing Mathematical Tasks • There is not a predictable, well-rehearsed approach • Require exploration and understanding of the nature of math concepts, processes, or relationships • Demand self-monitoring of one's own thinking process • Require access of relevant knowledge and experiences • Require analysis of the task and the limits of possible solution strategies • Cause students to struggle to solve the problem due to the unpredictable nature of the solution process required.

Adapted from OCTM, Professional Development Cadre — March 2009

Figure 4.8: Task Analysis Guide used in fifth session.

As I entered, Pedro explained that he added a slope activity to the session content the night before. Non-MTFs measured the length and height of stairs, shoe sizes, and other objects to determine the "best" slope for a staircase, demonstrating an inquiry approach. Pedro and Lance circulated as non-MTFs solved the "Mangoes Problem" (Figure 4.9).



The Mangoes Problem NAME _____

As a group, work to solve the following problem. Explain your strategy and the reason you chose that strategy.

1. One night the King couldn't sleep, so he went down into the Royal kitchen, where he found a bowl full of mangoes. Being hungry, he took 1/6 of the mangoes.

   Later that same night, the Queen was hungry and couldn't sleep. She, too, found the mangoes and took 1/5 of what the King had left.

   Still later, the first Prince awoke, went to the kitchen, and ate 1/4 of the remaining mangoes.

   Even later, his brother, the second Prince, ate 1/3 of what was then left.

   Finally, the third Prince ate 1/2 of what was left, leaving only three mangoes for the servants.

   How many mangoes were originally in the bowl?

Figure 4.9: Mangoes problem used to transition from slope activity.

Lance asked teachers to explain how they solved. Then, Pedro introduced *Smoke and Croak*. This activity illustrated questioning in Geometry and explored volume and circumference through measuring balloons. As groups worked, Pedro emphasized how literacy integration supports students' thinking in a math task like *Smoke and Croak*. First, he connected monitoring understanding with students determining the reasonableness of their estimates. He gave an example. "We're talking about a balloon and you wrote 4 meters. Really? We need to have our tasks let students learn how to assess their answers. This goes across disciplines, like with science. Your students can know that it applies beyond math," (Field Notes, 1-21-13). Second, Pedro asked, "Our first session was teaching vocabulary…how are you going to teach the terms?" Finally, he offered examples of open-ended questions:

- What would you do if your balloon pops?
- Could you measure the circumference of the large part and the small part and average it? Why or why not?

- What does the graph look like if you compare circumference to diameter?
- Even without plotting it, what would you expect the graph to look like? Why?
- If you have a cubed term, what would it look like? Why?

"Why use these?" Pedro asked, "We want to focus on the deeper questions, not here's the formula, here's how you find volume." Pedro described how questioning practices shift teachers from interpreters to moderators. He asked, "How can we phrase a question to shift students from being fed a process to developing and understanding it themselves without realizing it happens?" Pedro then described quality math tasks stating, "If it has a numerical answer, it wasn't a good question to begin with!" and distributed a linear functions lesson packet. It contained sample lessons that divert students from "plug and chug" mathematics to problems requiring critical thinking. Teachers discussed similarities and differences between the samples and their typical lessons.

Lance and Pedro circulated the room and listened to each group's discussion. I sat with a group of four Geometry teachers, who seemed to like the sample tasks, but voiced concerns about teaching concepts *and* vocabulary. One teacher said, "You'd have to add another day to do this. Is there time to do that?" seeming to indicate vocabulary adds to overall instructional time. A veteran teacher posed, "Can you afford to take the common practice of 20 problems that get at these five concepts and hope they get it?" His veteran counterpart said, "You would be watering it down," which seemed to reinforce the challenges of shifting from a "more is better" mentality to deeper, open-ended questions. A first-year teacher suggested, "What about making a problem for the entire unit and breaking it into pieces?" The group seemed intent integrating literacy and new types of problems, but wrestled with time and curricular constraints. Pedro and Lance concluded

the session with time to apply the morning's content. In the following section, I share reflections related to the MTF role from interviews.

The outliers and central tendencies of being an MTF. MTFs voiced neutral, positive, and negative aspects of their literacy integration PD. Some focused on interpersonal challenges of working with colleagues, while others restated the misalignment between the PD content and mathematics. I begin with MTFs' descriptions of their role and continue with themes that emerged as I investigated the research questions surrounding (a) how MTFs describe literacy integration PD and (b) tensions between literacy and secondary mathematics.

I am NOT the expert. When Alice, Pedro, Sue, Bailey, Brynne, and Claire agreed to serve as MTFs, they received a role description with these traits:

- Have effective communication/presentation skills
- Enthusiastically support the concept of literacy integration
- Assist building colleagues following the training
- Be willing to implement practices in his/her own classroom
- Have an interest in this leadership opportunity to promote literacy across all content areas.
- Be available to attend all training and presentation dates.

(Role Description, June 2011)

How did MTFs embody these traits? Middle school MTF, Brynne, summarized, "One thing that I've learned is even though we listened to Shelly, we are not experts. We are just repeating basically what she said. I think that's the biggest part. Don't shoot the messenger. I'm like I'm your messenger, don't shoot me" (Interview #1, 11-20-12). In

her second interview, she described herself as a "relayer" and voiced frustration when non-MTFs held her responsible for their required attendance. Even so, Brynne shared, "I feel like I'm an expert in it because I taught reading, so I bought into it. I always tried to prove to the kids I could do it in math even though it would be a stretch," (12-14-12). Brynne remained torn between her experience and the MTF role , feeling like a messenger. She did not reveal growth during the research period Bailey positioned herself as a partner and facilitator, not fully aligning with Brynne's messenger role. After the fourth session, she indicated, "I feel like I lay it out there. I'm not the know-it-all, end-all. I don't know everything" (Personal Communication, 9-11-12). She reiterated this stance after the fifth session, "I am an interactive colleague. I work with them. I'm willing to learn and if you can teach me ideas and I can teach you ideas…all of our students are going to be better off" (Personal Communication, 1-25-13). Bailey's disposition resulted in rich discussions throughout sessions and safeguarded her from losing rapport with colleagues.

High school MTFs offered similar descriptions. Alice said her role was to "trickle down all that information" that she learned in train-the-trainer, while Pedro viewed himself as a "facilitator of nuggets" whose role was to pass on what was "given to us." Sue felt like her role was monotonous and consisted of "spewing information" (Interview #1, 8-30-12) and to "sit-and-get and regurgitate" (Interview #2, 9-21-12). When I asked her to explain given the adjustments that she made to presentations with Lance, she said, "We would try our best to make it math…We [Lance and I] would go back to the small comment that she [Shelly] made that made sense, so it might make sense to math people." Sue attempted to bridge intermediate literacy instruction with mathematics

pedagogy. Pedro replicated this approach, wanting the literacy content to be palatable to math teachers. He noted that it was not a choice as an MTF to accept or reject the content, but to "present it in a way that is accepted…At whatever cost" (Interview #2, 2-12-13). Overall, MTFs described themselves as transmitters or translators, which highlighted another resounding theme.

Is it literacy or Shelly? Throughout the data, MTFs branded the PD by the person, often using phrases like "Shelly session" or "Shelly strategy." Prior to the sixth session, I developed assessments with Brynne and mentioned that the gradual release of responsibility framework would be infused in the next train-the-trainer session. Brynne looked confused and sought clarification. When I said, "You know, the monitoring understanding session that we're doing in August?" Still perplexed, Brynne asked if I was talking about a new PD series. It wasn't until I said, "You know, the 'Shelly' presentation that we're doing June 4th," that she understood. During the fourth session, Bailey remarked, "Shelly [national literacy consultant] said…" and "the district thinks…", which placed the onus of literacy integration on others. This emerged again during Bailey's interviews as she called the PD "Shelly sessions." Sue used similar language when presenting, while Pedro referred to specific literacy tools as "Shelly tools." The repercussions of this language seemed to result in MTFs' assumption of "messenger" roles.

Anxiety. A ubiquitous reflection made by most MTFs involved a sense of angst when presenting to colleagues. Sue described it as "being out on a limb and nerve-racking" (Interview #1, 8-24-12). Nerves emerged from several tensions. First, MTFs were concerned with the longevity and lack of novelty. Bailey said, "I'll say again that I

hear people all the time dread the fact that we're doing literacy, Shelly, information again" (Interview #2, 12-14-12). Secondly, Claire reported feeling nervous and responsible to her colleagues as an MTF, wanting to be able to answer a litany of questions related to implementing a literacy strategy in mathematics:

- Did it work?
- How did it work?
- How did you implement it?
- When did you use it?
- How long did it take?

(Interview #1, 9-12-12)

Claire elaborated, "I don't want to be somebody standing up there and [say] 'I don't know. I haven't tried it.'" Pedro offered similar reflections, comparing the use of literacy tools with making recommendations in general. He said, "You can't say something works or not if I don't know if it works or not…teachers try something and if it doesn't work, they never do it again, and if it does, word of mouth happens…It has to be the same way [with literacy integration]" (Interview #2, 2-12-13). Claire also noted her perception of colleagues, "Math teachers think it [a literacy strategy] will interrupt the entire flow of their lessons…these are meant to be 5-10 minute tools, not forty-five," (Interview #2). Over time, Claire shared that student examples were a powerful way to make connections with non-MTFs, as demonstrated with the note-booking vignette above.

Collegial challenges. Non-MTFs challenged MTFs. Alice recounted instances with non-MTFs who would not participate and described how she would not "fight that battle" (Interview #1, 11-30-12). Brynne and Claire found nonverbal behaviors such as

eye rolling as "unprofessional," yet were unsure how to respond. Bailey lost her first MTF partner, Matt, due to his colleagues. Bailey described Matt's peers as being "very stubborn…heavy sighs and eyes rolling and talking under their breath….very off task, not willing to work with other people" (Interview #2, 12-13-12). Bailey and Matt attempted to engage his colleagues without avail. Bailey reported that when Matt returned to school, he was "shunned" because he tried to get them to "act professional" and shared his concerns with an administrator. Once aware, I moved his colleagues to Brynne's group for the next session, but it was too late. Matt resigned as an MTF and relocated to another school. While Bailey was able to adapt to working with Claire, she shared, "It's unfortunate because Matt was phenomenal…it would be nice to work with the same person" (Interview #2, 12-13-12). I will discuss non-MTF engagement during sessions and elaborate on the relationship between MTFs in Chapter 5.

Brynne and Sue expressed inconsistencies in non-MTFs' behaviors during sessions. When a district leader or administrator was present, Sue described non-MTFs' active participation. Brynne noted that as soon as an administrator left, non-MTFs would go back to checking email or other tasks, not using work time effectively. She questioned why administrators attended train-the-trainer sessions, but only attended non-MTF sessions for 5-7 minutes. Sue posited non-MTFs would hold themselves more accountable with administrator presence. This suggestion never manifested during the data collection period; thus, it is unknown whether leadership presence influences non-MTF behavior and literacy integration.

Alice described the challenge of "selling" the concept of literacy integration. **"**I hate to say 'sell it', but you kind of have to sell it to them," (Interview #2, 12-18-12).

Pedro also struggled with his peers' dispositions and need to "come fully armed to defend why it works" rather than collaborating toward literacy integration (Interview #1, 12-21-12). Alice speculated that having non-MTFs participate in train-the-trainer sessions may remedy resistance. She used the tools, knowing that she would be presenting them to others. Would others be more likely to integrate literacy with additional PD? Alice thought so.

When I asked Alice to share any positive feedback from non-MTFs regarding her role as an MTF, she laughed. "The positive feedback I get is 'thanks for doing it, so we don't have to.'" (Interview, 12-18-12). Pedro conveyed how rewarding it felt when non-MTFs shared "Hey, this works!" or "I could see this working." He equated this progression with students who do not like math at the beginning of the year and grow to appreciate it by the end of the year. Brynne recounted how a veteran colleague liked how she facilitated discussions, listening to concerns without pontificating, while Bailey recalled specific discussions during sessions that were rewarding. Claire and Sue did not recount a specific incident of peer feedback.

Collectively, MTFs identified positive and challenging aspects of serving as peer facilitators and exposed tensions within peer-led literacy integration PD. In the following section, I report MTFs' reflections and recommendations for future literacy integration PD as it relates to the first portion of the research question: How do secondary Mathematics Teacher Facilitators (MTFs) describe their professional development in literacy integration and their enactment of it in their instruction?

After the literacy PD session: Pondering

Because Sue, Pedro, and Claire had experience as both MTFs and non-MTFs, I asked them to articulate differences. Valuable aspects were additional PD and time to

collaborate with other math practitioners. Sue expressed how being an MTF fostered her understanding of the rationale for literacy PD and encouraged her to implement practices. She missed the MTF role during the second year because "you just learn so much more when you teach somebody something" and described how train-the-trainer sessions provided time for ideas to percolate and then come to fruition (Interview #1, 8-30-12). Like Sue, Claire described how the MTF role "forced her" to apply literacy practices in her classroom. While Pedro appreciated the additional PD hours to learn these practices, he noted challenges of being released from classroom duties for train-the-trainer days, suggesting off-contract time to MTFs. Pedro alluded the MTF role altered his perception of PD. Instead of viewing it as something he was "forced" to do, he became intent on learning and applying new pedagogies.

Because Sue participated as an MTF and then non-MTF, she suggested that sessions be more interactive and productive, which could be because of the slide requirements and pacing guidelines she experienced as a first-year MTF. She illustrated how non-MTFs could create literacy examples that they could apply immediately because "…movie clips are fun and they are entertaining, but they are not enough…" (Interview #2, 9-20-12), which suggested Sue sought a richer PD experience.

Alice served as the math department head at Plains High School A. She noticed that many of her colleagues did not use the literacy integration tools. Why? She shared, "Sometimes I think it's because 'It's another thing.' Instead of seeing literacy as a tool, something to help or to understand easier, it's another thing. It's not the norm in a math classroom to use tools like this," revealing tensions between the PD content and mathematics instruction (Interview #1, 11-30-12). Claire agreed that literacy integration

was viewed as another dish added to an already full mathematics pedagogical menu. Bailey overheard comments like, "We have *this* again…I thought we were done!" She, like others, struggled with the knowing-doing gap. "Are people actually using it? The things that we're learning, or is it just something they think is just another thing, just another thing?" (Interview #2, 12-13-12).

Sue described how many of her colleagues felt PD is "boring, a waste of time, long…" and shared how PD can be difficult to apply in math (Interview #1, 8-30-12). Alice agreed that math teachers are often missing from the PD equation, leaving ambiguity. To remedy, Bailey made several recommendations. First, she recognized that many of her colleagues struggled with how to integrate literacy; consequently, she campaigned for collaborative work time. Secondly, Bailey posited, "…I feel our teachers are more disengaged at professional development days than our students are in our classrooms. Many teachers dread going." (Interview #1, 11-20-12). She described effective sessions would balance learning content with work time and reiterated the importance of non-MTFs leaving sessions with something tangible. Bailey equated success with non-MTFs applying the literacy tools (Interview #1, 11-20-12; Field Notes, 1-23-12). Sue and Claire reiterated these suggestions in their interviews, reflecting a "make-and-take" form of professional development.

Bailey expressed the longevity of the PD series was both beneficial and challenging. First, non-MTFs became aware that literacy integration through learning the 8 Power Strategies was not "a phase…something that's only here for one year and then it's gone" (Interview #1, 11-20-12); however, some were burdened by the consistent focus, remarking "oh, we're doing this again. We're still doing this…and it's the same

thing, again," suggesting the PD lacked application or a general misunderstanding of the complexity of literacy integration in secondary mathematics (Interview #1, 11-20-12). Brynne, Sue, and Pedro agreed. Brynne summarized, "They [non-MTFs] think it's a trend in Plains, so why would I put all this effort into this when in two years, nobody's going to talk about it anymore?" (Interview #2, 12-14-12). She, and Alice, recounted other PD that had come and gone and reported feeling lackluster about professional development. Bailey attempted to demonstrate the differences of each power strategy, justifying the need for multiple sessions, but questioned it herself. Following the fourth session, Bailey proposed the rationale was to "really engrain it in the minds of teachers and let them know that this is something that is not going away," and articulated that change takes time, is difficult, and requires persistent practice. Even so, she felt the series should have been shortened for math teachers.

MTFs questioned literacy integration PD as conflicting needs surfaced such as state mathematics testing and the Common Core State Standards for Mathematics. "We [MTFs] didn't know it was going to be a four-year program and every year it gets harder to present. I know a lot of people [who are] saying, 'I can't do this anymore.' People feel like 'I'm beating a dead horse' because I keep saying the same things and nobody is listening." (Bailey, Interview #1, 11-20-12). Non-MTFs were saturated in the 8 power strategies and wanted to find more discipline-specific practices that "really make a difference with *my* students" (Survey Evaluation, 9-1-12). During the fifth session, Brynne's non-MTFs raised concerns, unearthing tensions between the literacy series and mathematics: "They [administrators] expect us to do small groups. They expect us to grade. They expect us to prep for the state test. They expect us to use

interventions…How are we supposed to do this? [and] Where do we find the time?" (Interview #2, 12-14-12). She offered insight and backed her colleagues' discontent, "I would feel ownership if the topic changed every time…we have a lot more to focus on in math than using all these eight power strategies." Even so, middle school MTFs felt responsible to complete and incorporate all eight power strategies in future professional development, but not use them as the sole focus (Interview #2). MTFs identified instructional strategies that offered the best potential for literacy integration. While some sessions were "better than others," other sessions were "overkill." Their reflections capture tensions between literacy and mathematics and further illustrate their experiences.

As noted, each PD session was organized around the eight power strategies (Table 4.10). MTFs reflected on the power strategies and implementation.

2010-11	2011-12	2012-13	2013-14
District Academic Vocabulary List (Middle School only)	Pre-reading and the Reading Process • *RAP Sheets* • *Anticipation Guide* • *Establishing purpose in reading* • *Difference between strategy and tool*	Note, Retrieve, and Organize Information • *Comparison Matrix* • *Chain Reaction* • *Give Me a Hand* • *Roll the Dice* • *Stop and Spin*	Text Structures and Text Features
	Content/Specialized Vocabulary • *Tic-Tac-Toe Vocabulary* • *Knowledge Triangles* • *Vocabulary Comparison Matrix*	Develop Questions About What Is Read • *Math Task Analysis* • *Talk Moves* • *Close reading of complex text*	Monitoring One's Own Understanding
	Activating and Building Background Knowledge • *KWL as Ready, Set, Go, Whoa w/90-second scan* • *Connections, Points, and Questions* • *How Sure Are You? (in stone, pencil, and pen facts)*		

Table 4.10: Literacy PD implementation and sample math tools.

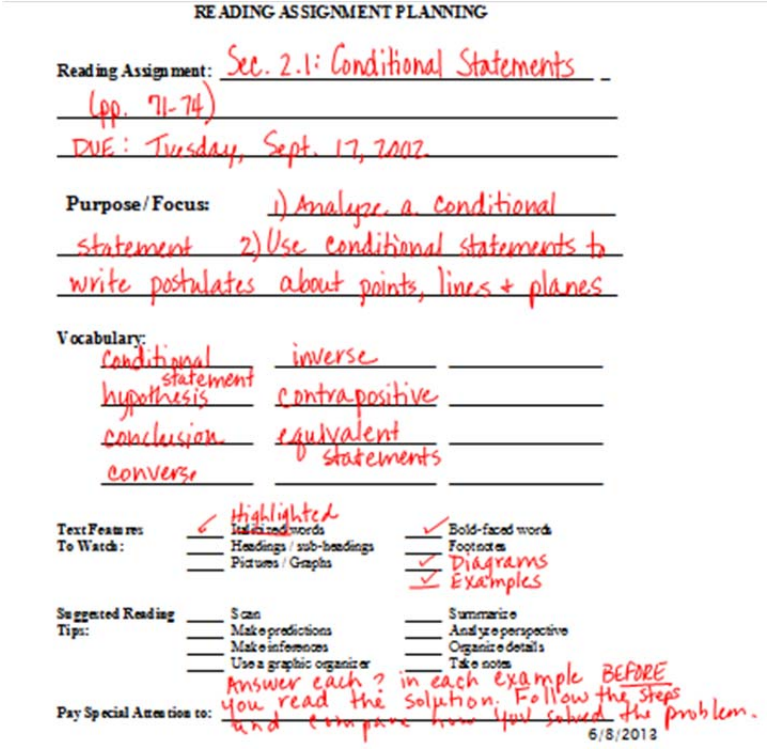
Sue reported, "…recognizing the importance of vocabulary in math. It was not something that I found to be important until I attended these sessions" as most significant (Personal Communication, 10-15-12). Four others agreed that Content/Specialized Vocabulary was the linchpin session, which centered on strategies to acquire and utilize mathematics language. Non-MTFs explored literacy tools during the second session that introduce or reinforce terminology. For example, Knowledge Triangles (Appendix C-1) require students to draw connections between three vocabulary terms, determine the commonality, and explain how the terms relate in a paragraph. Many MTFs used this tool.

Pedro stood as an outlier, suggesting the fourth session, Note, Retrieve, and Organize, was most important because students need to learn (a) how to organize their notes in a way that facilitates retrieval when solving problems and (b) distinguish main ideas from tangentially-related details. He also shared, "I think that was the one I got the most out of because I was forced to research it more because it was my first time presenting" (Interview #2, 2-12-13). Alice found applying the session's strategies made her students more independent, able to summarize and generate their own notes, which reinforced Pedro's reasoning.

Text Features and Text Structures remained as power strategies at the end of the research period. MTFs felt these strategies were explored sufficiently during the previous sessions, were not significant enough to warrant a separate session, and felt nervous. As Brynne said, "Our books are already set up. We can't talk two and a half hours about that," suggesting tension between these power strategies and the written mathematics curriculum (Interview #1, 11-20-12). Aside from these strategies, RAP sheets illuminated MTFs' disposition that some sessions were "overkill."

The RAP sheet was the fulcrum of the first, second, and third sessions designed to focus teachers on a single literacy integration tool and students' reading. RAP sets a reading purpose, highlights key vocabulary, text features, and critical information, and offers reading tips (Figure 4.11). Plains District required all teachers to use RAP sheets at least once during the first year of PD. Bailey voiced concern over this mandate, fearing redundancy across disciplines. Later, she shared, "I think being able to be familiar with those [literacy tools] and not overusing them as a teacher so that the kids still get excited, but to be comfortable…can really be successful," suggesting a balanced approach

(Interview #1, 11-20-12). Many students dreaded seeing the same organizer and wondered how it applied to *doing* math. Alice described frequent use of RAP sheets initially, but how she abandoned them because "I think I know the way to guide them without actually giving them the actual form" (Interview #1, 11-30-12). She crafted several iterations of the RAP sheet, calling them "guided notes," emphasizing specific operations and formulas as students read their text. Her colleagues did not use RAP sheets beyond the requirement. Perhaps Brynne's reflection explains: "RAP sheets were confusing in math. They didn't work in math sometimes…Kids understood [RAP sheets] while they were reading the book, but when it went into math, they were like, 'Whaaat?'" (Interview #1, 11-20-12). The RAP graphic organizer depicted inherent tensions between teaching mathematical processes and integrating literacy.



READING ASSIGNMENT PLANNING

Reading Assignment: Sec. 2.1: Conditional Statements (pp. 71-74)

DUE: Tuesday, Sept. 17, 2002.

Purpose/Focus: 1) Analyze a conditional statement 2) Use conditional statements to write postulates about points, lines & planes

Vocabulary:
conditional statement
hypothesis
conclusion
converse
inverse
contrapositive
equivalent statements

Text Features To Watch:
✓ Highlighted words
___ Headings / sub-headings
___ Pictures / Graphs
✓ Bold-faced words
___ Footnotes
✓ Diagrams
✓ Examples

Suggested Reading Tips:
___ Scan
___ Make predictions
___ Make inferences
___ Use a graphic organizer
___ Summarize
___ Analyze perspective
___ Organize details
___ Take notes

Pay Special Attention to: Answer each ? in each example BEFORE you read the solution. Follow the steps and compare how you solved the problem.

6/8/2012

Figure 4.11: Sample math RAP sheet.

MTFs sought greater non-MTFs engagement. Current MTFs could facilitate as non-MTFs shared classroom exemplars. Brynne thought that having non-MTFs share would (1) engage all math teachers around the same goal, producing more interactive sessions and camaraderie and (2) provide others with an experience in presenting professional development. Alice felt this approach would foster change, stating, "I think people would be more open to it [literacy integration] if they had to turn around and present it" (Interview #2, 12-18-12) and reiterated how she felt responsible for making sense of "it" for hundreds of others. Sue and Pedro also felt they were translators for others, making sense of literacy in mathematics and demonstrating instructional applicability. Bailey offered an alternative plan. What would happen with a new MTF group for each train-the-trainer session? Bailey predicted this approach would require "a whole lot of back teaching, but would be more beneficial. Would everybody have a better understanding? It's just like doing a jigsaw reading assignment," (Interview #2, 12-13-12). Involving all teachers was a cornerstone of MTFs' improvement suggestions.

Taken together, MTFs voiced the power of experimenting with literacy integration, carefully selecting and sequencing the power strategies, and alternatives for the train-the-trainer PD structure. Markedly, MTFs had greater PD experiences. How did they enact literacy practices?

Literacy Integration Enactment

In this section, I illustrate each MTF's mathematics instruction from field note data, highlighting three aspects of enactment: a) intermediate literacy tool transfer with the power strategy identified, b) disciplinary literacy integration, and c) reflections relative to the second portion of the research question: How do secondary Mathematics

Teacher Facilitators (MTFs) describe their professional development in literacy integration and their enactment of it in their instruction? I begin with middle school MTFs.

Bailey

Bailey's Math 6 students were not performing well, causing her to investigate a flipped pedagogy during the second year of literacy integration PD. Bailey introduced the concept of "flipping" to her students, "We're going to flip what we do at home and what we do at school. Your homework will be to watch a video or to read a couple of pages, and you have a couple questions that go with that. You'll come back the next day and we'll check those questions," (11-28-12). These guiding questions reinforced vocabulary and problem-solving processes. Bailey explained that students would generate notes from the video or text, suggesting they determine the content and scope of their notes. When a student asked, "How do you know which notes to take?" Bailey responded, "You will watch and think, 'oh, I think that's important. Oh, that's something I don't know so I'm going to write it down.'" After this lesson, I asked Bailey if she planned to model note-taking and how she would assess notes. Her students had learned note-taking in English courses and established an interactive math notebook; thus, she felt confident in their abilities and did not plan to model (Personal Communication, 12-1-12). To assess, Bailey assigned numerical scores and determined instructional groups:

1. Student did not have notes and would watch the video during class.
2. Student watched the video and wrote notes, but missed 2-3 questions. These students were in a guided group.
3. Student missed 1 question, had sufficient notes for skill and would begin practice.

4. Student produced exceptional notes, successfully completed all questions and began (a) independent practice or (b) watched the next instructional video during class. These notes were not used as exemplars during the research period.

A "flipped" approach produced opportunities for students to generate notes, read the math textbook, and practice terminology.

Bailey's questions shifted throughout the research period. During early observations, she used frequent questions as a way to check for understanding or cue students such as: "What did you do first?" and "Ok, but how did you get there?" After the questioning train-the-trainer session, her practices changed. Bailey extended her questioning with Talk Moves (Chapin, O'Connor, & Anderson, 2009). While adding and subtracting fractions, Bailey asked her coteacher, "Did you hear any good explanations, Mrs. Cook?" Mrs. Cook asked Paul to explain whether 9/16 was closer to zero, one-half, or one. After he explained that it would be closer to one-half because sixteen divided by two is eight, Bailey followed with, "Marcus, can you explain why you agree or disagree with Paul?" (11-28-12). She also promoted discussions through planning questions in advance, which she attributed to the literacy integration PD. During a geometry lesson, she asked student groups to discuss, "Could a perpendicular line be an intersecting line? Explain how you know." (2-19-13).

Bailey integrated vocabulary daily. When introducing geometry terms, she said, "Vocabulary is *very* important in Geometry, so you want to use this page…especially for test time," (2-19-13). At multiple points, she drew distinctions between multiple meaning words such as "plane" and activated background knowledge to build meaning. For

example, Bailey used an analogy comparing lines and line segments with a story and an excerpt. Additionally, Bailey modeled terms with hand motions and students identified examples of the terms inside and outside of their classroom. During the lesson, Bailey reiterated student-generated note-taking: "If you want to make a chart that says, 'word and definition and then a picture and symbol,' that might help you. These are your notes, though, so you can do them however you choose" (2-19-13). This format, My Own Description, was shared in the second literacy integration session and paired with research suggesting 7-14 meaningful exposures to learn academic vocabulary (Figure 4.12).

Word	**My Description of the Word**	**An example or picture to remember…**

Figure 4.12: My Own Description vocabulary tool.

After the fifth session, Bailey developed a March Madness basketball challenge. This collaborative activity required students to assess background knowledge, sustain group discussions, and solve problems. Bailey identified that the purpose was to convert fractions, decimals, and percents, but it also previewed the upcoming probability unit. As students worked, Bailey prompted, "use your groups…you know about probability from previous years…use your textbook," (3-21-13). Their task involved questions such as, "Based on the information in your tables, no prior knowledge or bias, determine and support mathematically which NCAA team you would expect to win the tournament?" (Instructional Materials, 3-21-13). Open-ended questions requiring textual evidence were absent in previous instructional materials.

Bailey's enactment centered on questioning practices, note-taking, and vocabulary acquisition and retention, with the most growth evidenced in her instructional materials and questioning practices

Brynne

Brynne integrated literacy to support increased student achievement on the summative state mathematics exam. She thought textbook reading and word-rich problems were foundational for such achievement. After the fourth session, Brynne adjusted her scatterplots and line of best fit lesson to increase the amount of reading. Students previewed the textbook section and completed guided notes in groups. She reported, "They [students] were lost on their notes…they had to work with their partners and figure[it] out…I wouldn't give them the answers, I would question them…" Brynne attributed her approach to guided notes and open-ended questions to the literacy integration PD. Her lessons always began with strategies to elicit students' background knowledge. In an intervention class, Brynne focused on making connections between the known and unknown. Brynne instructed students to visualize a number line and asked when they used them in the past. Students cited using number lines with decimals, coordinate planes, and graphs. Then, students moved along a physical number line on the floor to demonstrate positive and negative integers. Brynne used similar practices with her sixth-grade Pre-Algebra students. Students shared pneumonic devices to number quadrants before beginning a Geometry unit. After the fifth session, students completed a review of mean, median, mode and range before creating box-and-whisker plots. Connecting current math topics with background experiences was central to Brynne's practice. For instance, after reviewing measures of central tendency, Brynne distributed

guided notes and asked students whether they had heard of box-and-whisker plots. After students responded, she said, **"**If you don't understand the vocabulary, you will never be able to make one," and began the lesson (2-26-13). Students filled in blanks with the terms as Brynne offered verbal explanations. After five minutes, students reviewed the terms by reading their notes and Brynne continued with additional terms. First, students labeled a box-and-whisker plot with the terms (Figure 4.13). Secondly, students created a box-and-whisker plot from bridge length data. Brynne asked students to explain each step and produced an enlargement of the box-and-whisker plot, with labels, along the whiteboard. Two days later, Brynne explicitly built background knowledge and applied questioning.

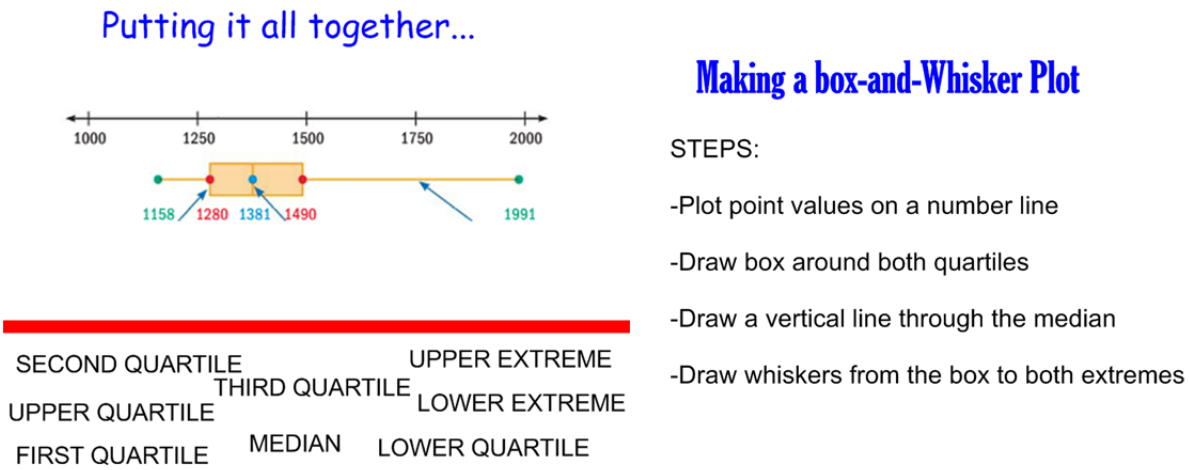


Figure 4.13: Box-and-whisker plot with vocabulary labels and steps.

Students created stem-and-leaf and box-and-whisker plots while Brynne distributed notes. She asked several students to share their warm-up graphs, which seemed to be completed with ease and accuracy, and then communicated the day's objective was learning how to interpret data displays (2-28-13). She posed: "What graphs have you seen?" and heard a litany of responses. Interestingly, one student offered, "a Venn diagram…is that a graph?" Instead of answering, Brynne posed additional

questions, “When do you use those usually? Could we use those in math? What could we compare?” Students suggested rational and irrational numbers and fractions and decimals as appropriate topics. Brynne continued by reviewing graph types and then students worked in groups to determine the best display for data sets. For example, what is the best data display for running times for three different students? How can you show stock market prices accurately? As groups worked, Brynne questioned, prompted, and cued:

- Why did you choose a bar graph?
- When I looked at A, I thought circle graph because you have to add…A is a lot like B. Why didn’t you choose a circle graph for B?
- What was going through your mind?
- Explain to Cal why you think A is a circle graph.

(2-28-13)

Brynne’s Pre-algebra students completed geometry lessons for two consecutive days near the end of the data collection period. These lessons illustrate the terse nature of texts and expansive terminology of mathematics. Students sat in a semicircle around a large set of parallel and perpendicular lines cut by a transversal (Figure 4.14). Brynne moved on the masking tape diagram while she reviewed the previous day’s vocabulary. She used hand motions to show right angles and stood on an example of supplementary angles during the review.

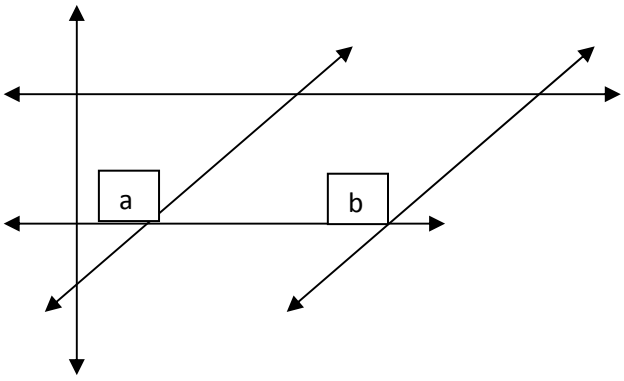


Figure 4.14: Brynne's floor diagram for types of lines and angles.

Standing on the diagram, she began, "Let's start with our first word, corresponding angle. It tells us that it's two congruent angles, both lying on the same side of the transversal. We know congruent means they are going to be equal. Look at your notes or the floor. If I took an imaginary pair of scissors and cut it and moved it over by Jordan, wouldn't it look exactly the same? Picture it moving right next to the other angles." Brynne prompted students to visualize, make notes, sketch pictures, and draw upon related words to build meaning. For example, "What do you think will happen with our next term, Hunter? Alternate Exterior Angles? What do you think about when you hear exterior? Right, outside." Each time she introduced a term, Brynne augmented the textbook definition with a student-generated description, visuals, and movement. Students then worked in groups to identify angle measures of a new diagram, drawing upon their notes and background knowledge. As they worked, Brynne reinforced terminology and concluded by assigning students to preview the next section and complete a MOD chart (see Figure 4.11). She instructed, "On the front, it gives you a place to write vocabulary words, a working definition…that means I don't want you to copy the definition from the book. I want you to put it in your own words and then draw a picture."

The following day, Brynne's students applied angles to a floor diagram and shared their MOD charts. Brynne reminded, "It says working definition, so it's a definition you understand that you can study from…[and] Who are the notes for? So, you record information that you need to remember and study from," (3-28-13). In sum, activating background knowledge through questioning and discussion, content vocabulary learned through explicit instruction and tools, and student-generated notes were emphasized as essential to mathematics, which surfaced in Brynne's enactment.

Claire

After the fifth session, Claire's students completed a jigsaw to review for the state mathematics exam. Students were assigned a skill, generated notes, and provided example problems for a peer group. As I observed three students, I noticed how each wrote descriptions rather than definitions. In non-MTF classrooms, students often recorded verbatim definitions from the textbook glossary (Research Journal, 2-13-13). The student assigned to teach one-step equations began. She asked her peers to imagine buying a candy bar and an undetermined number of pops from the school's vending machine with a total cost of $4. After writing the equation, she explained that each pop was $1.50 and the candy bar was $1. "Because we don't know how many pops, we will use the variable *p* and use one dollar and fifty cents as the coefficient…the number that tells us how much each costs." The use of academic vocabulary, thinking aloud, and modeling were replicas of Claire's instruction.

Claire summarized the inseparable bond between writing and conceptualizing mathematics as, "writing cements thinking." How did writing surface in Claire's instruction? To combine like terms, students sketched buckets, wrote different values

inside the buckets and "swirled them around." Then, students wrote directions for combining like terms in equations and inequalities. During other lessons, students explained how to rewrite decimals as percents, drafted learning summaries, and took notes.

Notes were married with visuals throughout Claire's lessons. After the third session, students reviewed exponent rules. Claire provided pictures, annotated with highlights, and used interactive notebooks. After the fourth session, she displayed drawings for operations involving integers (Figure 4.15) and explained, "You are drawing pictures related to adding integers. When you have all positives or all negatives and you draw a picture it makes sense…when they are all in a pile, it makes sense, but it gets tricky when you have one of each. Can someone explain what you think about when you have positives and negatives?" (3-29-13). Her lesson illustrated note-taking, monitoring understanding, content/specialized vocabulary, and questioning, while demonstrating how students held the onus to think and converse mathematically.

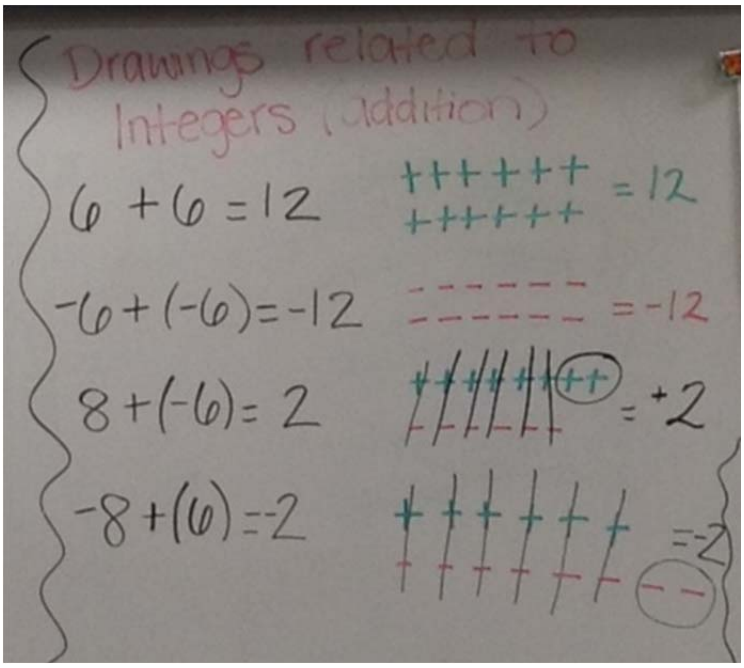


Figure 4.15: Drawings for integer operations.

Claire modeled mathematics discourse. Why? Her college professor incessantly repeated: "Say what you mean and mean what you say" (Interview #1, 9-12-12). She explained,

"There are too many pronouns and not enough nouns in mathematics; therefore, it is critical to identify the mathematical objects in problems" (Interview #2). Claire posed questions that required students to utilize mathematics vocabulary:

- "Andrew, which of these are constant terms?"
- "Where did I get negative thirty?...Five times negative six" (while pointing to each term)
- "What is the relationship between the coefficient and the variable? Turn and explain to your neighbor. As you are talking, I want to hear *coefficient* and *variable*."

(Field Notes, 10-3-12)

She focused students' attention on parts of problems using highlights, demonstrating one way to monitor understanding through annotation. Claire taught these strategies to non-MTFs during literacy PD sessions.

Ultimately, Claire integrated literacy practices to improve state math test scores. A prime example of her enactment and practitioner growth occurred after the third literacy session. She excluded Chapters 1-4 in her Math 7 course. Why? As she recalled, "Around November/December, kids grades would drop from 100% to a 3 or 4…all of a sudden it went from stuff they already knew to new content" (Interview #1, 9-12-12). She attributed her realization to the literacy PD, "…because of those sessions, I knew we needed to build background knowledge, but I needed to figure out when and where that could happen." Through restructuring the course sequence, students explored integers through playing putt-putt golf, balancing atoms, maintaining a checkbook register, and reading thermometers while reviewing the skills from chapters 1-4 throughout the year. When she introduced equations after the fifth session, students cited temperature, scoring in golf, bank account values, and balancing molecules as examples of integers, drawing upon her lessons (3-29-13). Prior to the sixth session, 88% of Claire's students met expectations on the state math exam, which she credited to literacy integration. Claire's enactment was nested in strategic integration of intermediate literacy tools and bordered by disciplinary literacy in the form of mathematics discourse and problem-solving.

In the following section, I report how high school MTFs, Pedro, Sue, and Alice, enacted literacy integration pedagogies, further investigating how MTFs described their literacy integration enactment and their instructional practices.

Pedro

The fifth session, Develop Questions, propelled Pedro to use an online polling tool. Students assessed whether four scenarios were biased in his Foundations course. For example, "When eating at a fast food restaurant would you more likely order a juicy cheeseburger or a boring salad?" (2-19-13). Then Pedro instructed students to "develop proper definitions" for vocabulary terms. Pedro wrote each term on the board, students recorded, and he drew connections. For example, Pedro said, "Like if we have taco dip…can take a little taste. Can we agree that a sample is a smaller part of something? So related to this, what would sample be? Good a smaller part of a population." Pedro continued the lesson with bias, distinguishing students' prior understanding of bias as "racist" and "prejudiced" with survey bias. This revealed the importance of explicit vocabulary instruction in mathematics. In another lesson, Pedro enacted other power strategies without the use of preformed literacy tools from the binders.

Pedro filled a large bucket with several types of candy to generate interest,. Students drew out single candies to determine probability, generated scenarios with dependent and independent events, and calculated probability using bags of marbles. After practicing, Pedro posed the following:

> "Jane and her husband are having a baby. What is the probability that she will have a boy? [and] What is the probability that Jane has a girl first and a boy second?"
>
> (Instructional Materials, 3-27-13)

Pedro explicitly guided students from concrete to representational to abstract, as demonstrated by the movement from physical candy and marbles to application

problems. He attributed this approach to the background knowledge literacy integration session. Further, he explained how the ability to define a term such as median, associate it with a box-and-whisker plot, and draw connections between the two or associating histograms and range *is* mathematics literacy.

Pedro's Algebra II Honors students investigated arithmetic and geometric sequences, depicting several literacy integration strategies in advanced mathematics (3-4-13). To begin he asked, "Have you heard arithmetic before? What is arithmetic density?" Students identified arithmetic as the four operations and shared connections to their Human Geography course. Pedro then introduced arithmetic sequences and highlighted their organization. "We need to understand labels and what they are called…The first term is called *a* sub one." As he continued, Pedro reinforced precise terminology and monitoring understanding through thinking aloud. For example, "Right, take two terms and see how they differ. Think with me here. If these are points on a graph, what shape would it make? [students respond] Let's talk about what your mind was doing. Do you need to write all this down? What is the point of notes again? …Right, so you can go back to them when you find a similar problem." Pedro emphasized how note-taking is identifying what is important through understanding the problem through metacognitive questions.

Pedro's enactment illuminates literacy integration strategies in a high school setting and demonstrates how a teacher's conceptions of *literacy* and *text* shape instruction. Pedro did not directly apply tools from train-the-trainer sessions nor utilize graphic organizers from "the binders"; yet, he enacted strategies consistently. His unique

enactment of both intermediate and disciplinary literacy strategies is discussed further in Chapter 5.

Alice

Alice integrated literacy strategies to provoke students' discovery of math concepts. In her Algebra II Honors course, student groups generated the rules for logarithms via guided notes. Alice encouraged students to investigate their text, use mathematical discourse, and draw upon terminology to establish the rules. Open-ended questions such as, "What can you deduce from Figure 2.3 and the previous problem?" and "Contrast this process with the previous rules. How can you reconstruct your understanding?" fostered student independence and constructive struggle, cornerstones of her practice.

After the fifth session, Alice's students reviewed graph forms. Factorial, duplicates, permutations, counting principle, and inflection point were associated terms used within the first three minutes of the lesson. To support students' retrieval, Alice reviewed the terms through a Word Recognition Chart (see Appendix C-3), provided "Graph Tracker" guided notes, prompted students to monitor their understanding through questions: "Do you have a visual in your mind of 'does the order matter? Not matter?' Is your answer possible? Does it make sense?" These cues and explicit vocabulary instruction were observed throughout Alice's lessons.

Alice's students acquired mathematical language through literacy integration. Alice reported how secondary math students typically copy verbatim definitions. Alice questioned this practice: "I don't think kids really suck in what the definition is and what it means and how does it apply [with textbook definitions]" (Interview #1, 11-30-12) and

embedded vocabulary in directions to assess. For example, if directions stated to synthetically divide, solve, or factor and students asked what to do, Alice said, "that's how I know whether [students] understand vocabulary or not" (Interview #2, 12-18-12). She expounded, "Memorizing seems pointless to me" and felt integrating vocabulary within mathematical processes was the best way to gauge her students' understanding. How did Alice's students build mathematical language?

Alice consciously pre-taught vocabulary before processes, "without taking away from the other content" (Personal Communication, 2-6-12). She used the Tic-Tac-Toe graphic organizer (Appendix C-4) as a semester review, which required students to draw connections between three vocabulary terms, explain their relationship, and generate a problem applying the terms. For example, students might connect *sum, terms*, and *finite arithmetic series* to write and solve the following: "Find the sum of the first 32 terms in the arithmetic series -12+-6+0+…+174 using the equation $S_n = {}^n/_2 (A_1 + A_n)$." Additionally, she used examples and counterexamples. For example she touted, "Don't confuse your cube roots and cubes. I want a cube root, not a cubic" during a College Preparatory Math lesson (1-25-13). Students in Alice's Honors Algebra II course read a definition for arithmetic sequences. She augmented, "This definition is lengthy, but an easy way to say it is you are adding and subtracting the same amount each time," (3-20-13). These practices encouraged students to think about vocabulary before recording notes.

Vocabulary instruction stretched beyond terms; it also involved teaching students to communicate mathematically and understand symbols with accuracy and precision.

While completing an arithmetic sequence problem with her College Preparatory Mathematics students, Alice stated the following within three minutes (3-20-13):

- "nth term is whatever one you are looking for" (7 times)
- "*d* is your common difference" (6 times)
- "*a* is your first term" (3 times)
- "A sub *n* is what you are looking for."

Naming the mathematical object and stating its role within problems was crucial to solving each sequence. She continued, "You will be expected to show notation and what it means…demonstrate you understand, not just pushing buttons," (3-20-13). Alice and Pedro were the only MTFs to explicitly focus on mathematics notation with literacy integration.

Alice indicated textbook reading is important, yet lacking in secondary mathematics as students and teachers are unsure of how to integrate reading in math. She attributed this to many teachers posing as the "knowers" in math classrooms. To overcome traditional roles of teachers as "knowers" and students as "receivers," Alice used a jigsaw format and guided notes. In groups, students "read a section, deciphered information, talked through it and got the material from reading the book instead of us [teachers] delivering the information," (Interview #2, 12-18-12). Why this approach? Alice shared, "Many of these kids are going on to math-related fields and need to be able to decode a text. They are independent, determined thinkers that understand the importance of truly understanding the material," (Personal Communication, 3-23-13). She then described other instructional approaches that deviate from "normal instruction" and foster students' use of the textbook "as a resource, not just practice problems," (3-20-

13). Alice attributed changes in students' behaviors throughout the research period to her emphasis on textbook reading, which did not occur prior to the literacy integration PD.

New non-English Language Arts teachers are required to complete a three-hour, Six Traits of Writing (Culham, 2013) training in Plains School district. For five years, Alice trained these teachers, offering examples of writing integration in a non-ELA course. For example, Alice developed a project around Jon Scieszka's *Math Curse*. Students wrote picture books with vocabulary terms and math concepts from the semester while applying the Six Traits of Writing. This project allowed Alice to build relationships with students and use writing as a mechanism for students to put words to processes, which is not typical in many secondary mathematics classes (Interview #2, 12-18-12). Writing also surfaced in Alice's assessments.

Alice used quiz reflection forms to garner information about how students prepared and solicit feedback and further questions. In her International Baccalaureate class, she administered a Calculus assessment. Through an open-ended prompt and some select formulas and vocabulary, students wrote "everything I know about Calculus" for 50 minutes. She encouraged diagrams, drawings, and examples to support the writing and used their assessments as a springboard for the unit test. She used student examples, without names, as instructional materials. "What's wrong with this?" or "Why is this confusing?" were posed to engage students in discussion. Alice noted how this approach "forces them to put their thoughts into words and communicate an idea clearly" (Personal Communication, 3-23-13). Alice printed online discussion boards at the end of the semester as review materials, highlighting difficult and important topics in student-friendly language.

Alice's enactment captured how textbook reading, writing, and discourse are applied in a high school context and how background experiences influence instructional practices and teacher change. These instructional choices will be discussed in Chapter 5.

Sue

Sue's MTF experience "translated" into her instruction after the second session, Content/Specialized Vocabulary. She emphasized precise use of vocabulary and cited the relationship between oral and written language. In a deductive reasoning lesson, Sue modeled language while pointing to sketches, "If two angles have a sum of 180 then they are supplementary. Now, let's reason deductively. I have A, 140, and B is 40, so what can I deduce?" This drew upon students' background knowledge of angle types and illustrated appropriate vocabulary. While learning midpoint and distance formulas, Sue instructed: "Midpoint…a point that divides a segment into two equal segments. Now to indicate equal segments, or congruent segments, we use two hash marks on the pieces that are congruent to each other. *Adds hash marks.* Now let's take a look at segment bisector." Sue used hand motions and drawings to ensure students understood the relationship between textual symbols and terminology. She "stay[ed] away from textbook definitions" and provided descriptions by juxtaposing everyday language with math terms, such as *equal* and *congruent* to further support students' understanding (Interview #1, 8-30-12). After the third session, Sue wrote "same position, different intersection" for a corresponding angles and said, "Thinking about that word, corresponding. If I said, I work in the accounting department and I am in the Leigh branch, but I say 'Gracie has a corresponding position at the Cook branch'. What does that mean?" This demonstrates

Sue's use of descriptions and marriage between everyday language and mathematics terms.

Sue's MTF experience prompted these instructional changes as "you learn so much more when you teach someone else." During a classroom observation (8-24-12), Sue expressed, "I appreciate the discussions you [students] are having with one another. When you explain it, you understand it better." What did students explain? Her Algebra students compared and contrasted solving systems of equations using substitution, graphing, or elimination, while Geometry students created vocabulary flashcards. Sue described, "I like to see them explain a process rather than just say, 'oh, subtract 3 and divide by 2' because you're not always going to subtract three and divide by two. You're subtracting the constant and dividing by the coefficient attached to the variable," (Interview #1, 8-30-12). Sue modeled vocabulary and attributed this to the literacy PD: "I've been a lot more conscious of how I talk. Instead of saying 'the bottom of a fraction,' I say the denominator…[and] saying expression [to] get them used to the difference between expression and equation," (Interview #1, 8-24-12). Vocabulary and math discourse centered reading in Sue's classes.

After the first literacy session, Sue used a textbook scavenger hunt, something she had not used prior to her literacy integration PD. Students investigated text features and structures while previewing the course content. Why? Sue realized her students seemed conditioned to turn to the textbook exercises without attending to the textual resources. "We are talking about the pages between the problems," Sue explained, "Even I found stuff I didn't know as in there," (Interview #1, 8-30-12). Her focused textbook investigation during the first train-the-trainer session cultivated her interest in literacy

integration and shaped how she assisted students. Sue began redirecting students' attention to their text rather than supplying answers. For example, Sue reminded students "Don't use the 'it looks like theorem,' read the directions!" After the fourth session, she noted "the most beneficial thing you [students] can do is open up your book…some of them are easier if we are all looking at the same graphic. It might spark something in your brain," demonstrating Sue's enactment over time (8-24-12).

Even with a strong disposition toward literacy integration to bolster learning mathematics, Sue was reluctant to assign reading. She described, "…students get to the English part of the math assignment and they say, 'no go on that. I'm done with it!' So that's a hurdle we're just starting to go over," (Interview #2, 9-20-12). Sue also hinted that some content does not lend itself to independent reading. She said, "Obviously you have to be careful about what sections [of the textbook] you choose. If it's going be a topic that's going to hit them smack in the face, I won't do that," (9-20-12, Interview). Yet, Sue attempted to integrate reading. After the fourth session, she wrote an email describing how she changed a lesson. "The kids will read from the book! I used to just give the students formulas for perimeter, area, and circumference, and give examples of concave and convex polygons....but I decided to create a quick note taking guide for the students to find and work with the formulas on their own…thanks for jump starting my brain!" (Personal Communication, 9-22-12). Sue routinely joined textbook reading and explicit instruction following this attempt.

Sue taught pre-reading strategies because of her MTF experience. For example, "How Sure Are You?" activates students' background knowledge and involves associating a percent with your level of surety for a given statement. After the fourth

session, Sue modeled, "How many of you are 97-98% sure that number lines exist? Have you used a number line in other classes?" Sue then introduced midpoint and distance formulas before students generated examples of congruency. Sue also made connections to her students' experiences. During a reasoning lesson (9-14-12), she explained:

> "Inductive reasoning is something you learned at a very young age. Think about when you were two years old and Grandma came over to cook dinner and she is boiling pasta…you want to see what's going on. You reach up and touch the stove. What happens? Grandma says, no! It's hot. Then you walk around and take a specific case, that stove, and think it's always hot. Our example for our notes-hot stove."

Sue continued with sporting event examples of deductive reasoning before introducing geometric figure problems such as, "Write a conclusion from the given conditional statement: If two angles have a sum of 180, then they are supplementary. Example: If angle A is 120 and angle B is 60, then _____." Sue explained how this approach built necessary background knowledge for geometric proofs and reinforced reading in mathematics. Overall, Sue integrated academic vocabulary, built upon students' background knowledge, and involved textbook reading. Her enactment demonstrates teacher change over time and reinforces high school MTFs' approach to literacy integration, which married intermediate and disciplinary literacy strategies.

Conclusion. MTFs provided varied conceptualizations of mathematics literacy, descriptions of literacy integration PD, and enacted practices in a variety of ways. Factors influencing each and tensions between literacy integration PD and mathematics are discussed in Chapter Five.

CHAPTER 5: DISCUSSION

This study examined how secondary Mathematics Teacher Facilitators (MTFs), who agreed to serve as peer trainers for an ongoing literacy professional development (PD) series, described their experiences. I wanted to better understand how MTFs taught literacy integration strategies to colleagues, incorporated these instructional approaches, and the significant differences between six participants relative to the train-the-trainer PD model. I specifically asked: (a) How do secondary Mathematics Teacher Facilitators (MTFs) describe their professional development in literacy integration and their enactment of it in their instruction? (b) How do MTFs describe literacy in mathematics? and (c) What, if any, tensions exist between literacy and mathematics as cited by MTFs? Through aggregating data, themes emerged that should be heeded as secondary schools attempt to integrate literacy in all disciplines in response to the Common Core State Standards (CCSSI, 2010) to increase adolescent literacy achievement (ACT, 2006) and prepare students for college and careers (Pimentel, 2013). Results show critical experiences that fostered teacher understanding of literacy integration in mathematics and influenced instructional practices.

Kegan's Constructivist-Developmental Theory (CDT), with footings in Guskey's (1986) model of professional development and Alexander and Fives' (2000) Model of Domain Learning (MDL), served as the theoretical framework (see Figure 5.1). Adult learners fall on a continuum of Kegan's CDT stages including imperial, interpersonal, self-authoring, and self-exploring (Drago-Severson, 2009). Each stage hinges on meaning construction and the relationship between Subject (MTF) and Object (Literacy Integration PD). The six MTFs demonstrated various stages of Kegan's theory; therefore,

their descriptions provide a rich tapestry for practitioners, researchers, and policymakers to shape adolescent literacy and mathematics education reform. As MTFs learned practices through professional development, they provided evidence of Alexander and Fives' Model of Domain Learning phases consisting of acclimation, competence, and proficiency. MTFs demonstrating competence and proficiency entered a progression of teacher change beginning with implementation (Guskey, 1986). Per Guskey's model, attempting new instructional practices is followed by increased student achievement and subsequent changes in teacher beliefs. MTFs produced qualitative evidence of this progression, which are discussed throughout the chapter.

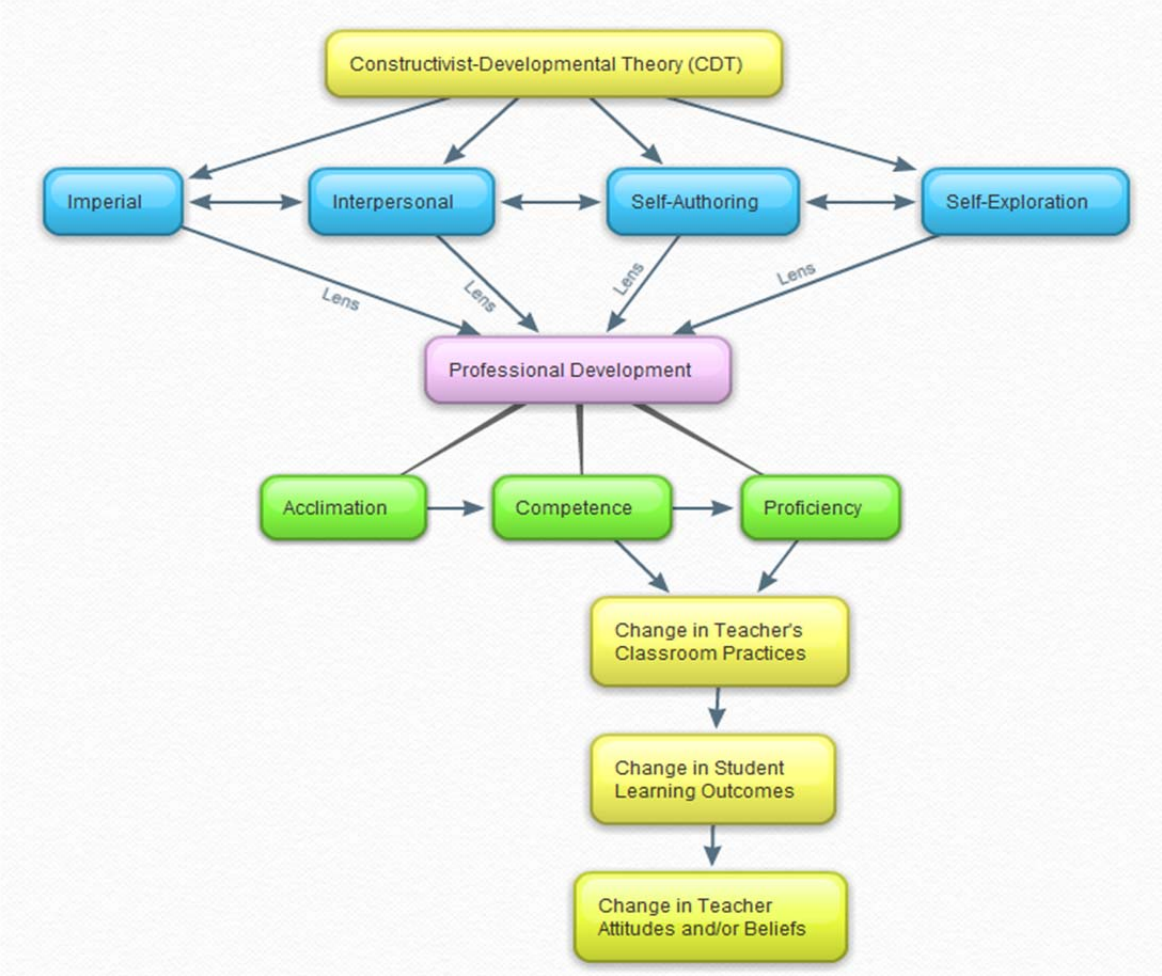


Figure 5.1: Theoretical framework.

As I examined the data, significant similarities and differences among MTFs emerged through qualitative themes: (a) professional development dispositions; (b) latitude of literacy descriptions; and (c) views of literacy integration. These themes served as explanations for the quality and quantity of literacy integration among the six participants and offered support for how they described the professional development series and literacy in mathematics.

Influential factors. Analyses suggest that MTFs' descriptions of PD, depth and breadth of literacy conceptualization, and degree of enactment are related to several factors: teaching experience, CDT stage, MTF experience, level of mathematics taught, and English-Language Arts (ELA) background experiences (Figure 5.2). MTFs with the most teaching experience, MTF PD hours, and ELA background experiences provided the strongest rationales for instructional practices and most comprehensive descriptions of literacy when teaching and facilitating PD sessions. Many of these MTFs exuded *self-authoring* and *self-exploration* behaviors, more advanced levels depicted in Kegan's Constructivist-Developmental Theory. Furthermore, this subset of MTFs showed command over a wide range of intermediate and disciplinary literacy instructional strategies and revealed changed beliefs (Guskey, 2002). MTFs with less teaching experience and fewer literacy background experiences provided limited conceptualizations of literacy, often limiting integration to using the textbook and teaching vocabulary, thereby narrowing opportunities for non-MTFs' learning. These MTFs typically demonstrated *imperial* and *interpersonal* behaviors in Kegan's model, identifying ways in which the PD did or did not support their self-interests; this subset of MTFs sought approval from superiors. High-school MTFs conceptualized literacy

integration as a pathway to learning mathematics and enacted disciplinary literacy practices, while middle school MTFs integrated modified intermediate literacy tools to mediate comprehension and voiced limited views of literacy. For example, Pedro and Alice modeled mathematics discourse and developed contextualized problems for students to solve through applying discipline-specific literacy skills, whereas Bailey and Brynne limited integration to students' application of general comprehension strategies to solve story problems.

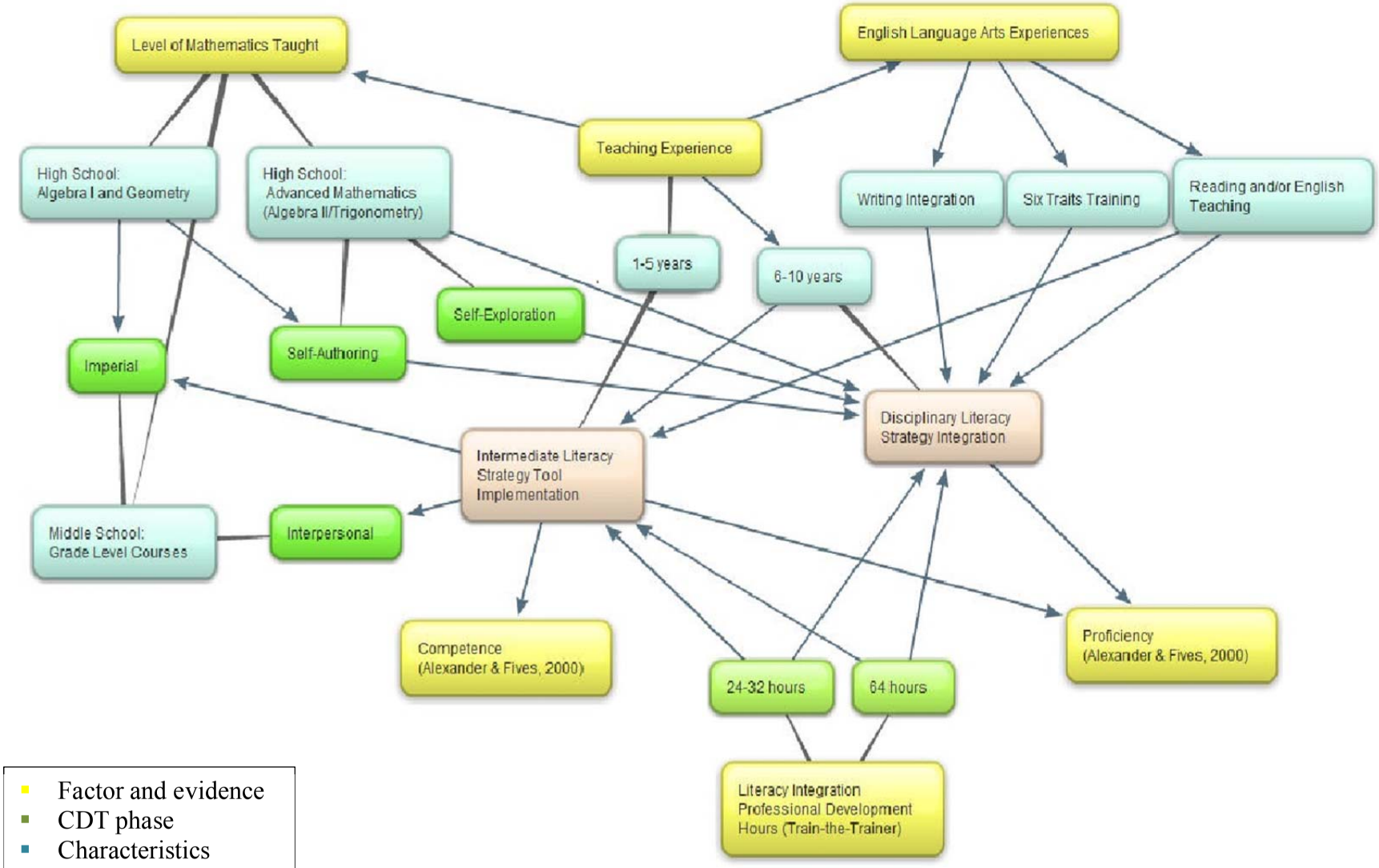


Figure 5.2: Emerging factors shaping MTFs' descriptions and enactment

Summary. The following discussion examines the research results surrounding (a) MTFs' descriptions of literacy integration PD (How do secondary Mathematics Teacher Facilitators (MTFs) describe their professional development in literacy integration and their enactment of it in their instruction? and What, if any, tensions exist between literacy and mathematics as cited by the MTFs?) (b) descriptions of "literacy" in mathematics (How do MTFs describe literacy in mathematics?), and (c) enactment of the 8 Power Reading and literacy integration strategies relative to the theoretical framework (How do secondary Mathematics Teacher Facilitators (MTFs) describe their professional development in literacy integration and their enactment of it in their instruction?).

Literacy Integration Professional Development

MTFs descriptions of the literacy integration series rested in their dispositions about professional development and stage within Kegan's theory (1982; Drago-Severson, 2009). Below, I discuss themes as they relate to the research question: how do secondary Mathematics Teacher Facilitators (MTFs) describe their professional development in literacy integration?

Autonomy and inquiry as stance. The data from this research supports the notion that teachers do not embrace professional learning without autonomy to critically interact with content and construct personal understanding. MTFs felt stifled, unable to adjust the training materials to meet the needs of their peers. The challenges associated with such inflexible PD pervaded every MTF's description of the first three train-the-trainer sessions. Sue associated the PD with animal-like phraseology, with teachers being "herded" and treated as inanimate sponges "sucking it [PD] all up and regurgitating it somehow" (9-20-12, Interview #2). This statement reflects Duffy's (2005) descriptions of

informational training, which Sue, Bailey, and Brynne seemed to expect. If MTFs and their colleagues assumed a stance of inquiry (Cochran-Smith & Lytle, 2009) and exercised professional autonomy, PD could transform to further mathematics literacy integration. Inquiry as stance suggests an openness to continual professional growth, ongoing reflection, and learning as part of everyday practice. This stance positions practitioners as critical analysts and change agents within schools; therefore, requires adult learners who demonstrate *self-authoring* and *self-exploration* behaviors. Pedro served as the MTF who embodied a stance of inquiry. He demonstrated the strength in using his constructed meaning for integration to teach his colleagues during the fifth session.

Pedro added mathematical activities and went "off the grid" from the original training materials. Through critical reflection, he wanted to facilitate a meaningful and useful session that would impact instruction. His background as a high-school math teacher at an inquiry-based school and experience as a non-MTF during the first three sessions may have served as catalysts for change. He did not want to repeat his experience of the first three sessions, informational PD, which Sue had delivered as a "canned message." The *Smoke and Croak* and slope activities edged on disciplinary literacy practices, wedding effective questioning, content/specialized vocabulary, and monitoring understanding with *doing* mathematics (Moje, 2008; Zygouris-Coe, 2012). By demonstrating the need for both intermediate and disciplinary literacy skills (Faggella-Luby et al., 2012) through teacher-directed professional development, Pedro's initiative served as an example of how to diminish the literacy "dualism" for secondary

mathematics educators (Draper, Smith, Hall, & Siebert, 2005). Below, additional evidence is discussed which supports the necessity of autonomy.

Evaluation surveys from the first three sessions revealed trainers don't "own the content," which was reified in Bailey's second interview (Evaluation Survey Analysis, 9-1-12). "Shelly is the one that presents and has this whole concept…patented. It's her focus and so we take what she gives us," (12-18-12). To remedy, I suggested that MTFs and other trainers work with their respective curriculum facilitator, allowing MTFs the autonomy to investigate mathematics disciplinary literacy practices rather than contrive examples. The PD transformed from a point into a ray, offering direction for secondary math teachers and influencing my collaboration with them. Consequently, non-MTFs' feedback became more positive, with comments such as, "thanks for focusing on our content specifically" and "continue to provide good examples and time to implement them into our curriculum. Awesome job!" (Survey Results, 1-21-13). Coburn's (2003) research supports the need for well-elaborated materials with challenging reforms like literacy integration in mathematics; therefore, exemplars had to demonstrate how strategies supported doing mathematics to impact instructional practices. Next, I discuss how dispositions about professional development shaped MTFs' descriptions of the literacy integration series.

Implementation versus integration. The supposition that PD is intended to promote technical implementation of strategies saturated Bailey, Brynne, and Sue's descriptions. Interestingly, these three MTFs had the least teaching experience, each with less than six years. Each reiterated the importance of teachers leaving with "something they can use the very next day" and "translating" practices into their classrooms. Often,

they promoted tools requiring low preparation time, consistent with Ross and McDaniel's (2004) work indicating math teachers "comply" with literacy integration. This disposition surfaced further in their facilitation as they promoted time to develop lessons or "tweak" lessons to include graphic organizers. Active learning through "work time" has demonstrated positive increases in teachers' knowledge and changes in classroom practice (Birman, Desimone, Porter, & Garet, 2000); however, Sue, Brynne, and Bailey's facilitation approach did not promote critical reflection or the metacognition necessary for meaningful literacy integration (Fisher & Frey, 2008). At times, Bailey, Brynne, and Sue used non-mathematics examples, which left non-MTFs wondering how to integrate a tool in their classes. For example, "Degrees of Meaning" (see Appendix C-2) showed relationships between social studies vocabulary terms. Clearly, these MTFs' implementation-based view of PD shaped their descriptions, demonstrating practitioners in Alexander and Fives (2000) competence phase. They lacked proficiency with how to integrate literacy in mathematics and were unable to produce examples for non-MTFs.

Sue demonstrated the most significant change during the research period. She transitioned from "filling time" and transmitting information to generating meaningful literacy applications to share with her peers. It is plausible that her experience as an MTF then non-MTF in Pedro's session served as the promoter. She also began a Master's program in Educational Leadership during her year as a non-MTF, which fostered her understanding of the "big picture" that was absent during the first three sessions (Personal Communication, 5-22-13). Sue's three-year experience demonstrates a shift from acclimation to competence to proficiency in literacy integration. It manifested

through how she facilitated professional development and enacted practices, which is discussed in subsequent sections.

Claire, Pedro, and Alice, with eleven, eight, and ten years teaching experience respectively, shared a belief that PD requires reflection and contextual considerations. PD is not about artificial implementation; rather it is evidenced in growing expertise and change. Effective professional development integrates teachers' previous learning (Lawler, 2003) with critical reflection and practice (Knight, 2007; Shell et al., 2010) through self-direction (Knowles, 1990; Ross-Gordon, 2003). The veteran MTFs embodied these characteristics; thus, their reflections and recommendations serve as research models for mathematics literacy integration PD. They determined classroom applications and drew upon their experiences to maximize the impact of literacy integration on student learning, offering more robust descriptions of the literacy series and demonstrating Alexander and Fives' proficiency phase. Throughout the research period, Claire, Pedro, and Alice showed changes in their instructional practices, student learning outcomes, and their beliefs.

Next, I discuss how each MTF's stage in Kegan's theory influenced his/her descriptions of the PD series.

Staying within the boundaries: The strategically compliant. Consistent with Kegan's *interpersonal* stage (Drago-Severson, 2009), Bailey and Brynne wanted to be viewed as good workers and centered on whether their actions would be perceived positively. Both desired district leadership positions in administration and curriculum, respectively, and carried out their MTF responsibilities as such. For example, Bailey's descriptions complied with boundaries established by district leadership. She reported (1)

it was “easier to modify” existing literacy tools than generate math literacy materials and (2) implementation was key (Interview #2, 12-13-12). Her compliance emerged as she described herself as a facilitator, not an expert. Brynne followed suit, attempting intermediate literacy tools in her own classroom and trying to “prove that it [literacy in math] works,” yet reiterated that she was a “messenger” (Interviews #1-2). It is reasonable that Brynne’s background as a reading teacher was an inherent inhibitor to more complex literacy integration because she taught the district's adopted scripted reading curriculum that delineates exactly *how* and *when* to employ the eight power strategies with *what* text. She was unable to demonstrate the metacognitive actions required to use strategies and model for students, which emerged in her use of the RAP to begin two-column Geometry proofs (Wilson, Grisham, and Smetana, 2009). Fisher and Frey (2008) indicate the importance of content teachers identifying *when* and *how* a graphic organizer, like a RAP, can support *what* type of thinking students do. The RAP graphic organizer was maligned with the cognition and mathematics processes Brynne expected, therefore, it was unsuccessful.

In sum, Bailey and Brynne wanted to fulfill the MTF role, maintain positive relationships with colleagues, and further their careers. Their strategic compliance emerged during their second interviews. Even though both dissented on the organization of the literacy integration PD, suggesting that it be shortened and certain power strategies be eliminated, neither communicated this to district administration outside of our interviews. Clearly, Bailey and Brynne felt responsibility as MTFs, but did not want to produce conflict with others and remained within their *interpersonal* stage.

Inside and outside the boundaries: The movers. Sue, with three years teaching experience, was an anomaly. She had the least teaching experience, but had the unique perspective of an MTF turned non-MTF turned back to MTF. At times, her behaviors and talk reflected Kegan's (1982) *imperial* perspective, requiring examples and knowing what the "payoff" would be for integrating literacy. She wrote, "I would love to see some concrete examples of how people are using these techniques in their classroom....even if it's just a tiny adjustment to what they previously did," after the second session (2-19-12). She grappled with whether literacy supported mathematics, describing some early sessions as "a stretch" and reported contriving examples without ever intending to use them. For example, she named a vocabulary bookmark from the second session, but had not used it.

Data revealed Sue's growth from the first three literacy sessions to the final train-the-trainer session. While she began describing PD as "spewing information," she concluded with *self-authoring* behaviors. She began to focus on upholding her personal integrity, standards, and values and viewed conflict as natural and healthy, challenging other MTFs to consider better PD materials during the sixth train-the-trainer session. Unlike Bailey and Brynne, Sue was willing to create disciplinary literacy examples rather than modify existing tools. It seems plausible that the district guidelines for the first three sessions paralyzed Bailey and Brynne, but Sue's experience as a non-MTF during the fourth and fifth sessions in which she completed Pedro's *Smoke and Croak* and slope activities propelled her toward meaningful literacy integration. Perhaps PD should be structured such that mathematics teachers serve as both participants and trainers due to the salient learning differences evidenced by Sue throughout the research period. Or,

districts may schedule peer observations of secondary math teachers who are adept at integrating literacy strategies into daily instruction. Observers could then deconstruct what they observed and why particular strategies were successful.

Claire was unique; she taught English during the research period and had substantial experience working with English-language Learners (ELLs). She viewed mathematics as a foreign language, requiring multi-sensory instructional approaches that often involved visuals and writing. Her Masters' program also served as a backbone to her instruction and PD facilitation, consistently reinforcing mathematics conceptual understanding through literacy integration. Claire's perspective fostered discussion with other middle school MTFs and non-MTFs, promoting a sense of applicability that may have been missed without her. Like Bailey and Brynne, she described how she "implemented" PD; however, she demonstrated *self-authoring* behaviors as she relied on past experience to determine how to adapt tools or integrate disciplinary literacy practices. She reflected on her multiple roles as an English teacher, math teacher, ELL-endorsed professional, and MTF to identify intersections of literacy and mathematics. How can secondary mathematics practitioners, who may not possess this diverse background, integrate literacy at high levels? A conceivable solution might be in Claire's context.

Claire's school was saturated with MTFs. Three colleagues served during the fourth, fifth, and sixth sessions, which provided Claire with support. She mentioned, "It was helpful to have other presenters in the building because we were all on the same page…having [Kelly and Tami] close by to answer last minute questions was helpful. Also, when I was getting ready to try a new 'Shelly' strategy in my classroom, it was

helpful to discuss my plan," (Personal Communication, 5-20-13). It seems that building-level support boosted Claire's literacy integration more than the integration of the MTFs who were isolated at their school site; Alice also noted benefits to having MTFs at her school site. PD may be more effective with school-based trainers, producing camaraderie and opportunities for job-embedded application (Knight, 2007; Joyce and Showers, 2002).

Pushing boundaries: The shakers. Pedro and Alice offered distinctive perceptions of PD. The role of PD was not a "make-and-take" affair, rather Pedro and Alice critically reflected on what they learned and were asked to do to determine how they would utilize their newly-gained knowledge. Both were willing to disagree openly with content, citing the Question-Answer Relationship strategy from the fifth train-the-trainer session as "fitting a square peg into a round hole." Despite that, Pedro and Alice integrated literacy at high levels to support mathematics learning as evidenced in classroom observations. They demonstrated *self-authoring* and, at times, *self-exploration* behaviors. Pedro became a change agent, advocating for instructional shifts, primarily in note-taking, questioning, and using an inquiry approach for conceptual learning. He gained insight from others to construct his own understanding of literacy integration and launched others forward. Alice drew connections between district processes, literacy integration, student achievement, and post-secondary expectations in a single reflection (Interview #2). Perhaps her roles as the math representative on the literacy core team, building staff development facilitator, mathematics department head, Six Traits trainer for non-ELA disciplines and her administration aspirations positioned her as a leading MTF, open to the potential of literacy integration.

Summary. While the MTFs vacillated as a collective whole, this study supports the power of autonomy and illustrates differences between adult learners relative to Kegan's CDT. MTFs grew optimally when given latitude to construct mathematics literacy integration exemplars as evidenced by the significant difference in descriptions following the fifth session. Teacher facilitators with ELA background experiences and who demonstrated more advanced CDT stages, like Pedro, Alice, and Claire, guided needed innovation toward disciplinary literacy, while teacher facilitators like Sue demonstrated teacher change over time. Bailey and Brynne's descriptions offer cautions for future PD as too little autonomy appears to truncate more complex literacy integration. Undoubtedly, practitioners with high levels of involvement, a reflective disposition toward PD, *self-authoring* or *self-exploration* behaviors, and a desire to transform mathematics education are forerunners in revealing disciplinary literacy instruction.

Descriptions of Literacy

MTFs' conceptualizations of literacy evolved during the research period relative to three factors: (a) level of mathematics taught with associated assessments, (b) literacy integration PD experiences, and (c) enactment. I discuss these factors using CDT stages.

The strategically compliant: Bailey and Brynne. As middle school teachers, Bailey and Brynne were steeped in assessment and basic mathematical processes. The juxtaposition of required state mathematics testing and the literacy integration PD informed Bailey and Brynne's conceptualizations of literacy. Implementation was a vehicle for increased student achievement as each described how it would result in higher state test scores; thus, illustrating Guskey's (1986) model of teacher progression from

changing classroom practices to changes in student learning outcomes. Each explained how intermediate literacy strategies would increase students' ability to solve word problems. Brynne suggested, "Our state math test, I think is a reading test and then a math test, so…what we're learning right now with the eight power strategies is important because the kids have to use those while they are taking the [state test]" (Interview #1, 11-20-12). Former assessments were littered with drill-and-solve problems. Instead of "solve for x," students were now challenged with "Write and solve an equation for the following scenario…," which often required students to make sense of problems and persevere in solving them (see CCSSM, 2010). Consequently, Brynne and Bailey limited "literacy," often citing the importance of comprehension strategies.

The movers: Claire and Sue. Claire shared Bailey and Brynne's views of literacy, marketing comprehension instruction to increase student achievement, yet evolved during the research period. As her PD hours increased and when she transitioned from non-MTF to MTF, she began to place a premium on students communicating mathematically. Because she enacted practices as part of her MTF role, she began to view literacy as getting students "to read about it, write about it, [and] use the vocabulary," (Interview #2, 10-17-12). Simply solving problems was not enough. She wanted students to construct viable arguments and critique the reasoning of others (CCSSM, 2010); hence, she did not limit literacy as a tool to find answers or solve word problems on the state exam. Her broad understanding deepened her instructional practices and edged upon disciplinary literacy throughout the research period. Uniquely, she valued explanation and evidence over determining *the* correct answer as evidenced during my last two

observations of her teaching. Experimenting with literacy integration strategies scaffolded Claire's description of literacy. Sue's description evolved similarly.

Because Sue's students were required to pass a mathematics test to graduate, the stakes were high. Sue was adamant that students be prepared for the test; consequently, assessment reinforced Sue's initial description of literacy: "reading the textbook and using vocabulary with precision and accuracy" to increase student achievement (Interview #1, 8-30-12). Throughout the research period, Sue began to recognize the "language" of mathematics, with learning mediated through oral explanations. Sue remarked how quiet her students were during initial classroom observations and how one of her goals was to increase discussion. She conjectured, "They've never had to have that interaction in a math class before, they've never had to talk it out with somebody," (8-30-12, Interview #1). As such, a core belief was mathematical discourse. She believed interaction produces deeper questions and leads to better mathematics learning, consistent with NCTM's *Principles and Standards* (2000) and the Common Core Standards for Mathematical Practice (CCSSM, 2010). These rudders guided Sue's instruction. She consistently cued students using phrases such as, "… talk to each other…If someone else got an answer, ask them how they got it" (8-24-12, Observation #1). As she completed more literacy integration PD, she fashioned a student-centered environment based on *literacy* as meaning-making skills in mathematics, deliberately integrating vocabulary and demonstrating disciplinary literacy skills as a fundamental part of content through a wide range of problem-solving strategies employed by mathematicians (Moje, 2008).

Claire and Sue expanded their descriptions of literacy. It is reasonable to believe that Claire's daily teaching experiences, merging desires to improve math achievement

and integrate writing, shaped her views of literacy; Sue's consistent experimentation swayed her toward a broad conceptualization. While each indicated assessments as promoters for literacy integration, additional PD experiences pushed them toward proficiency (Alexander and Fives, 2000).

The shakers: Pedro and Alice. Pedro and Alice's instructional context demanded literacy integration, which emerged in their comprehensive descriptions. Both Pedro and Alice taught advanced math courses such as Algebra II and College Prep Math. While each shared textbook reading and content/specialized vocabulary as imperative to mathematics learning, each envisioned discipline-specific literacies. Students solve complex problems that require multiple algorithms and approaches; thus, intermediate literacy tools designed to acclimate students with vocabulary or organize concepts are insufficient. For example, their arithmetic sequences lessons resulted in blending intermediate and disciplinary literacy approaches involving student-generated notes and mathematics discourse; thus, Pedro and Alice included reading equations, graphs, and "anything that helps them understand the math better" (Pedro, Interview #1) as *literacy*, which is consistent with Borasi and Siegel's (2000) research. Additionally, their precise use of mathematics terminology, discourse, and texts (Siebert & Hendrickson, 2010) are indicative of their comprehensive views. It is plausible that teaching more advanced levels of math produced broader views of literacy.

Interestingly, other MTFs posited integration would be more difficult with advanced mathematics courses. Bailey explained, "It's hard to find the connection…the more difficult the math gets, that harder it is to find written literacy in the sense of 'the dog jumped over the cat,'" suggesting a lack of applicability in advanced mathematics

(Interview #1, 11-20-12). Continuing, she shared that "…most people don't see numbers as literacy," which coincides with extant research. Text and literacy have been narrowly defined to exclude equations, graphs, and tables as *text* (Draper, 2012). Brynne concurred with Bailey, "I cannot imagine being an AP Calculus teacher and being told that I needed to do a RAP sheet when you're trying to prepare kids for…you're in a college-level course," (Interview #2, 12-14-12). If literacy integration is limited to reading textbooks and using graphic organizers to navigate limited "texts," professional development efforts are pointless in secondary mathematics. Conversely, broad conceptualizations of literacy and texts engender meaningful integration. Perhaps teachers of advanced mathematics courses, like Pedro and Alice, are prime candidates for literacy integration PD, given Bailey and Brynne's shallow descriptions.

Literacy integration experience. Greater experimentation with literacy approaches led to broader descriptions. Because Bailey and Brynne utilized existing practices, their descriptions of literacy remained constant. For example, Brynne continued to use Venn Diagrams to compare mathematical processes and focused on helping students read word problems, while Bailey used Word Recognition Charts (Appendix C-3), an iteration of a previous practice, to teach Geometry terms. It is also plausible that Brynne and Bailey's first-year MTF experience was a hurdle to broader conceptualizations, given that they experienced informational PD (Duffy, 2005) and were communicating a "canned" message. Claire, Sue, Pedro, and Alice offered progressively broad descriptions of literacy because of substantial integration attempts.

Claire was at a pivotal time in her career, seeking ways to improve student achievement and uniquely positioned as an English and mathematics teacher. It is

reasonable to believe that her daily teaching experiences were catalysts for writing integration and her dissatisfaction with existing practices as a change agent. Because she exhibited adequate pedagogical content knowledge (Shulman, 1986), she was able to integrate literacy in new ways. For example, her use of jigsaw produced exemplars of disciplinary literacy integration, illustrating students' application of mathematics skills and discourse. These experiences framed her views of literacy.

Sue's *self-authoring* behaviors toward the end of the research period pushed her beyond implementation. While she focused on vocabulary and textbook reading initially, she demonstrated disciplinary literacy integration through discussions and cultivating a student-centered environment. Sue's syllogism lesson was a primary example of students' application of both literacy and mathematics skills, capturing expansive notions of literacy that would be missed without shifting instructional practices (Guskey, 2002).

Pedro described literacy as "Seeing it. Reading it. Applying it in three or four different ways instead of just one way where, 'here's an example, let's work it out. Go! Thirty problems, do it.'" (Interview #2). Several experiences cultivated this view. During his year as a non-MTF, Pedro attended a one-day workshop focused on mathematics discourse and vocabulary. He referenced this experience as he described PD, but also indicated that his use of specific vocabulary practices were the backbone for further literacy integration. Word walls and foldable note-taking devices became standard across his courses during the first year, allowing him to develop integrated literacy approaches during the second year. He wed intermediate strategies such as vocabulary graphic organizers with disciplinary questioning practices, evidenced in his probability lesson. As students demonstrated greater success, his beliefs and descriptions of literacy evolved

(Guskey, 2002). He did not view reading and vocabulary as the only applicable literacy practices in mathematics. Instead, he infused meaning-making behaviors of mathematicians (Moje, 2007) with literacy tools; consequently, "Anything that we do to be able to understand math, this is literacy" (Interview #2). Pedro's experience is a blueprint for integration. It is feasible that PD should begin with intermediate tools, focusing on vocabulary, activating background knowledge, and note-taking, and conclude with assimilated disciplinary literacy approaches.

Alice produced capacious conceptions of literacy. As a self-authoring practitioner, she depicted mathematics as "a language in itself. Whether you're reading math or reading about math or reading directions, there's a lot of reading and writing and it's not just problem solving" (Interview #1). Experiences with students learning how to decode such language produced growing conceptions of literacy and texts. She named equations, graphs, and statistical problems as mathematical texts and coupled these with literacy strategies to build problem-solving perseverance and scaffold students' communication (CCSSM, 2010). She experimented with questioning and using writing as assessment. It seems her focused integration attempts informed her conceptions of literacy. Next, I discuss factors influencing MTFs' enactment of literacy integration in secondary mathematics.

Enactment of Literacy Integration Strategies

Research provides a litany of approaches designed to support pedagogical shifts and improved instruction (Belzer & St. Clair, 2003; Clewell, 2004; Guskey, 2002; Joyce & Showers, 2002; Kise, 2009; Knight, 2013), yet the paradox of changing practices alongside beliefs remains elusive. All MTFs reported the value of literacy, offering

vignettes of classroom practice that illustrated how literacy not only intersects, but supports learning mathematics. They associated literacy as central to *doing* mathematics, establishing a continuum ranging from being able to navigate mathematics textbooks and use vocabulary to applying problem-solving strategies and discourse used by mathematicians. By the end of the research period, every MTF believed that literacy integration had the potential to impact student learning outcomes (Guskey, 2002). While Bailey and Brynne felt this would emerge through higher state exam scores, Sue and Claire indicated students would demonstrate more robust mathematical reasoning and discourse. Pedro and Alice suggested new pedagogies combining intermediate and disciplinary literacy skills would bolster student problem-solving and mathematics proficiency, building connections between processes. Even so, MTFs struggled with how to integrate literacy and, at times, returned to previous classroom practices. MTFs collectively demonstrated Alexander and Fives' (2000) acclimation stage throughout the research period as they oriented themselves to new, unfamiliar instructional practices. While some developed competence, a foundational basis for literacy integration, others progressed to proficiency. Proficient MTFs engaged in deep-processing strategies to identify problems with specific literacy integration approaches and constructed alternative solutions that emerged in the data. Their enactment relative to Alexander and Fives' model is discussed and organized by the Power Strategies.

Voracious vocabulary. Discourse is gaining traction in mathematics instruction (CCSSM, 2010; NCTM, 2000). It "is simultaneously technical, dense, multisemiotic, drawing on natural language, symbolic language, and visual display, which interact in discipline-specific, synergistic ways" (Fang & Schlepegrell, 2010, p. 591). Therefore,

when students describe and solve problems using mathematical discourse, they demonstrate expertise. Accordingly, Content/Specialized vocabulary was the linchpin power strategy cited by MTFs.

MTFs insisted on precise, accurate use of terminology and articulated this to their peers during the second PD session and their students daily. Consistent with content-area reading research (Barton & Heidema, 2002), MTFs incorporated visuals and graphic organizers such as the Word Recognition Chart or Frayer Model (Blachowicz & Fisher, 2006) in classroom observations, effective vocabulary strategies in mathematics (Gifford & Gore, 2008). Some MTFs demonstrated proficiency by adapting organizers to assess vocabulary and scaffold mathematics understanding. For example, Alice used the Tic-Tac-Toe grid to measure students' acquisition of terms. Claire's students used organizers to develop explanations for converting fractions to decimals, demonstrating how vocabulary is central to discourse and supported by House's (1996) exploration of integrated writing tasks. Sue revealed how discourse assists students in consolidating understanding of symbols by designing vocabulary prompt charts and graphics, while Pedro guided students to describe and associate vocabulary with math skills and processes. These examples depict the integral nature of intermediate and disciplinary literacy instruction (Faggella-Luby et al., 2012).

MTFs with broader conceptions of literacy engaged in more complex instruction; therefore, data indicated more sophisticated discourse. Introducing terms, multiple exposures, and consistent teacher modeling were foundational to solving complex problems in these contexts. MTFs with limited literacy views and background experiences taught terms, but generated less discourse. Bailey and Brynne's Geometry

units depicted the use of intermediate vocabulary tools; however, there is not data to support deep processing of literacy integration approaches and discourse. Findings indicate standard vocabulary "instruction" consisting of filling in blanks and recording textbook definitions, reflecting Bailey's and Brynne's levels of competence. Claire, Sue, Pedro, and Alice incorporated explicit vocabulary instruction, shined light on writing integration, and illustrated discourse. These MTFs constructed avenues to direct students' mathematics language acquisition, depicting proficiency (Alexander & Fives, 2000).

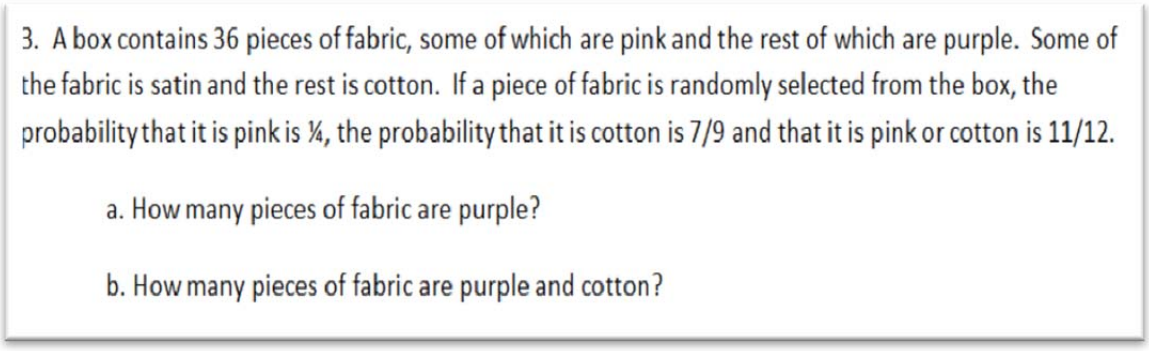
Take note. Two instructional modes dominate mathematics: lectures and texts, respectively illustrating a traditional lesson sequence—first, teachers offer oral explanations and then provide practice textbook problems (Stigler, 1999). Textbooks are often referred to as resources, not curriculum. This distinguishes textbooks from the "real" mathematics that is taught and learned under the facilitation of a teacher, who possesses deep pedagogical content knowledge (Shulman, 1986). In accord, MTFs described the lack of textbook use by themselves and non-MTFs, yet indicated the potential in "the pages between the pages" (Sue, Interview #1). To uncover this potential, MTFs changed note-taking practices.

The fourth train-the-trainer session, Note, Retrieve, and Organize, facilitated pedagogical shifts for some MTFs. Bailey and Claire implemented interactive notebooks. Claire's notebooks served as models of intermediate and disciplinary literacy practices and Bailey's notebooks showed the potential for literacy integration PD to support other content-aligned PD (Cohen & Hill, 2001), such as flipped classrooms. The findings support (1) increased time for MTFs to learn the power strategy and (2) their MTF-partnership promoted teacher change. Bailey and Claire worked through the summer

months to plan their implementation involving textbook reading and student-generated notes. This job-embedded, peer-coaching approach (Joyce & Showers, 2002; Knight, 2007) fostered a consistent focus that impacted classroom instruction, student learning, and teacher beliefs (Guskey, 1986), pushing Bailey beyond her typical *imperial* and *interpersonal* behaviors. It is plausible that maintaining MTF partners and including coaching practices within literacy PD are influential venues for sustaining instructional practices.

Pedro, Alice, Sue, and Brynne demonstrated pedagogical innovation. Each had established note-taking practices, but voiced changes in their role during the research period. In lieu of "feeding information," each suggested guided notes with textbook reading assignments fostered skills of independence, thereby changing the traditional mathematics sequence of oral lecture and textbook exercises (Stigler, 1999). During observations, they referred students back to their text and notes, seeming to reflect the PD content, which included a discussion about teacher and student roles in a literacy-rich environment. It is likely that focused discussions about *how* teachers enact practices support higher levels of literacy integration.

Questioning. The clearest enactment of literacy integration was flanked in rich math tasks and the Common Core State Standards for Mathematical Practice. Quality math tasks and effective questioning were the foundation of the fifth session. I observed Alice and Pedro immediately following this session. Alice's students completed a partner quiz on probability concepts. Students referred to notes as they solved problems:


3. A box contains 36 pieces of fabric, some of which are pink and the rest of which are purple. Some of the fabric is satin and the rest is cotton. If a piece of fabric is randomly selected from the box, the probability that it is pink is ¼, the probability that it is cotton is 7/9 and that it is pink or cotton is 11/12.

a. How many pieces of fabric are purple?

b. How many pieces of fabric are purple and cotton?

Figure 5.3: Sample math task.

I observed two students apply questioning practices to monitor understanding:

STUDENT B: So the probability of A or B, which is .4….5…oh, that's going to be a negative number. That can't be right.

STUDENT A: Will it?

STUDENT B: Oh, never mind. Ok, so…

STUDENT A: Are the two events mutually exclusive?

STUDENT B: Ok, so it would be mean each is the same thing…independent.

STUDENT A: So, yes…because they have no impact on each other?

STUDENT B: Yeah.

Their exchange reveals the relationship between discourse, questioning and problem solving. While Monitoring Understanding was not a power strategy during the research period, data indicates MTFs reinforced students' metacognition with questions. It is reasonable that future literacy PD integrate both strategies to arm mathematics practitioners with instructional practices that support students' sense-making ventures. Pedro utilized "Talk Moves" (Chapin, O'Connor, & Anderson, 2009) during discussions, which seemed to render a symbiotic relationship between questioning and problem solving. Students were *doing* mathematics while practicing speaking, listening, writing,

and reading. Cohen and Hill's (2001) findings that content-aligned PD produces high levels of reform-oriented practice with an emphasis on higher-order thinking is substantiated in Alice's quiz and Pedro's questioning practices.

The data indicates the fifth session cultivated these instructional shifts. MTFs enacted literacy strategies and used questioning to support students solving problems. This starkly contrasted previous literacy sessions in which even MTFs felt the content was tangentially-related to their daily instruction. Adapting the PD materials to content-aligned examples propagated literacy integration.

Time is of the essence. The findings indicate literacy integration proliferated in MTFs' classrooms during the weeks immediately before and after PD sessions. Sue, Bailey, and Brynne seemed to rely on the PD sessions to boost their own instructional practices, given the fact they attempted to include exemplars to share with non-MTFs. While the veteran MTFs also peaked around the PD sessions, Pedro, Alice, and Claire planned lessons with literacy integration in mind. It is plausible that carefully-sequenced PD with time to integrate and reflect upon literacy practices in collaborative environments (DuFour, 2004; Joyce & Showers, 2002; Knight, 2013) would further enactment.

Taken together, MTFs' literacy integration enactment and descriptions of classroom practice expose the integral nature of vocabulary and discourse, note-taking, and questioning in secondary mathematics courses. Clearly, timing of professional development, collaborative partnerships, and disciplinary literacy exemplars are crucial catalysts for integration and teacher change. Below, I summarize this study's key findings, explain its significance, and offer implications for future research.

Summary

This study illustrates practitioners' conceptions of literacy, the relationship between literacy integration professional development and enactment in secondary mathematics, and tensions of literacy integration in mathematics. The degree of enactment and latitude of literacy descriptions related to teaching experience, Constructivist-Developmental Theory stage, MTF experience, level of mathematics taught, and ELA background experiences. Intermediate literacy strategies, including questioning, vocabulary, and note-taking, emerged as paramount for mathematics learning. Consistent with content-area literacy research, MTFs crafted literacy examples that were "easy to implement" and "beneficial" to actually learning and practicing math (Davis, 1994; Ross & McDaniel, 2004; Siebert & Draper, 2005). The coincidence of literacy integration PD with other influential factors resulted in significant change for some MTFs, depicting how literacy supports mathematics learning. MTFs revealed strengths and opportunities of literacy integration PD for secondary mathematics educators, impelling further research.

Limitations

This qualitative research offers an in-depth depiction of MTFs literacy PD and integration experiences. Because this study was bounded by demographics, the location of Plains district and participant pool of six MTFs, the teachers and their interactions with the PD content and enactment cannot be duplicated. Therefore, findings may not be generalized to other populations and will not convey causality between literacy integration professional development and improved adolescent literacy or mathematics achievement. The synthesis of data through rich, thick descriptions of enactment and

experiences informs mathematics practitioners, literacy coaches, and professional developers relative to the implementation of the CCSSELA (2010), CCSSM (2010), and literacy integration.

I was the principal researcher and conducted interviews and classroom observations. As the mathematics curriculum facilitator, I served on the District Literacy Team as well as several core planning committees that steered and developed the PD materials that MTFs experienced. To eliminate possibilities for bias, I have ensured that the results of the research are accurately recorded and have made every effort to consider possibilities for bias in the analysis of data through member checks and peer review. In addition, each participant was treated independently to ensure that I did not focus on one viewpoint designed to prove a specific research goal.

Study Significance

Although there is support to establish discipline-specific pedagogical knowledge relative to literacy, few researchers (e.g. Davis & Gerber, 1994; Draper & Siebert, 2004; Olson & Truxaw, 2009) have focused on professional development that blends mathematics teachers' disciplinary knowledge with literacy strategy instruction. Existing studies suggest math teachers do not see a need for or relevance in literacy integration (O'Brien et al., 1995) and have focused on (a) content-area reading strategy use and professional development (e.g. Alger, 2009; Borasi, Sigel, Fonzi, & Smith, 1998; Fisher & Frey, 2008), (b) the readability of mathematics texts (e.g. Osterholm, 2005), (c) relationships between higher-education practitioners (e.g. Siebert & Draper, 2012) and pre-service teachers of various disciplines (e.g. Donahue, 2003), and (d) literacy coaches' work with mathematics practitioners (e.g. Alvermann, Friese, & Beck, 2011; Draper,

2004). Emerging disciplinary literacy research, the continued implementation of the Common Core State Standards, and professional development provided the research context for this study.

Moje's (2007) research review illuminates the significance of this study. Her query using the search terms *disciplinary literacy, mathematical literacy, scientific literacy,* and *historical/social science literacy* yielded 31 disciplinary literacy articles, 648 science and scientific literacy articles, 180 historical literacy articles, and 75 and 103 articles for mathematical literacy and math literacy, respectively. This study adds to this research, reporting instructional strategies and tensions secondary mathematics practitioners experience as they integrate literacy.

Overall, MTFs' reported descriptions and enactment highlights the: (a) intersections of mathematics learning and literacy strategy instruction; (b) disciplinary ways of constructing meaning in mathematics, which supports literacy coaches, mathematics practitioners, and administrators/professional developers; (c) practices and dispositions needed to support mathematics teachers' literacy integration; and (d) characteristics of effective professional development.

Implications for Future Research

Literacy integration PD will exponentially increase with the CCSS, requiring that students "be taught disciplinary literacy in grades 6-12" (CCSS, 2010). A recent issue of *Reading Today* called for content-area teachers' involvement in teaching the CCSS-ELA through literacy strategies "that are pertinent to each discipline" and providing appropriate professional development in "literacy practices appropriate for their

disciplines" (Zygouris-Coe, 2012). Inherent to these recommendations are opportunities for further research. Several aspects of my study offer potential avenues for research.

The first three sessions were developed as informational PD (Duffy, 2005), leaving little room for MTFs and myself to exercise autonomy and assume a stance of inquiry. We were unable to produce rich mathematics literacy examples, confined to "stand-and-deliver" professional development. Once pacing guidelines were eliminated, transformation occurred. It is reasonable to believe that greater autonomy and an increased focus on mathematics disciplinary literacy would improve literacy integration. Future research may substantiate such claims.

MTFs engaged in literacy integration PD over the course of 24 months; however, some MTFs were present for the entire research period while others experienced fragments of the series. What would occur in a cohort group of secondary mathematics educators who served as peer trainers? Brynne shared positive feedback concerning her partner, Larry. Claire fostered Bailey's growth. How would peer feedback and coaching influence descriptions and enactment? When teachers try new instructional approaches, they need opportunities to reflect through structured opportunities (Knight, 2013). What would happen in such a context? Future research may examine peer coaching and teacher change.

Train-the-trainer sessions were strewn across school years, with limited time for MTFs to integrate practices. Because learning requires repetition and engagement over time (Shell et al., 2010), how could the PD structure be adjusted to better serve practitioners? What impact would a more condensed PD approach have on mathematics instruction? Some non-MTF feedback (August 2012) requesting "more math examples"

and "how do you actually *do* this?" may have been alleviated if MTFs had classroom application time. Enacting literacy practices seemed to require tangible examples and evidence of improved student learning. How does timing of PD influence such enactment?

The findings indicated that the level of mathematics taught influences the complexity of literacy integration, offering another avenue of research. While middle school MTFs limited integration to intermediate literacy skills, high school MTFs joined intermediate and disciplinary literacy strategy instruction. Are there mathematics concepts that are best mediated through literacy integration? What are the characteristics of such concepts? What are the instructional strategies? Future research may examine such questions.

Conducting this study as a practitioner researcher shaped my work during the research period and cultivated my dispositions about professional development, adolescent literacy, mathematics teaching, and adult learning. Actively interrogating the intersections between educational theory, policy, and practice influenced my discussions with mathematics practitioners, administrators, and community members while pushing me to advocate for improved adult learning opportunities for teachers. My leadership skills matured as I critically analyzed *what, how,* and *why* decisions were made relative to my problem of practice. I shared my reflections formally and informally with professional learning communities and practitioners, seeking to better understand emerging tensions. As I continue as a curriculum facilitator, I have learned the art of coaching, principles of partnership, and understand practices that foster teacher growth. This study propels me to investigate other problems of practice.

Final Thought

My research demonstrates the potential of involving mathematics teachers in literacy integration PD and offers a vision for professional learning through inquiry as stance. I revealed characteristics of effective professional development, the role of a curriculum facilitator, how background knowledge and experiences influence adult learning and the critical relationship between intermediate and disciplinary literacy skills in doing mathematics. My case study demonstrates how intermediate literacy strategy professional development is an antiquated approach to literacy integration for secondary mathematics teachers (Borasi, Siegel, Fonzi, & Smith, 1998; Davis, 1994; Draper, 2008; Larson, 2013). A complementary approach combining intermediate and disciplinary literacy instruction holds promise for meeting the CCSS and professional learning needs of mathematics educators; thus, supporting teachers in learning and enacting the specialized ways of thinking, problem-solving, and communicating in mathematics. Supplementary literacy professional learning will continue to fail, as it is viewed as just that, supplementary, tenuously tied to learning mathematics. Today's mathematics practitioners are part of the "notch generation," a group of teachers who are being asked to teach in a way they never experienced as students (Confer & Ramirez, 2013). Therefore, studies such as this one are imperative to supporting practitioner growth as they offer rich illustrations of and expose tensions in literacy integration for secondary mathematics teachers.

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APPENDIX A: DATA COLLECTION INSTRUMENTS

A-1: IRB Participation Letter
A-2: Field Notes Template (Observations)
A-3: Interview Protocol
A-4: Disciplinary Literacy in Mathematics: Teacher Self-Report Survey

A-1: IRB Participation Letter

IRB approval number: 20120312473 EX

Dear Mathematics Teacher Facilitators,

Greetings! As some of you know, I am a doctoral candidate at the University of Nebraska-Lincoln majoring in Teaching, Learning, and Teacher Education. As a requirement for
completion of my Ed.D degree, I am working on a dissertation entitled "Disciplinary Literacy: Secondary Mathematics Teachers' Development and Instructional Practices." The study will require input from a group of RtI+I-Tier 1: Best Learning Practices members from secondary school buildings in the XXX Public Schools district through a series of interviews, surveys, and classroom observations. I would be very grateful if you would consider participating in this study.

This study will examine disciplinary literacy in mathematics. Specifically, it centers on disciplinary literacy professional development (PD) and how these efforts impact classroom practice and teacher decision-making in mathematics with a particular emphasis on the teacher's role. Mathematics teachers employ various instructional practices and design activities that students engage in to develop conceptual understanding of mathematics. The study will hone in on how teacher's dispositions toward literacy are formed and manifest themselves in secondary math contexts. The study examines the question:

How do secondary Mathematics Teacher Facilitators (MTFs), experiencing a train-the-trainer model, describe their literacy professional development experiences?

By participating in this research study, it is not anticipated that you will experience any personal risks, nor are there any direct benefits to you. Your valuable input in this study will help provide insights into the teacher development of mathematics' educators relative to disciplinary literacy instructional practices. The results of the study will be beneficial for improving the quality of education offered to students and guide the district literacy team and secondary mathematics department in future professional development efforts.

Participation in this research study is voluntary. You are free to decide not to participate in this study or to withdraw at any time without adversely affecting your relationship with the investigators, the University of Nebraska-Lincoln, or Millard Public Schools.

The time commitment and participant involvement required for this study is described below:

1) Four selected-response surveys, 10 questions each, administered via an online survey tool at four points during the study.

Three participants will be selected to engage in more in-depth analysis of teaching and learning through the following:

1) Two semi-structured interviews (60 minutes each) in which participants will respond to questions that will be audio recorded and transcribed. These will conducted at a participant-selected site.
2) Four observations in your classroom (60 minutes) during which field notes will be generated.

These participants will be selected based on past involvement as a presenter in RtI+I-Tier 1: Best Learning Practices, high school teaching placement, and consent to participate.

All responses will be confidential and will be used only for this study. Although I am the secondary mathematics curriculum facilitator, your relationship with me and your role in the secondary mathematics department (e.g. serving on district writing committees, completing assessment reviews, etc.) will not be affected by participation or non-participation, nor will your relationship with the University of Nebraska. The results of this study may be used in professional journal articles or presented at professional conferences. However, your identity and the identity of XXX Public Schools will be protected in the reporting of results. Your name will not be associated with any results. If the name of your institution appears in the study, I will use a code or pseudonym throughout the reporting of the research results.

Please accept my sincere thank you in advance for your involvement in this study. Again, there are no rewards for your efforts other than the knowledge that you have assisted a graduate student in post-secondary learning endeavors and contributed to further research in the teacher development process of secondary mathematics' educators.

If you have any questions about this study, please contact me at (XXX) XXX-XXXX or email jllarson@XXXX. If you have any questions about your rights as a research participant that we have not answered, or to report any concerns about the study, you may contact the University of Nebraska-Lincoln Institutional Review Board at (402) 472-6965.

If you have any questions or comments about this study, I would be happy to talk with you. My contact information is below.

You are voluntarily making a decision whether or not to participate in this research study. Your signature certifies that you have decided to participate having read and understood the information presented. You will be given a copy of this consent form to keep.

_____ _____

Signature of Participant Date

I hereby give consent to audio record my interview.

_____ _____

Initials of Participant Date

I hereby give consent to videotape my classroom instruction on two occasions to be determined by the principal investigator and myself.

_____ _____

Initials of Participant Date

Thank you again for your valuable input,

Janet Larson, Principal Investigator
Email: jllarson@mpsomaha.org
Phone: (402) 715-6356

Dr. Kathleen Wilson, Secondary Investigator
Email: kwilson3@unl.edu
Phone: (402) 472-5970

A-2: Field Notes Template

OBSERVATION TIMES PARTICIPANT Observation-COURSE Class Composition: __ females & __ males= present today

Power Strategy Observed (Literacy Strategies from PD sessions)	**Observation** (Teacher/Student Interactions & Dialogue)	**Interpretive Commentary**
CONTENT / SPECIALIZED VOCABULARY		
☐ Environmental print ☐ Graphic organizers ☐ New vocabulary words are "front-loaded" ☐ Multiple, meaningful exposures		
TEXT FEATURES		
☐ Teachers describes features ☐ Suggestions are made for which text features might be most helpful		
TEXT STRUCTURES		
☐ Organizational pattern is identified ☐ Attention is drawn to structure clues		
MONITORING UNDERSTANDING		
☐ Chunking of content ☐ Pauses and/or reflection time ☐ Frequent checks for understanding ☐ Think-alouds		
PREVIEWING TEXT		
☐ Identified purpose ☐ Students identify unfamiliar vocabulary words ☐ Sample problems ☐ Connection to "real world"		
ACTIVATING BACKGROUND KNOWLEDGE		
☐ Activity to activate ☐ Connections ☐ Teacher prompts reflection w/questions ☐ Similes, metaphors, analogies and comparisons ☐ Builds interest around topic		
QUESTIONING		
☐ Predictions ☐ High-level questions ☐ Student-generated questions ☐ Talk moves		

NOTING, ORGANIZING AND RETRIEVING INFORMATION		
□ Visual images □ Ongoing summarization □ Note-taking options □ Graphic organizers □ Words and images		

Other:

A-3: INTERVIEW PROTOCOL
(2 interviews x 45 minutes per interview)
Date_____
Pseudonym_____

Introduction Protocol for all interview sessions:
 Introduce yourself
 Discuss the purpose of the study
 Provide informed consent
 Provide structure of the interview
(audio recording, taking notes, and use of pseudonym)
 Ask if they have any questions
 Test audio recording equipment
 Smile, open body position-make the participants feel comfortable

Conclusion Protocol for all interview sessions:
Is there anything else you would like to add or share about this topic that you feel is important for me to know?
 Thank them for their participation
 Ask if they would like to see a copy of the results
 Record any observations, feelings, thoughts and/or reactions about the interview

Session 1: BELIEFS ABOUT MATH TEACHING & LITERACY INTEGRATION

1. If your teaching career was a book and each significant event was a chapter, where would it start?
2. What does a successful math class look like?
3. Would you describe what you think the best professional development for math teachers would be?
4. Do you believe literacy supports learning mathematics?
    a. If so, please describe an incident in your own teaching context in which literacy directly supported a student understanding a math concept more fully because of something you did.

Provide overview of the professional development plan to participant to refer to.

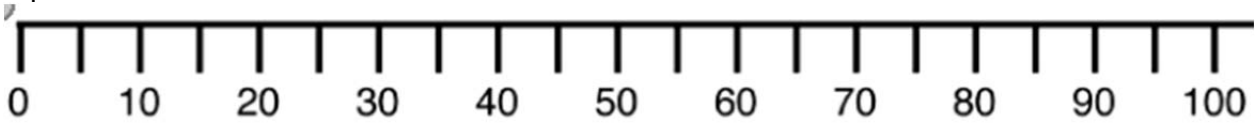
5. From your perspective, describe the goal of RtI+I-Tier I: Best Learning Practices.
6. How do you decide which literacy tools to use from the sessions?
7. How successful do you think you have been in implementing the tools and strategies emphasized in literacy professional development sessions? (Give choices if needed, i.e. “Ready, Set, Go, Whoa”)
8. Describe the barriers you may have encountered as you tried to use the tools/strategies.
9. How likely are you to integrate the literacy strategies in your classes?
    a. Describe why you feel this way.

Session 2: LITERACY PROFESSIONAL DEVELOPMENT FOR MATH TEACHERS

1. Some people would say that literacy is only learned in English-Language Arts classes. What would you tell them?
    a. Tell me more about literacy in math.
2. Suppose I was a first-year teacher in your district, how would you describe the literacy professional development so far?
3. What is your opinion of the literacy professional development?
    a. What have your colleagues said about the PD?
    b. Talk to me about a conversation you've had with a colleague about this initiative.
    c. Have you seen your colleagues use any of the tools?
    d. How does that make you feel?
4. Describe how you came to be a presenter for this initiative.
    a. What influenced your decision to become a presenter?
    b. What differences do you see between yourself and your peers who have not been at the training sessions?
    c. Have you received any positive or negative messages from colleagues as a result of being a presenter? Tell me about them.
    d. Describe how you prepared for your presentations.
    e. Tell about the most frustrating thing when you presented.
    f. Tell about the best thing about presenting literacy tools and strategies to your colleagues.
    g. Overall, what was it like for you when you presented to your colleagues?
5. Has your thinking changed since we began this initiative? Tell me more.

A-4: Disciplinary Literacy in Mathematics: Teacher Self-Report Survey

Directions: This section contains a series of statements. Please indicate how you feel about each statement and consider your current instructional practices as you respond to each item using a scale of 1-100. 1 represents STRONGLY DISAGREE and 100 represents STRONGLY AGREE.



Strongly Disagree Neutral Strongly Agree

1. Students need to understand vocabulary to complete their assignments in my class.
2. It is a waste of instructional time to read and write in classes outside of English Language Arts.
3. It is important that teachers focus on *how* students learn, not just *what* students learn.
4. I assess the academic vocabulary used in my text and plan instruction so all students can succeed.
5. I know how to teach vocabulary effectively and use literacy tools and strategies to teach and reinforce vocabulary in mathematics.
6. Students have opportunities to interact with vocabulary in a variety of ways in my class.
7. I intentionally activate and build on students' prior knowledge during pre-learning instructional activities.
8. I explicitly connect concepts and skills students are learning with their experiences both inside and outside of school.
9. Students can complete their work without applying the academic language of mathematics.
10. When students preview text, I assist them in developing questions and utilizing tools that guide reading mathematics texts and learning.

APPENDIX B: PROFESSIONAL DEVELOPMENT INFORMATIONAL ARTIFACTS

B-1: Letter of Invitation to Potential Literacy PD presenters (MTFs)
B-2: Sample Agenda for Train-the-Trainer Session
B-3: Sample District Literacy Team Meeting Agenda
B-4: Sample Timing Sheet Distributed by Office of Staff Development during Train-the-Trainer Session
B-5: Sample Facilitation Guidelines for Trainers (MTFs)

B-1: Letter of Invitation to Potential Literacy PD Trainers

TO: Select Staff
FR: XXXXXX, Director of Staff Development
XXXXXX, Director of Secondary Education
DT: January 19, 2012
RE: Leadership Opportunity in RtI+I Tier I: Best Learning Practices

Teaching literacy across content areas with an emphasis on pre-reading/pre-learning strategies will be the secondary staff development focus for 2012-2013. You are considered an excellent candidate to become a 2012-2013 RtI+I district trainer.

By agreeing to become a 2012-2013 presenter, you will have the opportunity to participate in two "step-ahead" training sessions with national educational consultant, Sue Beers. Each session will prepare you to train colleagues in your subject area on district designated staff development days.

Individuals committing to this leadership opportunity should:

- Have effective communication/presentation skills
- Enthusiastically support the concept of RtI+I Tier I: Best Learning Practices
- Assist building colleagues following the training
- Be willing to implement practices in his/her own classroom
- Have an interest in this leadership opportunity to promote literacy across all content areas.
- Be available to attend all training and presentation dates:

Training Dates	**Presentation Dates**
June 5th, 2012	August 10th, 2012
November 15th, 2012	January 21st, 2013

Please review the information above and contact your Curriculum MEP Facilitator or us with any specific questions about this opportunity.

Please RSVP by February 10, 2012 by registering in ***Better and Better*** for the 2 training sessions – Course #XXXX.

B-2: Sample Agenda for Train-the-Trainer Session
RtI+I Tier I: Best Learning Practices
June 8, 2011 / 8am-4pm

Introductions & Thank Yous!
Today's Objective for You as Trainers
Participants will demonstrate comprehension of their role and responsibilities for 2011-2012 secondary staff development by discussing the research and relevant examples provided by our national presenter.

Outcomes for You as Participants
Identify factors that affect reading comprehension
Generate ideas for increasing student motivation to read
Identify the qualities of a "good" reading assignment
Create reading assignment plans for students
Begin to process the 8 Power Reading Strategies and how they can be integrated with content

2011-2012 Goal
Secondary staff will understand and apply RtI+I Tier I: Best Learning Practices with a specific focus on reading strategies. Staff will understand and apply reading strategies to help MPS students read to learn and therefore improve student achievement in the content areas.

Multi-year focus - Results-oriented – Evaluation Planned

Training Dates	Presentation Dates
June 8th, 2011	August 5th, 2011
October 6th, 2011	
November 17th, 2011	January 16th, 2012
January 19th, 2012	February 20th, 2012

Payment of Trainers
DEADLINE for payment - Timesheet due to the Office of Staff Development no later than July 25

ANGEL Community Group Demo (See attached document for details.)
Master power point – you will tailor for your content area – upload by July 25, 2011
Video clips of Sue – loaded before July 1

Sue Beers – Best Learning Practices

Team Time – Tailor Your Presentation!

B-3: Sample District Literacy Team Meeting Agenda

RtI+I Tier I: Best Learning Practices
September 1, 2011 / 12pm-4pm
Conf Room B1 & B2

Our Goal in 2011-12

Secondary staff will understand and apply RtI+I Tier I: Best Learning Practices with a specific focus on reading strategies. Staff will understand and apply reading strategies to help students read to learn and therefore improve student achievement in the content areas.

Training Dates	Presentation Dates
June 8th, 2011	August 5th, 2011
October 6th, 2011	
November 17th, 2011	January 16th, 2012
January 19th, 2012	~~February 20th, 2012~~ (When will we?)

Today's Objective

Participants will demonstrate evaluation of the initial implementation of our 2011-2012 goal for RtI+I Tier I: Best Learning Practices by reviewing August 5th presentations and preparing for future presentations.

Welcome, Enjoy Lunch / Table Tent Activity for Introductions
Review 2011 Spring Committee Norms

- Challenge the status quo
- Agree to be comfortable; speak honestly and respect confidentiality
- Respect all opinions; views & listen fully
- Be present at all meetings and focus on task at hand
- Do We Need a Time Keeper Needed? / Recorder Needed?

Review of Aug 5 presentations
Analysis of comments by themes – see attached
Updated future presenter list – see attached

2011-12 Building Staff Development Facilitator Meeting Support
Optional Stipend Sessions - see attached

Update on Evaluation Plans

Determine 2011-12 Plans with No Presidents' Day

Prep/plan for October & November sessions with Shelly and teacher presenters
Next steps and roles/responsibilities prior to October 6, 2011 session
Shelly's calendar for teleconferences for planning
Confirm decisions & minutes from today

B-4: Sample Timing Sheet Distributed by Office of Staff Development during Train-the-Trainer Session

Power Strategy 8: Note, Organize and Retrieve Information from Text
Power Point Timing

Slide #'s	Content	Timing	Timing for August 10th Presentation
1-7 (Millard Team)	Objectives Norms MPS Vision Facilitation Skills From the Field	1 hour	10 minutes *(*Opener, introduce self, location of RR, norms, technology use, etc.)*
8-11	Intro to Power Strategy 8 Reflection Activity Today's Learning Targets	10 minutes	10 minutes
12-15	Review of Reading Process Diagram When the Text Gets Tough Reader Confidence Reading and Retention	10 minutes	10 minutes
16- 18	Direct / Explicit Instruction Gradual Release of Responsibility	5 minutes	5 minutes
19-24	CITW Chart Big Six Overview of Summarizing Reflection Activity	10 minutes	10 minutes
25	Every Child, Every Day Activity	15 minutes	15 minutes
26-36	Summarizing Practice Using Rule-Based Strategy (Photographic Process) Taking Notes Quick Note-Taking Tips	15 minutes	15 minutes
37-38	Every Child, Every Day: Round 2	5 minutes	5 minutes
39-47	Visual Summarizing	10 minutes	10 minutes
48-57	Sample Tools	15 minutes	15 minutes
58	Break – Q and A	15 minutes	15 minutes *Activity: Rank the tools-which one is best for your content area? Explain why in groups of 3.*

59-64	Sample Tools	15 minutes	10 minutes
65	Break – Q and A	5 minutes	5 minutes *Activity: Two-sentence summary. Describe the thinking students would do with one of the tools. Match the tool to a topic you teach in your content area.*
66-71	Sample Tools	15 minutes	10 minutes
72	Break – Q and A	5 minutes	5 minutes *Activity: Think about all the tools you have seen so far. How often do you think you will work with these types of tools each week? Line up in order of how often (1x per week, 3x per week, daily). Discuss with the people around you why you chose that particular usage and the role of note-taking in learning and understanding content in your discipline.*
73-80	Sample Tools	15 minutes	10 minutes
81	Break – Q and A	5 minutes	5 minutes *Activity: Pick a tool you have seen today. Partner up with someone who has the same birth month as you. What prerequisite skills would students need to work with the tool you chose? How would you explicitly teach these skills?*
82-88	Sample Tools	15 minutes	10 minutes
89	Plan for the Afternoon	5 minutes	5 minutes Closure: **Thank participants, plan an intentional closing activity (i.e. "Ticket Out the Door")*

B-5: Sample Facilitation Guidelines for Trainers (MTFs)

Facilitation Tips and Tricks

Openers: Raise the BAR.

- Break preoccupation, Allow networking, Relate to the content
- *Presentation Tip: Don't use the term "Ice Breaker." Many adults see that as a waste of time.*

Opener Ideas:

- Show an inspirational video. Ask participants to discuss how the video connects to their work as teachers and their classrooms.
- Select from an image provided (projected or envelope of clip art) and describe how the topic (e.g. Literacy in my classroom) is like the image.
- Line-Up: Form a line (e.g. years experience, birthdays, etc…) fold the line and discuss a prompt that connects to the topic.

The Office of Staff Development and your Building Staff Development Facilitators have resource books with more ideas.

Some additional thoughts to prepare to present staff development:

- Arrive early, at least 30 minutes before
- Find out if you can even set up the night before
- If you can't set up in advance, have envelopes with table materials packaged together so you have less to hand out
- Room Arrangement—MOVE things around
- What makes the most sense for your activities & # of participants?
- Tables & chair arrangement, consider sight lines
- Do you want to strategically assign participants to groups/tables?
- Take a picture of the room before you move it around… this way you'll remember how to put things back!

Music as an Energizer: Create a playlist of upbeat music

- Celebration…Kool & the Gang
- I Gotta Feeling…The Black Eyed Peas
- ABC… Jackson 5
- Walking On Sunshine…Katrina and the Waves
- Eye of the Tiger…Survivor
- TV show theme music, oldies, soundtracks

Set Norms for the Day:

- Remind to turn off phones
- Explain when/if computers are needed
- Location of restrooms, plan for break(s)
- Beginning and ending time; general timeline of day (NOT specific)
- Others:

Attention Signals

- Music stop/start
- Noise maker: chimes, bell, cell phone alarm
- Raise hand
- Clap or Chant
- www.online-stopwatch.com
- Others:

Calling On Participants:

- Number your tables, handouts or table tents
- Pass out number to participants and use popsicle sticks to call out random numbers
- Use SMART notebook random selector tool… individual or table selector
- Print roster, cut into strips and draw names
- Throw a ball at person you call on

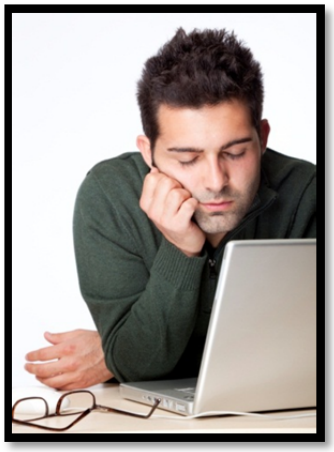
- "First one to share is the first one to leave"
- Roll-a- Number: Number the people at the table 1-6. Roll dice to select.
- Ticket Drawing: Hand out tickets as people share and use tickets for a door prize drawing.

Discussion Starters: State the prompt. The discussion leader will be the person who…

- birthday is closest to today's date
- most buttons
- ate the healthiest breakfast
- is wearing a specific color of clothing
- is tallest/shortest
- has the most pets
- most experience/least experience
- first or last name is first or last in the alphabet
- funkiest shoes
- most unique vacation spot within last year
- has the darkest/lightest hair
- lives the farthest distance away

Processing Ideas—AKA What to do when their eyes are glazing over:

- Say Anything!: Stop and let individuals say anything in response to learning to neighbor
- Turn to your neighbor and discuss…
  - how you could use this in your classroom
  - what you think you need to work on
  - how this could help your students
  - what do you think should be your next step
- Think, Ink, Share: Provide reflection time, written reflection and sharing time
- Stand up and discuss with your table partner…
- Stand up and find someone you haven't talked to today to discuss…
- Get up and Move: Grab your handout and move to another area of the room to discuss



Closers:

- Celebrate Success
- Summarize the content/ Tie it all together
- Action Planning/ Plan for next steps

Closing Activity Ideas: Source—SCORE! By The Bob Pike Group

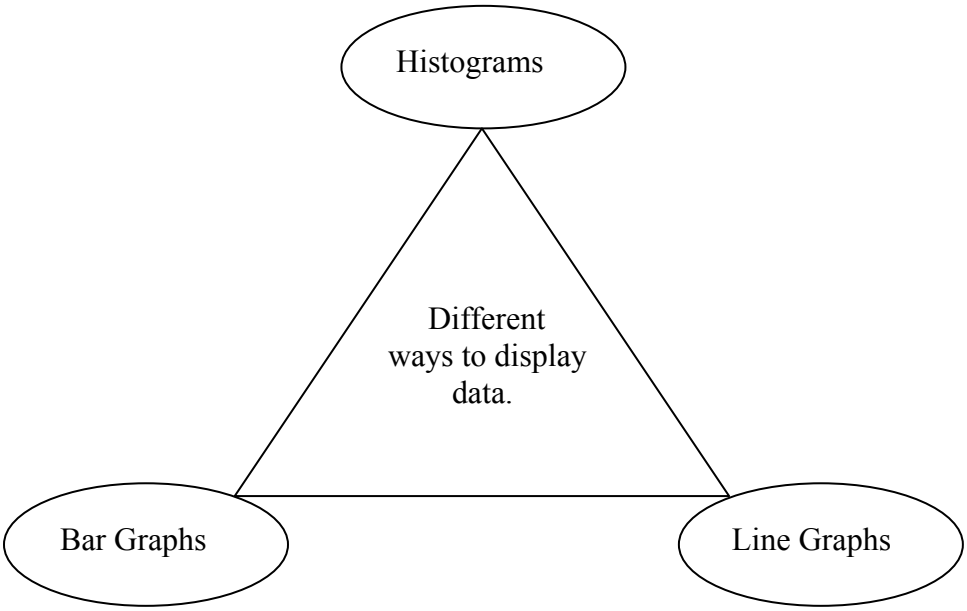
- **"Cheat" Cards**—Create 3 "cheat sheets" on index cards to remind you of three things you learned today. Write how you will apply this learning in your classroom. Share with table groups. Take back to post near your desk. Or collect & send to them in a couple of weeks.
- **Find Three**—Stand and find 3 different people to ask the following questions: What is the most meaningful thing you learned in this program? What specific idea will you apply as a result of this program? How will your job be easier as a result of this program?
- **Set a G-O-A-L**—On an index card write one of each:
  Goal: A goal I will set as a result of this training/class
  Obstacle: What obstacle will I need to overcome to accomplish this goal
  Action: What action steps will I take to overcome the obstacle and reach my goal
  Learn: What I learned in this class that will help me reach my goal

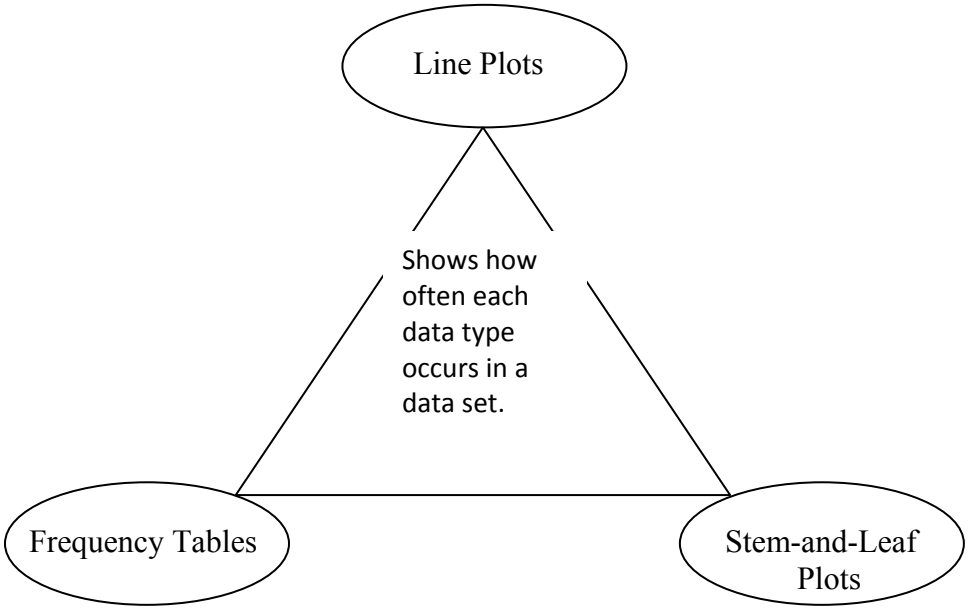
APPENDIX C: SAMPLE CONTENT/SPECIALIZED VOCABULARY TOOLS

C-1: Knowledge Triangles
C-2: Degrees of Meaning
C-3: Word Recognition Chart
C-4:Tic-Tac-Toe Grid

C-1: Knowledge Triangles

Select two sets of three words that are important to the topic you have been studying. Write each set of three words in the ovals at each point of the triangles below. Then explain how the three words are connected by writing summary sentences or drawing a picture in the middle of each triangle.





Share your work with a partner and discuss additional ways that the words might be connected.

C-2: Degrees of Meaning

WORD: Square	MEANING: 4 right angles, all sides equal
WORD: Rectangle	MEANING: 4 right angles, opposite sides equal
WORD: Parallelogram	MEANING: Both pair opposite sides parallel
WORD: Trapezoid	MEANING: One pair opposite sides parallel
WORD: Quadrilateral	MEANING: 4 sided polygon

C-3: Word Recognition Chart

Word Recognition Chart

Express	Ratio	Represent
Integer	Measurement	Order Decimals
Order Fractions & Decimals	Centimeter	Decimal/Fraction Conversion

C-4: Tic-Tac-Toe Grid

Tic – Tac – Toe

After Reading Words

Choose 9 words from the front page to place anywhere in the boxes

Choose 3 of the words that make a tic-tac-toe. Write a paragraph showing that all three words can be connected.