MATHEMATICS ASSESSMENT AND TEACHING IN TWO ELEMENTARY CLASSROOMS

by

HEATHER LEIGH MITCHELL

(Under the Direction of Martha Allexsaht-Snider)

ABSTRACT

The purpose of this case study was to develop a deeper understanding of how one second grade elementary school teacher and one third grade elementary school teacher relate mathematics assessment, mathematics instruction and student learning. The study was based on interviews with the two participating teachers, observations in their classrooms, a focus group with the two participating teachers, analysis of their assessments, analysis of district and state policies and de-briefing sessions with the teachers after they administered assessments in their classrooms. The experiences of these teachers helped to identify how mathematics assessments could be used to inform instruction and make decisions regarding the mathematical development of students.

INDEX WORDS: Reform based education, Standards, Mathematics teaching and learning, Mathematics assessment, Case study

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DEDICATION

This work is dedicated to my family. My mom and dad are two of the most amazing people. They have supported my education tirelessly and set a strong example for me and my brother about how to work hard and persevere to achieve our goals. Their encouragement was never-ending. From an early age, they instilled in me the value of education. Their influence has never left me. I will carry it with me always.

I am also fortunate enough to have an incredible brother and sister-in-law. Paul and Carla have seen me go through many trials and tribulations in this process, always offering their love and support. It is comforting to have this accomplishment to share with them. I still laugh when Paul says, "What's up Doc?"

My heart smiles the most when I think of my precious nephews, Joshua and Matthew. They have been such an incredible blessing to our family. Not a day goes by that I don't thank God for them. I enjoy every minute I spend with them and miss them terribly when we're apart. My hope is that I communicate to them, as my parents did to me, how far an education can take them. Their success and happiness means so much to me.

My sweet, wonderful grandmother is an angel on earth. Sadie literally prayed me through my dissertation. She's always been a great example of the importance of a strong faith in Jesus Christ. She was so compassionate throughout this process and was sure to remind me to pace myself. While I'm saddened that my other beloved grandparents were not physically present to participate in this journey, I know they were in spirit. Not only that, but Sadie's continued support, love and encouragement was enough for all four of my grandparents.

Completing a dissertation requires sacrifice. Unfortunately, one of those sacrifices usually includes a reduction of extracurricular activities. My friends can share at length the significant sacrifices I made in my social life. However, they never abandoned me nor forgot about me. In fact, even after my repeated, “No, I can’t do that. . .” “No, I need to work on my writing. . .” “No, I’ll be home all weekend, typing on my laptop. . .” they remained vigilant.

I love you all!!

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I have known about The University of Georgia since I was a child. In fact, the tradition began long before I was born. Most of my family members bleed red and black. I consider it an honor to graduate from such a prestigious University. Whenever I had a conversation with someone about my education and they inquired about where I was enrolled, it gave me great satisfaction to see the look of admiration I saw on their face when I said UGA.

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"Chestnut Hill" was always a blessing to me. Having taught there for several years, I developed many close relationships with my colleagues and felt lucky to go to work each day. The school has enabled me to learn an enormous amount about how to be an effective educator.

I was so fortunate to work in such an innovative school system. There are high expectations set for teachers. The administrators in the district implemented a strong support system for the teachers to ensure they met those expectations. Teaching and learning was a priority in the district.

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CHAPTER 1

INTRODUCTION

Mathematics assessment has evolved considerably over the years and is a common topic among educators during collaborative sessions between colleagues, at professional development, and during lesson planning periods. It "is employed for a wide range of purposes – from providing information to help a teacher work with a student so that she or he will gain a greater understanding of number sense, to plotting a national strategy that will have far-reaching implications for improving mathematics education for the nation" (Webb, 1992, p. 102). Too often educators view assessments as a means for academically judging students, that is, as an evaluation tool. However, in order to improve mathematics teaching and learning, assessments must be "used to help students learn and to improve instruction, not just to rank students to certify the end products of learning" (Shepard, 2001, p. 27).

Much of the research in the area of mathematics assessment over the past several years, specifically since the implementation of the No Child Left Behind (NCLB) legislation in 2001, has focused primarily on the impact of large scale assessment and standardized testing in education. While studying the implications of large scale assessments and standardized testing, researchers often focused on particular groups of students, such as English language learners (Wright & Li , 2008), students with disabilities (Eckhout, Plake, Smith, & Larsen, 2007; Flowers, Browder, Ahlgrim-Delzell, 2006) and students in low income areas (Ellis, 2008; Munoz, Potter & Ross, 2008) in regards to NCLB. Still other research has been more general, including the effect of large scale assessment on motivation (Ryan, Ryan, Arbuthnot & Samuels,

2007) and closing the achievement gap (Beecher & Sweeney, 2008; Harris & Herrington, 2006). Teachers have also been the focus of research about "teaching to the test" (Pinder, 2008; Zimmerman & Dibenedetto, 2008). Even before NCLB, there was a developing trend in research regarding large scale assessments, specifically their negative effects, including the decrease in effective teaching, the increase of teaching to the test and the near elimination of inquiry-based instruction (Shepard, 2000).

While these studies make important contributions to the area of mathematics assessment, the shift of interest toward investigating large scale assessment has caused a gap in the literature regarding research about educators' classroom assessments and how the results of these assessments inform their instruction. According to the National Council of Teachers of Mathematics (NCTM), "Assessment should inform and guide teachers as they make instructional decisions" (NCTM, 2000). In the name of accountability, we have lost sight of what is happening at the classroom level. One of the few studies found during the search for literature regarding the link between assessment and instruction explained that when working with a group of 20 middle grades teachers, researchers noticed that "after puzzling over the students' responses, the teachers questioned how they could use this evidence to guide their next steps for instruction" (Krebs, 2005, p. 407). When collaborating with their colleagues regarding their students' work, the teachers discussed how they could use their findings during the analysis process to inform their instruction. Kaftan, Buck & Haack (2006) suggest that in order for the focus to return to "learning for understanding, formative and informal assessments need to be part of the instructional process" (p. 44). Advocates for closely connecting assessment and instruction maintain that ". . . assessment and instruction must form a seamless web that promotes teacher/student collaboration, active learning, critical thinking skills and multidisciplinary understanding" (Khattri, Kane, & Reeve, 1995, p. 80). Based on that assertion, this study will offer insight into the classroom teacher's enactment of assessment and the role it plays in her lesson planning and subsequent teaching.

Rationale for Study

Very few of the assessments involved in the available research regarding mathematics assessment are created by classroom teachers for use in their own classrooms for teaching and learning. While the available research offers a great deal of insight regarding standardized testing, large scale assessments and their impact on education, the focus of this research has been through a NCLB lens. A gap in the literature exists that fails to narrow the scope of examination to what is happening at the classroom level and how individual teachers are including assessment as part of their instructional plan and their teaching. Even though researchers (Baxter, Woodward, & Olson, 2001; Saxe, Franke, Gearhart, Howard, & Crockett, 1997) have advocated a close examination of reform mathematics, including the role of assessment, the focus has primarily been on assessment in terms of large scale assessment and using it as a tool for accountability. The research has neglected to consider assessments that are not standardized and are only administered to selected individual students, small groups of students or selected classes of students.

Purpose of the Study

In a context dominated by high stakes testing, teachers and mathematics educators both need a better understanding of how teachers might view the relationship between assessment and instruction. While much of the research in mathematics education, assessment in particular, has focused on the ramifications of NCLB (Eckhout et al., 2007; Ellis, 2008; Flowers et al., 2006; Munoz et al., 2008; Wright & Li , 2008) there is a growing need to continue to include research that is focused on classroom assessment and is more a part of day to day life for students and teachers.

The purpose of my study was to understand how teachers see the relationship between the mathematics assessments they conduct in their classrooms and their mathematics instruction. Teachers spend significant amounts of time searching for assessments, creating assessments, and administering assessments. Furthermore, teachers spend a great deal of time planning lessons according to the district standards which are identified on the instructional calendar provided by the district and are aligned to the standards published by the state. After the implementation of NCLB, the state standards were revised and the phase-in plan began in the 2004-2005 school year, beginning with new language arts standards. The initial mathematics standards were implemented during the 2005-2006 school and the process was completed by the conclusion of the 2007-2008 school year for all elementary schools. During the second year of the implementation process, the state administered a year-end test which was aligned to the content areas that had been implemented thus far. As standards for each additional subject was implemented, the end-of-year state test has reflected those changes.

The Burton County district calendar, which teachers use as their source for mathematics standards, is organized according to four nine-week segments. Each nine-week segment has two to five units, depending on the difficulty of the content. Quite often the tasks of searching for assessments, creating assessments, administering assessments, and planning lessons according to the standards are completed separately and independently of each other.

A secondary purpose of this research was to determine exactly what teachers identify as assessment in their day-to-day teaching of mathematics. A review of the literature revealed little research about classroom assessments and the connections teachers make between mathematics assessments and planning for instruction.

Background of the Study

The 2009-2010 school year marked my 10th year as an educator. All ten years were at the elementary level. In fact, my entire teaching career has been at the same school in a metropolitan area of the southeast United States.

My career in this large, diverse county began with teaching first grade, which I taught for four years. That four-year stint included one year team teaching with another first grade teacher. We had 30 students in one classroom and team taught every subject. Another year my classroom served as an inclusion classroom for two students who received special education services for being diagnosed with Asperger's Syndrome. During two of those four years, I served as the grade chair. At that time, the grade level consisted of 14 members – 11 classroom teachers and 3 reading specialists.

During my last year in the classroom, our local mathematics specialist shared with me an article on Math Recovery (Phillips, Leonard, Horton, Wright, & Stafford, 2003). Math Recovery is a one-on-one intervention program for primary students, specifically first graders, who struggle with mathematics. What intrigued me most about the article was the assessment component of Math Recovery. My interest in the program grew and the next school year, 2004-2005, I was hired as the second mathematics specialist at the school.

Over the course of many conversations, much reflection and extensive research, my colleague and I approached our principal to request becoming trained as Math Recovery teachers. Having our principal's full support, we spent the next several months in training. Over the next two school years, we each worked with two first graders during two different ten-week blocks. Our ongoing, formative assessments of the students and our lesson plans were cyclical. As we instructed, we were noting areas of improvement for the students and areas of weakness. At the conclusion of each lesson, we made a journal entry regarding the students' progress and changes that needed to be made to the lessons. That experience of closely connecting assessment and instruction has lead me to where I am today in my professional career.

Research Questions

- How do one second grade teacher and one third grade teacher construct relationships among mathematics assessment, mathematics instruction and student learning in their classrooms? How do they analyze the assessments and how do they use the subsequent results of their analyses in mathematics lesson planning?
- How do these elementary school teachers define mathematics assessment? Why do they use mathematics assessments in their classrooms? What are some examples of mathematics assessment from their classrooms?
- How are mathematics assessments enacted in their elementary school classrooms?

This study aimed to provide insight into the experiences of two elementary school teachers with lesson planning and administering assessments. I explored the connections they made or did not make between the assessments they used to determine the mathematical understandings of their students and the lessons they employed in their classroom. Teachers shared their plan for increased student learning based upon the connections they saw between assessment and lesson planning. While looking through this assessment lens, teachers explained how they saw it as linked to instruction and vice versa – how instruction built on assessment.

Theoretical Framework

School mathematics has experienced a significant reform movement in the past two decades (Battista, 1994; Baxter, Woodward, & Olson, 2001; Chinnappan & Lawson, 2005; Frykholm, 2004; Smith, Smith, & Romberg). Smith (2000) explains that the instructional practices of reform-based mathematics classrooms are vastly different from more traditional classrooms where "memorization and imitation are primary goals and the teacher is seen as the source of knowledge and intellectual authority" (p. 352). Jones (2001) suggests that traditional instruction that appears solely guided by a textbook "assumes a learning theory based upon whole class direct instruction, individual guided practice, and a highly structured scope and sequence topic of presentation" (p. 3). The student plays a passive role in the classroom. Rather than constructing his own knowledge, he is viewed as a recipient of knowledge and "the teacher plays the active role of knowledge dispenser" (p. 3). This notion contradicts Piaget's (1950) assertion that when a student interacts with his environment, rather than passively observing and it, he "modifies it by imposing on it a certain structure of [his] own." (p. 9) Further, this portrayal of teacher-focused classrooms is contradictory to that of mathematics reform where educators should consider authentic learning (Graue, 1993), which refers to a classroom that is "active, dynamic and focused on the outside world and its connection to the subject matter at hand" (p. 292). Furthermore, in reform-based mathematics classrooms, students are seen as more involved in collaborative efforts and the "teachers create opportunities for students to explain and justify to other students their newly developed ideas, to understand other students' ideas and reflect on their own viability" (Beck, Czerniak, & Lumpe, 2000, p. 323). Jones (2001) explains that in a reform-based classroom, learners are "engaged with a novel task that requires an extension, application or transfer of previous learning" (p. 2). This engagement allows students to make connections to previously learned concepts.

Parallels can be drawn between reform-based mathematics instruction and constructivism. There are similarities in the theoretical underpinnings of the two. Vygotsky (1962) proposed that children develop language and thought separately for a while, but eventually the two develop concurrently as children become aware of personal thoughts and ideas. We see this emphasis on the close relationship between social interaction and the development of thought with reform-based mathematics instruction. Further, Shirvani (2009) explains that in order for a teacher to "create an environment that supports constructivism," his instruction should involve lessons that support "the use of hands-on activities and promote interactions among and within groups" (p. 253). In a classroom that supports constructivism, teachers focus more on the mathematical development of their students than on completing a textbook. The pedagogy of those teachers extends beyond providing their students with necessary knowledge into a pedagogy that is "based more upon a constructivist theory of learning. . . learning occurs as individuals make their own connections to prior knowledge" (Jones, 2001, p. 3). Piaget and Inhelder (1969) believed that children moved through a series of stages when developing mathematical ideas where those ideas are constructed based upon experience and mental development rather than strictly teacher-directed lessons in school. The discussions surrounding curriculum and instruction in reform-based mathematics classrooms involve

> new ways of teaching, learning, assessing and reporting that will fundamentally change what occurs in US classrooms. The first relates to radical change in theory and practice in curriculum and instruction. We are less likely to see pedagogy, theories of

> learning, curriculum and teaching from a transmission-oriented perspective. Instead, the focus is on constructivist images of collaborative activity. (Graue, 1993, p. 285)

The beginning of a child's education is often identified as when he begins his schooling career and *formally* increases his knowledge and understanding, even though that process actually began much earlier. "Children begin to study arithmetic in school, but long beforehand they have had some experience with quantity – they have had to deal with the operations division, addition, subtraction and determination of size" (Vygotsky, 1978, p. 84). The experiences thus far in a child's life have contributed to his current knowledge and have an impact on his future interactions at school. However, knowledge and understanding are not a set of ideas bestowed upon students by someone more knowledgeable, that is, the teacher. Children formulate their own knowledge and understanding, which are constructed as a result of their schooling experiences and experiences out of school. "Children grow into the intellectual life around them." (Vygotsky, 1978, p. 88) Those experiences, that *intellectual life* involves interactions with peers, interactions with teachers, independent learning and conversations with others about new concepts. As we add to our collection of experiences, our knowledge and understandings of the world are constructed (Phillips, 1995). Knowledge emerges "as a function of the settings, people, activities and goals" (Boaler, 2000, p. 1) with which we interact.

That leads us to the theoretical framework which directed this research, Constructivism. Typically, researchers who follow constructivist learning theory lean either toward Piaget or Vygotsky, or at least their ideas stem from one of those scholars. While both Piaget and Vygotsky focused on the individual (Phillips, 1995), they had differing ideas regarding the process of learning. Since the work of Piaget and Vygotsky, many other researchers have contributed to the theory of Constructivism. von Glaserfeld (2000) defines constructivism as "a theory of knowing that attempts to show that knowledge can only be generated from experience"

(p. 6). It refers to how we learn, how we interpret the world and how we incorporate new experiences into our bank of previous experiences that have shaped our knowledge. “Construction of knowledge is an active process,” (Phillips, p. 9) which can be a social process, a political process, or both. Furthermore, the activity of learning can be physical, mental, or both (Phillips, 1995). “Opportunities for children to construct mathematical knowledge arise as they interact with both the teacher and their peers. As a consequence, their mathematical constructions are not purely arbitrary” (Cobb, Wood, & Yackel, 1990, p. 137). According to Crotty (1998), “Constructivism describes the individual human subject engaging with objects in the world and making sense of them” (p. 79). Cobb, Yackel, and Wood (1992) extend this theory in saying that “students build on and modify their current mathematical ways of knowing” (p. 20).

The theory of Constructivism is quite complex and involves numerous ideas. For the purpose of my research, I am going to focus on three ideas. The first idea is that children learn from experiences with objects. Secondly, I will discuss the idea that students learn from social interactions. The third and final idea that I will discuss is the idea of scaffolding by a knowledgeable other, that is, the classroom teacher.

The first idea that children learn from experiences with objects originates with Piaget. More recently researchers have taken up Piaget’s theory and apply “a biological metaphor and characterize mathematical learning as a process of conceptual reorganization” (Cobb, 1995, p. 364) as well as “stressing biological and psychological mechanisms” (Phillips, 1995, p. 7). According to one of the principles put forth by Piaget regarding constructivism, “Knowledge is not passively received but is actively built up by the cognizing subject” (Ernest, 1998, p. 29).

Whereas Vygotsky expanded upon students' learning experiences in regards to social interaction, the second idea I'd like to share, he tended to use a "sociocultural metaphor and characterize learning as the process by which children appropriate their intellectual inheritance" (Cobb, 1995, p. 364). Basically, Vygotsky's ideas focused more on the social component of learning. He asserted the connection between social interaction and language development was critical (Vygotsky, 1978). Children's experiences in the classroom involve interactions at the social level, those that are interpersonal, and interactions at the individual level, those that are intrapersonal, both of which contribute to the "process of internalization" (Vygotsky, 1978, p. 57). Phillips (1995) elaborates by explaining that Vygotsky's focus is on social factors and those factors are what contribute to learning. In order for students to effectively learn and retain information, they must be able to make a connection to previously learned material. They must have a strong background knowledge that allows them to assimilate new knowledge and skills into their education. "Understandings are constructed by learners as they attempt to make sense of their experiences, each learner bringing to bear a web of prior understandings, unique with respect to content and organization" (Simon & Schifter, 1993, p. 331).

Scholars emphasize the influence that social interaction between students has on constructing knowledge. In fact, Ball (1993) proposes that "mathematical knowledge is socially constructed and validated" (p. 394). She explains that the classroom community is a strong influence that impacts student learning by providing insight when "the students hear one another's ideas and have opportunities to articulate and refine or revise their own. Their confidence in themselves as mathematical knowers is often enhanced through this discourse" (Ball, p. 394). In alignment with Ball's assertions, Phillips (1995) contends that the construction of knowledge is "influenced chiefly by the minds or creative intelligence of the knower or knowers together perhaps with the 'sociopolitical' factors that are present when knowers interact in a community" (p. 7). The interactions students have with each other become as influential as the independent thought processes they have. "Learning awakens a variety of internal developmental processes that are able to operate only when the child is interacting with people in his environment and in cooperation with his peers" (Vygotsky, 1978, p. 90). The students' social experiences involve interactions with teachers as well as with classmates. "The qualities of the students' thinking are generated by or derived from the organizational features of the social activities in which they participate" (Cobb & Yackel, 1995, p. 19).

Finally, there is the idea that students learn when instruction is scaffolded by a knowledgeable other. The students engage with the mathematical ideas in their classroom in an attempt to make sense of them. The ideas are originally presented by the teacher in a way that encourages students to critique the idea, articulate their understanding of it and determine how the idea fits into their current schema of mathematical knowledge. Hence, the role of the teacher is paramount. She must "form an adequate model of the students' ways of viewing an idea and she then must assist the students in restructuring those views to be more adequate from the students' and from the teachers' perspective" (Confrey, 1990, p. 109). The teacher is viewed as a facilitator of sorts. "The goal is still that students eventually construct correct or true mathematical understandings with the teacher's guidance" (Cobb et al., 1992, p. 16).

When working with elementary teachers on a constructivist teacher experiment, Cobb, et al. (1990) found that as teachers interacted with students they would gain insight into the students' mathematical understandings and "select instructional activities and interact with (the students) in ways that might give rise to opportunities to construct mathematical knowledge" (p.

128). This example illustrates how the teacher can contribute to the students' mathematical constructions.

Strengths/Limitations of the Study

For this study, there is significant overlap between the limitations and the strengths. I have developed a strong, professional relationship with the teachers, having worked with them in a coaching capacity for a few years. Our relationship has involved lesson planning together and teaching mathematics lessons together. That closeness has enabled us to establish a comfortable, positive relationship where we feel open to share our ideas and concerns about mathematics teaching and learning, an obvious strength of the study. However, our relationship can also be a limitation in that the teachers may actually be concerned that they cannot be as candid with me as they would like to be because I have communicated with them over the past few years my ideas about assessment and its role in the classroom, specifically with planning mathematics instruction. Knowing that, they may feel compelled to express my ideas as their own for fear of appearing oppositional. Furthermore, many professional meetings at our school over the past few years (faculty meetings, grade level meetings, and the like) have involved conversations regarding the expectations of our administration for teachers to closely connect mathematics assessment and mathematics instruction. A limitation is that the teachers who will be working with me may be influenced by these experiences and the ideas they share will be a result of messages they have received by administration, rather than their own ideas about assessment.

Another limitation is that the teachers may have a difficult time viewing the interviews as opportunities to share their ideas without input from me. In the past our interactions have been conversations where we both share our ideas about assessment and planning, our insights about student understanding and our goals for increased student learning. Rarely, if ever, has our time together been such that I do not offer input and interject suggestions, hence my role as a coach. Initially, this could be a limitation in that the teachers will have to adjust to my new role. However, my hope is that after a little while it will become a strength because the teachers will have time to share without interruption from me.

During the data collection process, I vacillated between coach/colleague and researcher. There were times when I was planning and discussing student progress side-by-side with the teachers as I have in the past and other times when I was more hands-off, functioning as researcher. This dual role as colleague and researcher was a limitation because the teachers had the inclination to request my input as a coach while I was in the researcher role.

Finally, I was a mathematics coach for both participants, but due to the structure of support set forth by the administration at Chestnut Hill for the 2009-2010 school year, I had significantly more interaction with Mr. Jenkins. Many of my meetings with Mr. Jenkins regarding his students involved discussions about their progress and how to ensure student understanding. Consequently, these conversations could have an impact on his input made during interviews, de-briefing sessions and the focus group, further adding to the limitations of the study.

Organization of the Study

The study consists of seven chapters. Chapter 1 of the study includes the purpose of the study, background of the students, research questions, theoretical framework, significance of the study, strengths/limitations, overview of the research procedures and organization of the study. The second chapter is a review of the literature in the area of mathematics assessments, including discussions regarding teaching and learning.

Chapter 3 explains the methodology of the study. Each teacher participated in two interviews - one at the beginning of the study and one at the conclusion of the study. The initial interview was an opportunity for the teacher to share what she/he thought about mathematics assessment, specifically its role in his/her classroom and its impact on his/her instruction. The second interview was again about mathematics assessment, but included discussion of her/his experience with mathematics assessment during the 2009-2010 school year thus far.

There was one group interview in which both participants were involved. At that time, the teachers discussed similarities and differences in what mathematics assessment looked like in their classrooms. Each teacher shared with me three different assessments he/she administered in his/her classroom. After administration of each of those assessments, I de-briefed with the teachers, individually, regarding their findings from the assessment and what they plan to do with the findings. Some of their plans included additional instruction and I observed that instruction.

Each interview, each de-briefing session and the focus group was audiotaped. I transcribed each recording and used the transcriptions during data analysis. I also collected artifacts that impacted the teacher’s planning and instruction. Those artifacts included materials produced by the administration at Chestnut Hill as well as by the administrators in the Burton County Public Schools district. Data analysis included the transcripts, copies of administered assessments, observation notes from the observed instruction and collected artifacts.

There were two participants involved in the study. Both were elementary school teachers at the same school in a metropolitan area of the Southeast United States. They had varying levels of experience and teach different grade levels. Other than one focus group involving both teachers, each participant's involvement was individual. This is a brief description of part of the context of the study which will be described at length in the fourth chapter describes the context of the study. There are five components of the context: the state, the district, the policy of the district, the local school and the participants.

Chapters 5 and 6 are narratives of the collected data. Finally, the seventh chapter is the summary and conclusion.

CHAPTER 2

REVIEW OF THE RELATED LITERATURE

Overview

As teachers enter the classroom fresh from their teacher preparation experience, they are inundated with standards to learn, protocols to follow, and procedures to implement. Critical to this assimilating experience is putting their philosophy regarding instruction into practice. While creating, reflecting upon, and modifying their philosophy, educators refer to resources available to them from agencies specializing in specific areas of instruction. One such agency is the National Council of Teachers of Mathematics, referred to by educators as NCTM. Included in the wealth of information NCTM provides teachers regarding research, lesson plans, and professional development are a collection of six principles – equity, curriculum, teaching, learning, assessment and technology. Within each principle, there are specific descriptions, definitions and examples to help educators fully understand the principle in order to effectively incorporate it into their approach to teaching. Teachers must also consider their approach to instruction. In doing so, they may ask themselves, "Do I approach teaching using a direct instruction model? Or, am I less traditional and follow a reform-based teaching model?" How a teacher defines mathematics will have the most impact on her mathematics instruction. Does she consider it "a body of absolute truth, or a set of arbitrary conventions? Is mathematics discovered or invented? Is it a set of rules and structures that exist apart from the individual, or does each person have his or her own set? What is the relation between mathematics and experience with non-mathematical entities, such as physical objects?" (Goldin, 1990, p. 44).

Definitions of Assessment

First of all, a distinction should be made between assessment and evaluation. People often confuse the two terms or they use them as synonyms for each other when in fact they have very different meanings. When teachers assess students, they are "gathering information about student learning that informs teaching and helps students learn more" (Davies, 2000, p. 1). When teachers evaluate students, they are trying to determine if students have made progress in learning certain material and, if so, how much progress they have made (Davies). Romagnano (2006) explains that "Mathematics assessment is the process of making inferences about the learning and teaching of mathematics by collecting and interpreting necessarily indirect and incomplete evidence" (p. 3).

Under the umbrella of assessment, there are several types teachers use. Assessment types refers to the purpose of the assessment. The discussion of assessment types in this research will focus on formative assessment, summative assessment and performance assessment.

Formative assessments are assessments that teachers use on a frequent basis to determine how students are progress on a set of skills as well as those skills that need further remediation. Romagnano (2006) explicitly states that formative assessment is "diagnostic; the evidence is used to guide subsequent instruction and support continued learning" (p. 14). Formative assessments may be student work samples, teacher observations, or more formal paper/pencil tasks. Regardless of the format, the purpose of formative assessments is for teachers to use them to determine further instruction, whether it's enrichment or remediation. According to NCTM (2007), formative assessment is much more broadly defined as "any task designed to promote students' learning" (Research clips and briefs: Formative assessment, ¶ 1). One goal of formative assessment is to provide feedback to both teachers and students. The feedback for students serves to impact learning so that students have a better conceptual understanding. The feedback for teachers enables them to adjust their instruction in order to increase student achievement. The latter part of this goal is congruent with Romagnano's (2006) claim that teachers use information gathered from formative assessments to make critical decisions regarding lesson planning.

Summative assessments typically occur less often than formative assessments. They are more objective and serve to provide teachers with a final determination of students' achievement. Summative assessment differs from formative assessment in that it "measures mastery" (NCTM, 2007, Research clips and briefs: Formative assessment, ¶ 1). Romagnano (2006) defines summative assessment as offering "evidence used to make inferences about what students have achieved – what they know and are able to do – at a specific point in time" (p. 14).

Formative assessments and summative assessments are often contrasted. They have different purposes, different applications and can have different types. Romagnano (2006) contrasts the two by explaining that "Written quizzes and the informal assessments of students' daily work, when used by teachers to give their students meaningful feedback and to plan subsequent lessons, would be examples of formative assessment. Final exams and most large-scale assessments would be examples of summative assessment" (p. 13). His definition of a summative assessment would imply that teachers do not provide feedback regarding those assessments, nor do they use them to guide instruction. A key term to acknowledge within his definition of a formative assessment is "informal." It is possible that these daily tasks, to which Romagnano refers, are not considered assessment items by teachers, yet they use them to inform their instruction.

Performance assessment is the third assessment type and is probably the most widely confused term. Some educators consider any assessment where students must complete a task or tasks independently a performance assessment. In addition, those educators usually accept one correct answer and consider there to be only a few select ways to solve the task. Other educators consider performance assessments to be those that require students to apply their knowledge and learned skills to solve a problem. The problem may have many solutions and several strategies may be applied to solve the problem. The latter definition is the definition used in this research. Essentially, a performance assessment is one where students solve a problem using a previously learned strategy. According to the United States Department of Education (1993), “Performance assessment, also known as alternative or authentic assessment, is a form of testing that requires students to perform a task rather than select an answer from a ready-made list” (Performance Assessment, ¶1).

Assessment Implementation and Its Effects on Classroom Practices

It is apparent that many classrooms in the United States, and quite possibly all classrooms, involve implementation of mathematics assessment at some level. What is less apparent is the extent of the implementation, which assessments are administered and how educators use those assessments. Simon (1996) discusses different practices teachers have followed to plan for mathematics instruction – following the textbook, reflecting on their own experiences learning mathematics and what’s the latest available technology. Further, he explains that “What is missing from this mix is an informed view of students’ mathematical thinking and learning. It stands to reason that instruction that is sensitive to students’ knowledge and their processes of learning is likely to be more effective” (p. 37).

There seems to be a lack of consistency in the area of mathematics assessment due to the fact that differences between educators’ assessment practices are not limited to contrasts from school to school and district to district, but within one school significant differences can be found between teachers. Research has shown that assessments administered create changes in teachers' approach to instruction and have an effect on what instructional tasks teacher assign. Both of these changes – teachers' approach to instruction and instructional tasks assigned – vary according to the type of assessment administered. Some of those changes in how teachers approach instruction reflect a trend toward moving away from adopting the teaching and assessment principles provided to teachers by NCTM.

Changes in Teachers' Approach to Instruction

Over the years, numerous approaches to teaching have been identified by educators and education researchers. There are similarities in the identified approaches as well as significant differences. One such approach is the direct instruction method, also known as didactic instruction. Many educators would consider this approach to be more traditional than others. Within a direct instruction classroom, one would see students working individually with little, if any, interaction between them. Goldin (1990) explains that when teachers are working from objectives which are operational, "it usually seems most 'efficient' to teach those behaviors as directly as possible, which may mean through rote than insightful process. . . computational speed and accuracy become ends in their own right, standardized paper-and-pencil tests come to dominate the instructional process" (p. 36). As a result, teachers become frustrated with their perceived lack of time to spend on "mathematical exploration, discovery learning, or problem solving" (Goldin, p. 36). During a typical direct instruction lesson, the teacher lectures to the students. Students may have an opportunity to ask questions, but much of the discussion is directed by the teacher and rarely initiated by the students. The questioning by the teacher is often knowledge based, meaning the questions do not require any critical thinking. The format of the lesson can be summed up as "an introductory review, a development portion, a controlled transition to seatwork and a period of individual seatwork" (Confrey, 1990, p. 107). This approach to teaching is very instructor-focused.

However, Boaler (2008) contends that there are educators who are labeled as traditional because "they lecture and they have students work individually, but they also ask students great questions, engage them in interesting mathematical inquiries, and give students opportunities to solve problems, not just rehearse standard methods" (p. 40). These teachers do not exhibit instruction that we need to be overly concerned with.

> The type of traditional teaching that concerns me greatly and that I have identified from decades of research as highly ineffective is a version that encourages *passive learning*. . . teachers stand at the front of the class demonstrating methods. . . while students copy the methods down in their books, then students work through sets of nearly identical questions, practicing the methods. (Boaler, 2008, p. 40)

She explains further that "Students who are taught using passive approaches do not engage in sense making, reasoning, or thought (acts that are critical to an effective use of mathematics), and they do not view themselves as active problem solvers. This passive approach, which characterizes math teaching in America, is widespread and ineffective" (p. 41). Cobb et al. (1992) warns that "the instructional strategy of being increasingly explicit and spelling out what students are supposed to apprehend brings with it the danger that mathematics will become excessively algorithmized at the expense of conceptual meaning" (p. 11). The concern is that there are levels of mathematics ranging from completely concrete to completely abstract and that moving from one to another too quickly, or skipping one altogether is detrimental to children. "With a direct instruction approach, new information is often too abstract for children to assimilate. If the use of objects and counting and not discouraged entirely, they are usually allowed only briefly when introducing arithmetic, place value and so forth" (Baroody & Ginsburg, 1990, p. 58).

As part of the Trends in International Mathematics and Science Study (TIMMS) video study, Hiebert and Stigler (2000) documented evidence of direct instruction in 8th grade classrooms across the United States as well as other countries. Their study included questionnaires completed by participating teachers and video recordings of the teachers instructing. Several trends consistent with the direct instruction approach were found. For example, rather than presenting a concept and guiding students in its development, teachers in the United States would simply state the concept (Hiebert & Stigler, 2000). "Formal mathematics instruction, even at the elementary level, does not suit children's thinking because it is too often based on a direct-teacher-and-practice model. That is, it involves a tell-show-do approach. Instruction beings by *telling* a class what they need to know. . . . Then the lesson is illustrated with examples. . . . The children then imitate the teacher and practice the fact or procedure until it is automatic" (Baroody & Ginsburg, 1990, pp. 57-58).

Furthermore, two types of problems implemented in the mathematics classrooms involved in the study were observed (Stigler & Hiebert, 2004). Those two types of problems were problems where students practiced learned procedures/algorithms and problems where students were given context related problems where the focus was on conceptual mathematics and relating different mathematical ideas, hence making connections problems. The study found that countries whose students were high achievers based on TIMMS, implemented the problems in different ways. Those teachers embedded many of the procedural practice problems within the making connections problems. Quite often, students completed making connections problems independently of procedural practice. It was rare that the students worked solely on procedural practice problems. On the contrary, the "U.S. teachers turned most of the problems into procedural exercises or just supplied students with the answers to problems" (Stigler & Hiebert, 2004, p. 15).

Additional variations were found among the classrooms, specifically between Germany, the United States and Japan (Stigler & Hiebert, 1997). One such variation was in regards to the grade level associated with the problems students encountered. The average grade level for problems posed in United States classrooms was mid 7th grade level, while in both Germany and Japan, students interacted with problems at or above their grade, mid 8th grade for German students and 9th grade for Japanese students. Another variation was how big ideas were incorporated into lessons (Stigler & Hiebert, 1997). Areas of mathematics learning were identified that are critical for high student achievement and strong conceptual understanding. One of those areas was deductive reasoning. In the observed lessons, deductive reasoning was observed in 62% of the Japanese lessons, 21% of the German lessons and 0% of the lessons in United States classrooms. After analysis of the videos from United States classrooms, the researchers concluded that a typical mathematics lesson in an 8th grade United States classroom has 2 main components – direct instruction, which involves the teacher modeling how to solve a problem by correctly following a set of procedures, and practice, which is when students are given the opportunity to work on problems that look very similar to those modeled by the teacher (Stigler & Hiebert, 1997).

However, having explained at length the characteristics of the direct instruction model and the potential negative effects, it must be said that there are times when it is entirely appropriate. There are times when students need to practice basic skills in order to master more complex skills (Noddings, 1990). Teachers must determine when critical concepts will require skill practice beforehand, in order for students to correctly construct the concept. A prime example of this an ideal direct instruction situation is when teachers are introducing a new mathematics manipulative (Noddings). It is imperative, though, that “goals of speed and accuracy in routine mathematical computation and the methods of drill and practice, which most mathematics education researchers reject as at best inadequate and at worst deeply damaging, do not follow from any a priori epistemological principles of scientific method” (Goldin, 1990, p. 37).

Another teaching approach is a constructivist approach to teaching. Educators who have adopted a constructivist approach to instruction serve more as a facilitator of knowledge rather than one who imparts knowledge upon her students. Jones (2001) found that these teachers are more focused on student performance and their teaching approach reflects a constructivist theory of learning. Teachers incorporate lessons which build upon background knowledge and give students an opportunity to explore new topics and ideas and investigate their own ways of making sense of the information. “The great strength of constructivism is that it leads us to think critically and imaginatively about the teaching-learning process” (Noddings, 1990, p. 18). Students in these classrooms are given significant amounts of time to interact with a partner and/or in a small group to discuss their learning. Lester (1996) explains that “Since I began to change the style of my teaching seven years ago, I have observed that the skills I’d like the children to acquire develop slowly. Within the context of solving mathematics problems, the children gradually become more confident and more comfortable, and over time they learn that this classroom is a safe place to pose questions and to pursue answers. It is an environment in which curiosity, questioning, and explorations are respected and encouraged” (p. 88). Over the course of the first two months of school, Lester had worked to establish an environment in her classroom where students were encouraged to share their ideas and consider the ideas of others. She states that "The children had listened to one another in order to figure out ideas and how they related to their own solutions. And they had validated each other's solutions without looking to me for direction or support" (p. 102). Contrary to direct instruction, teachers who follow constructivist principles have classrooms that are student-focused. The classroom community of a teacher who follows constructivist theory involves "active experiences, personal engagement, and social interaction" (Jones, p. 5). These teachers work with their students to create "a context for learning mathematics in which the students are encouraged to think creatively, to question, to explore and to communicate their ideas. There is very little teacher showing and telling. . . students will seek to make sense of mathematics and will question and explore in ways that allow them to make connections and build more powerful mathematical ideas" (pp. 37-38).

NCTM, the National Council of Teachers of Mathematics, proposes that teachers adhere to a set of principles to ensure they deliver effective instruction and their students are successful. Those principles are aligned with reform-based instruction. For example, the teaching principle explains that teachers must have a deep, yet flexible understanding of mathematics that reflects more than just understanding the content, but understanding it well enough to teach it effectively. This includes the ability to recognize possible misconceptions students may have and how to address those misconceptions. Their understanding of the content must be deep enough so that they are able to implement assessments which will successfully determine students' understanding (NCTM, 2000, Teaching principle section, ¶ 3).

Furthermore, the teaching principle indicates that effective educators provide a "challenging and supportive classroom learning environment" (NCTM, 2000, Teaching principle section, ¶ 8). The classroom environment must empower students to take risks and be comfortable taking those risks. The comfort comes from a teacher who has established a strong classroom community where students are encouraged to share ideas. While sharing ideas, students collaborate with classmates and prove their thinking. The tasks presented are meaningful ones to which the students can connect and apply to their world.

The teaching principle also refers to the teacher's attitude toward self reflection and improvement. "Effective teaching requires continuing efforts to learn and improve. These efforts include learning about mathematics and pedagogy, benefiting from interactions with students and colleagues, and engaging in ongoing professional development and self-reflection" (NCTM, 2000, Teaching principle section, ¶ 12). Those educators who consider themselves lifelong learners can strongly identify with this principle. It exudes the notion that teachers must continually seek to improve their craft.

Evidence of the teaching principles is seen in classrooms throughout the country. While working with three groups of teachers on effectively integrating assessment throughout the course of a fractions unit taught traditionally or non-traditionally, Gearhart and Saxe (2004) found that "excellent teachers are concerned with knowing what students understand and how they learn, so they can help students integrate new ideas and transform prior misconceptions" (p. 304). These teachers recognize mathematics understanding set forth by NCTM. They identify three domains of knowledge including knowledge regarding their own mathematics development, knowledge regarding how well they understand children's development, and knowledge regarding how to support students' learning in order to guide them toward building "new and powerful mathematical ideas" (Gearhart & Saxe, p. 306).

While these findings are encouraging, much of the research identifies approaches to teaching that are not in alignment with the NCTM principles. The approaches follow the direct instructional method of teaching. The teachers may have a deep, conceptual understanding of the mathematical content, but they are not providing lessons that enrich the students' conceptual understanding. Classrooms have very little interaction among students or opportunities for investigating mathematical ideas.

Firestone, Monfils and Schorr (2004) sought to determine how the instruction of teachers in New Jersey was effected by the process of implementing a new state test in the areas of mathematics and science for students in 4th grade. The researchers found two types of instruction were apparent – didactic, also known as direct, teacher-centered instruction and inquiry-oriented instruction, which follows a more constructivist stance and is student-centered.

Critics of didactic instruction have related it to teaching to the test, an approach to teaching noted by Firestone, Mayrowetz and Fairman (1998) when completing a case study in Maine and Maryland. The study compared the two states' assessments and their effect on instruction. Whereas teaching to the test has historically been reported as negative, Firestone, et al. (1998) identified it as effective in Maine due to the fact that the instruction included general topics such as "number relationships, measurement, and mathematical connections" as well as more specific areas, "vocabulary, how to format a graph and how to make stem and leaf charts" (Firestone et al., 1998, p. 103). In Maryland, the most obvious evidence of teaching to the test was test-preparation tasks the teachers assigned to the students. Quite often those tasks would resemble the actual state test. However, there were times when students completed projects that appeared to be related to the state assessment, but that was not indicated to the students. Furthermore, students participated in lessons that incorporated "a variety of mathematical and nonmathematical concepts as well as manipulatives and multiple forms of representation" (Firestone et al., 1998, p. 103). These tasks were deemed as potentially preparing the students for the assessment because they were observed less often. These findings were based upon interviews with the participating teachers. In over half of their observations, the researchers found that in both Maine and Maryland students practiced "procedures using small problems with teachers telling them about procedures rather than developing them" (Firestone et al., 1998, p. 106). In addition, despite what teachers reported during their interviews, "there were no notable differences between the states. Basic mathematics teaching was much the same in both Maine and Maryland" (Firestone et al., 1998, p. 106).

Furthermore, the didactic approach to instruction was found to be more evident in poorer districts. Though similar reform has occurred in Maryland, Lane, Parke and Stone (2002) found that more than 90% of teachers "indicated that they place a moderate or great amount of emphasis on problem solving" (p. 302). This problem solving type of instruction is strongly correlated to the inquiry-oriented model in New Jersey. Additionally, over the course of a four year period, from 1992 to 1996, teachers indicated their emphasis on "mathematics problem solving, reasoning, and communication increased somewhat or greatly" (p. 303). Fuchs, Fuchs, Karns, Hamlett, and Katzaroff (1999) noted the same trend in their study of two groups of elementary school teachers.

These findings are inconsistent with the learning principle set forth by NCTM which states that "Students must learn mathematics with understanding, actively building new knowledge from experience and prior knowledge" (NCTM, 2000, Learning principle section, ¶ 1). The principle puts a great deal of emphasis on conceptual understanding and how imperative it is for students to be able to apply knowledge learned in one situation to another situation.

In order for students to learn mathematics with deep understanding, teachers must give extensive consideration to the tasks assigned to students. The tasks must be engaging and designed to connect current learning to previous experiences. “Learning with understanding can be further enhanced by classroom interactions, as students propose mathematical ideas and conjectures, learn to evaluate their own thinking and that of others and develop mathematical reasoning skills” (NCTM, 2000, Learning principle section, ¶ 7).

Effect on Instructional Tasks

As we have seen, there are teachers who have demonstrated changes in their approach to instruction based upon assessments they have administered in the classroom. Closely related to that observation is the idea that some teachers have reflected upon the assessments they administer and changed the instructional tasks they assign to students accordingly. While researching performance assessment driven instruction, Fuchs et al. (1999) and Jones (2001) found that teachers who administered performance assessments to their students at least three times a year began to stress the importance of problem solving and applying effective strategies as opposed to solely mathematical computation. Their instruction shifted based on their analysis of the assessments. Similar findings were evident in what Shepard (2005) found when teachers implemented formative assessment as part of their instruction. Those assessments served to provide “insights about a learner’s current understanding to alter the course of instruction and thus support the development of greater competence” (p. 67).

Fuchs et al. (1999), Jones (2001) and Shepard (2005) share examples of teachers following the assessment principle proposed by NCTM which guides teachers toward implementing meaningful assessment practices. The principle explains that “assessment should enhance students’ learning” (NCTM, 2000, Assessment principle section, ¶ 2). It is ineffective for teachers to rely on assessment solely for the purpose of assigning grades. Teachers must use assessments to determine how to better support students and their learning. Assessments should be thoughtfully created in order to serve as a resource for enhancing students' learning. Furthermore, students should understand what is expected on an assessment and should be provided feedback.

Further discussion of the assessment principle states that "Assessment is a valuable tool for making instructional decisions" (NCTM, 2000, Assessment principle section, ¶ 5). Formative assessment, those often used to make such decisions regarding lesson planning, should be included in teachers' daily practice. Data collected from the formative assessments should serve to inform instruction. Teachers should know how to analyze an assessment to determine a student's strengths and weaknesses. Their analysis will help to determine future steps to be made in instruction.

Findings contradictory to Fuchs et. al. (1999), Jones (2001) and Shepard (2005) were found when Shepard and Doughtery (1991) examined how instruction changed when schools administered high stakes testing, also known as standardized testing. Teachers shared that they emphasized "basic skills instruction" and "paper and pencil computation" and they felt they "cannot afford to take the time required to set up science activities or do divergent problem solving" (Shepard & Doughtery, p. 7). It is evident there is a great deal of pressure felt by teachers when following state mandates regarding high stakes testing. Unfortunately, they do not feel their daily instruction is sufficient enough to prepare students for these tests so they devote sacred instructional time on test preparation activities. Nearly half of the teachers involved in the study claimed to spend at least two weeks "giving students worksheets to review content they expect to be on the test and giving students practice with the kinds of item formats that are on the test" (Shepard & Doughtery, p. 8). Furthermore, an additional two weeks were spent "giving students commercially produced test preparation materials, giving practice tests and instructing students on test taking strategies" (Shepard & Doughtery, p. 8). Contradictory to the primary purpose of assessment, these schools indicated that the use of test scores was typically to evaluate teachers and compare schools. Teachers rarely reported using the data regarding students' understanding collected from the tests to improve instruction.

What Changes in Mathematics Instruction do Researchers Suggest?

Researchers suggest that the low performance of students in mathematics in the United States is not based on a great deal of time being devoted to concepts and understanding, as some would suggest, but on a lack of experience being engaged in investigating mathematical concepts. This is seen in 8th grade classrooms throughout the United States where much of students' time is spent practicing procedures (Stigler & Hiebert, 2004). In order to improve mathematics instruction, there needs to be "an approach that recognizes that teaching can be studied and improved but at the same time acknowledges the cultural complexity and embeddedness of teaching" (Stigler & Hiebert, 1997, p. 18).

Many of Boaler's (2008) suggestions emphasize the types of experiences students have in the classroom and how they interact with tasks assigned to them. For example, the classroom environment should be "communicative – the students learn about the different ways that mathematics could be communicated through words, diagrams, tables, symbols, objects, and graphs" (Boaler, 2008, p. 59). There is a great deal of emphasis on explaining how problems are solved and representing their ideas multiple ways. Students should be "given opportunities to work on interesting problems that require them to think (not just reproduce methods) and be required to discuss mathematics with each other" (Boaler, 2008, p. 66). Another consideration is the project-based approach (Boaler, 2008). Concepts and skills taught and reinforced by being embedded in problems students work on independently, with a partner or in a small group. Students are given choices regarding which projects they would like to complete. The mathematics curriculum is not differentiated between algebra, geometry, trigonometry, etc., but simply by the year, therefore classes are heterogeneous and students are not tracked.

Researchers assert that in order to effectively reform mathematics teaching in the United States, educators should consider implementing professional development modeled after the lesson study model used in Japan. Furthermore, they suggest that creating national standards for all educators to follow is ideal, but that they should at least be in place at the district level. "Lesson study as we propose it, is driven by achieving clear learning goals for students, not by implementing particular pedagogies or curricula, nor even by meeting specific sets of teaching standards" (Hiebert & Stigler, 2000, p. 14).

Teachers must be confident analyzing students' assessments in order to evaluate their instruction to determine how to improve (Hiebert & Stigler, 2000). The administered assessments must be aligned with goals that support student success. "If teachers are to improve their practice, they must have access to a steady flow of information about the effectiveness of their lessons. They must be able to sort out improvements from mere changes. Clear goals, linked to assessments, and both tied to the curriculum, provide the context teachers need to plan and evaluate their teaching" (Hiebert & Stigler, p. 14).

Implications for Research

There are many factors for educators to consider when entering their profession. Those factors range from classroom management and room arrangement to lesson planning and record keeping. One critical area is assessment. State and district mandates require teachers to administer designated assessments, but those assessments alone are not sufficient. Teachers must administer additional assessments specifically designed for their students. Prior to administering those additional assessments, teachers must determine where those assessments will come from. Who will create them? Will they be commercially created? Will they follow a traditional or nontraditional format? Once these questions have been answered and the assessment has been administered, teachers must determine what they will do with the information gathered from those assessments. That task is the focus of this research. We will look at how a group of elementary school teachers administer assessments and use them to inform instruction.

As we have seen, there is a wide variety of implications for administration of assessment. Teachers alter their approach to instruction according to the assessments they administer. Unfortunately, those alterations do not always follow what the education field, NCTM in particular, deem reform teaching practices. Assigned tasks are also influenced by the assessments that teachers administer. The teachers involved in this case study will lend further insight into these two ideas.

CHAPTER 3

METHODOLOGY

What is Case Study Methodology?

Definition

As part of a qualitative strategy for inquiry (Stake, 1995), the purpose of a case study is to learn more about the case in order to understand it more deeply. Based on the following differences between qualitative and quantitative research, it is apparent why case study methodology is associated with qualitative work: "(1) the distinction between explanation and understanding as the purpose of inquiry; (2) the distinction between a personal and impersonal role for the researcher; and (3) a distinction between knowledge discovered and knowledge constructed" (Stake, 1995, p. 37).

Case studies "seek to answer focused questions by producing in-depth descriptions and interpretations over a relatively short period of time" (Hays, 2004, p. 218). They "explore processes, activities and events" (Creswell, 2003, p. 183). These indications – descriptions, interpretations, and explorations – reveal how case studies are close, intimate examinations of the research subject.

Initially, the researcher determines what areas and topics of research are of interest. The interest could be personal, where the researcher seeks to learn more about that specific case, not necessarily in order to learn about other cases. In the instance of a teacher as the researcher, the findings enable the researcher to make decisions about her career as an educator. Her research findings are reflected in her future practice as an educator and can include decisions regarding her beliefs about instruction, student learning, assessment, collaborating with colleagues, professional learning, etc. In doing so, the researcher orchestrates an intrinsic case study (Stake, 1995). Within this category, Bassey (1999) explains that there are two different approaches, story-telling, “a narrative account of the exploration and analysis of the case, with a strong sense of a time line” (p. 62), and picture-drawing, “a descriptive account, drawing together the results of the exploration and analysis of the case” (p. 62).

However, there are times the researcher takes a broader stance than as seen in an intrinsic case study, yet maintains a certain focused objective. For example, she

> may choose a teacher to study, looking broadly at how she teaches, but paying particular attention to how she marks student work and whether or not it affects her teaching. This use of case study is to understand something else. Case study here is instrumental to accomplishing something other than understanding this particular teacher, and we may call our inquiry instrumental case study. (Stake, 1995, p. 3)

Bassey (1999) refers to these types of case studies as theory-seeking and theory-testing case studies. These studies are differentiated from intrinsic studies “because it is expected in some way to be typical of something more general. The focus is the issue rather than the case as such” (Bassey, p. 62).

Finally, within instrumental case studies, the researcher may maintain a broader view, but choose several teachers or schools rather than just one. “Each case study is instrumental to learning about the effects of the marking regulations but there will be important coordination between the individual studies. We may call the work collective case study” (Stake, 1995, pp. 3-4).

My research will be an instrumental collective case study because I am looking broadly at how two teachers use mathematics assessment to inform their mathematics instruction. The focus is on the *issue* of using mathematics assessment rather just focusing on the teacher. My study goes beyond the teacher's teaching practice. It is theory-seeking; it is looking at the connection the teachers make between mathematics assessment and mathematics instruction. Since there are two teachers involved in my research and I will be looking at patterns which emerge in each individual case as well as patterns that emerge in *both* cases, the study is a collective case study.

Site Selection

When beginning to formulate a plan, there were several factors to consider. Drawing upon the work of other case study researchers, one characteristic many of them share is that they are 'outsiders' in their research. As an outsider, they must seek entrance to the research site, establish trust with their subjects and work to maintain these relationships. While maintaining an outsider's perspective can offer many advantages, specifically regarding subjectivities, there are several considerations which will not have to be taken into account for my study since I am already a member of the research setting. For example, after determining the research focus and research questions, a researcher must identify a research site. When selecting a site for study, Esterberg (2002) suggests that a researcher consider the following questions:

> Is this an appropriate place to study what you want to study? How can you define the boundaries of your field setting? Who are you in relation to this site? What kinds of connections do you already have to it? How can you gain access to this site? What kinds of ethical dilemmas will you need to consider in using this site? What kinds of risks are inherent in the setting? (p. 62)

Due to the nature of my occupation and research questions, the most logical choice of research site is the school in which I teach. While this is my tenth year at Chestnut Hill, I have worked as one of three math coaches for six years. I work closely with teachers regarding mathematics instruction and meeting the needs of all students. My goal is to continue to support the teachers at my school.

Deciding to complete my research at Chestnut Hill began the process of considering how the case would be bounded – within the school. Further, this case study will be bounded by the classrooms of the teachers involved in the study. Having a question that focuses on mathematics assessment, the case study is also bounded by assessments and instruction occurring only during the mathematics instructional block. Therefore, the teachers' classrooms serve as the primary context. The classroom includes the physical components – students' supplies, teaching materials, student created work posted in the room, the areas where the students work, the students and the teacher herself/himself. The larger context in which the classroom is contained is the school, the district and the policies of both the influence what happens in the classroom.

Researcher's Role

In case studies, the researcher may play various roles, which may be altered according to the purpose of the research and the researcher's relationship to it. Those roles may include "teacher, participant observer, interviewer, reader, storyteller, advocate, artist, counselor, evaluator, consultant, and others" (Stake, 1995, p. 91). While these perspectives have specific identities, there may be some overlap, which depends on the purpose of the research. One of the more obvious examples is that of participant observer and interviewer. During the course of research, a researcher as participant observer will most likely employ an interview method, among others.

While completing my research, I will play several roles. Initially, I will play the part of interviewer. The data collection will begin with interviewing each participant individually. I'll revisit the role of interviewer during the de-briefing sessions that will occur after administering each assessment. Further along in the process, I will be a participant observer when I am observing the teachers administer three different assessments of their choosing as well as when I am observing possible remedial lessons based on the results of the administered assessments and instruction during selected units. During the focus group, I will be a facilitator. The function of a facilitator is similar to that of an interviewer. However, since both participants will be present they will have an opportunity to converse with each other, share their ideas about assessment and respond to each other's ideas, not just answer a series of questions.

Throughout the research, while I will play these different roles – interviewer, participant observer and facilitator – I will also continue to maintain my professional relationship with the participants as their colleague and mathematics coach. For my 3rd grade teacher participant, Mr. Jenkins, our professional relationship entails supporting him in his classroom every day during his math block. Furthermore, Mr. Jenkins and I meet once a week during his planning period to plan mathematics instruction and discuss the students' progress. Therefore, our interactions will not only be in regards to the study, but also part of our daily conversations and weekly planning meetings that are a regular part of our working relationship. On the contrary, I do not have an opportunity to work with Ms. Moreno as often. I am available to her on an "as needed" basis. If she has concerns about a student or students or if she has an instructional question, we can schedule a time to meet together. However, she is not included in my weekly support schedule. Despite the difference in the levels of support I offer Mr. Jenkins and Ms. Moreno, I do have a working, ongoing relationship with both. That connection affords me the opportunity to work as a teacher action researcher during the course of my study.

Data Collection Methods

As part of research planning, the researcher gives serious consideration to data collection methods. The three major data collection methods are interviews, observations and documents (Bassey, 1999). While conducting interviews, it is imperative that the researcher not only poses questions, but "listens intently to the answers" (Bassey, p. 81). In doing so, she must take copious, detailed notes in order to accurately report her findings. Quite often, the interviews are audio recorded to further ensure there are no errors in the case report. Under the umbrella of interviews are focus groups and de-briefings. These methods are typically less formal than interviews.

My research included interviews, de-briefings, and a focus group with both participants and collecting documents. The documents were student work and guidelines provided to the teachers by the district and the local school regarding assessment and instruction. The interview formats were both formal and informal and took on a semi-structured model where the ". . . goal is to explore a topic more openly and to allow interviewees to express their opinions and ideas in their own words. . . . Although the researcher typically begins with some basic ideas about what the interview will cover, the interviewee's responses shape the order and structure of the interview" (Esterberg, 2002, p. 87). Interviews allow ". . . two individuals [to] come together to try to create meaning about a particular topic" (Esterberg, 2002, p. 84). Interviews are employed as a means to discuss specific issues and contexts with teachers (Boaler, 1998; Cobb, 1995; Eisenhart et al., 1993; Wood & Frid, 2005).

The formal interview followed a set of open-ended questions that served as a guide for beginning a conversation about mathematics assessment with each participant. Sheila's interview occurred at a local restaurant of her choosing a few days prior to the beginning of the school year and lasted about an hour. Greg's interview was a few days later at a local coffee shop after school had begun. It lasted about 45 minutes.

Throughout the interviews, modifications were made to the questions based on the responses of the participants. At times I inserted an additional question to clarify information the participant had shared. At other times I omitted questions that seemed redundant because the participant had included the necessary information in his response to previous question. The interviews were audio-recorded (Smith, 2000; Wood & Frid, 2005) to allow for precise transcription, but I did take notes while I was interviewing the participants as reminders for topics to revisit. At the conclusion of the interview, the participants had an opportunity to make additional comments or to clarify earlier statements.

The informal interviews were de-briefing sessions that occurred after the classroom teacher had administered an assessment. All of the de-briefing meetings occurred in the respective teacher's classroom either before school or after school, depending on the preference of the teacher. When we met to de-brief, we examined the students' assessments to determine academic progress and possible misconceptions. Based on the de-briefing, the teacher determined the most effective way to address students' misconceptions. Furthermore, he/she identified additional support needed to maintain academic progress made based on the results of the assessments.

To allow for triangulation of data (Stake, 2005), the data collection methods included interviews (and de-briefings), a focus group, observations and artifacts (Bassey, 1999). The emphasis on accuracy exists in all areas of data collection, including observations. Bassey encourages that the researcher take careful notes of the experience. Observations appear to be a little more intrusive because those being observed are well aware of the presence of the researcher. Based upon this additional stress of the observed individuals being *in the spotlight*, some researchers choose not to record the observation. However, if the researcher does choose to record the observation, it is typically done via video rather than simply audio, as is usually the case with interviews.

An observation is "looking in a focused way" (Esterberg, 2002, p. 58). When observing a teacher, ". . . researchers go into the 'natural' settings in which social life takes place and observe what people 'really' do in these settings" (Esterberg, p. 58). By observing instruction in the classroom, researchers are able to get a picture of typical daily occurrences in the classroom (Boaler, 1998; Cobb, 1995; Eisenhart et al., 1993; Wood & Frid, 2005). Observations occurred during whole group lessons which were planned in preparation for an upcoming assessment or in response to students' performance on an assessment the teacher had already administered. Most of the lessons that were planned as a result of a previously administered assessment were instructed with small groups of students. When observing the teacher during these small group instructional periods and during lessons, I recorded field notes (Wood & Frid) which included connections between the lessons and students' performance on the assessment. Additional notes were recorded during lessons instructed as part of the mathematics block in preparation for an upcoming assessment. The notes for both whole group lessons and the small group instructional periods also offered a detailed description of the setting, the lesson and the students' responses to instruction. While the majority of artifacts (Boaler, 1998) were the administered assessments and the lessons planned according to the results of the assessment, the notes made during small group observation were also included.

The final data collection method was the collection of artifacts (Bassey, 1999). The artifacts in my study included the administered assessments, the teachers' assessment logs, the teachers' instructional calendars and the guidelines provided by the district and local school regarding assessment and teaching requirements and expectations. The assessment logs were documentation the teachers recorded regarding daily and weekly assessments they administer throughout the course of the study. Not all of the assessments were included as part of the study, in fact only three were included, but evidence of administered assessments were helpful in understanding the role that assessments played in each classroom. However, the logs were not a complete list of the assessments the teachers used. Sheila and Greg confessed at the focus group that they had neglected to record some of the assessments. I greatly appreciated their candidness and was pleased with the logs they gave; even though they were somewhat incomplete.

Data Analysis

Throughout the data collection process, as a case study researcher I also analyzed the data. I did not begin data analysis at the conclusion of the data collection process. Analyzing data actually began near the beginning of the data collection. Bassey (1999) provides a useful diagram for explaining the stages involved in evolving from the research question to the case report, or case study. It begins with the research questions. Based upon the research questions, the researcher identifies the effective data collection methods and applies those methods to collect the raw data – audiotapes, field notes, documents, etc. Any necessary transcriptions are created, becoming part of the raw data, and the researcher transforms the raw data into data items by carefully analyzing transcripts then organizing and labeling or coding the transcripts according to themes or patterns. The researcher uses the data items to create analytical statements which are strictly based upon the data and should provide insight into the research questions. From the data items, the evolution continues to the analytical statements. This step is usually cyclical because the researcher may decide to revisit the data items to confirm the analytical statements. From the analytical statements, the daunting task of empirical findings begins, that is, answering the research questions based on the collected data. These findings are shared in the case study report, which can be written in many different styles. The style of my case study will be narrative.

Bassey's (1999) diagram served as a useful guideline for analyzing my data. My transcriptions of the interviews and de-briefings served as raw data and I read each of those first. As I read through the transcriptions, I highlighted any key phrases or words related to assessment as well as themes that began to surface. After highlighting each transcription, I copied and pasted the corresponding pieces of transcription into one document. For example, Sheila and Greg often discussed the curriculum map provided by the district which they followed when planning lessons. Each time they mentioned the curriculum map, I copied and pasted that comment into another document titled *curriculum map*. When I pasted the quote, I included the corresponding participant, data piece, page number, and collection date. These organized documents enabled me to create analytical statements and respond to my research questions.

As I began to collect data, I entered each item on a chart. That chart identified the piece of data, the corresponding participant and the date of collection. When I organized the findings into their respective sections according to the identified themes, I was able to share the data relatively chronologically. By creating a timeline of data collection, I was able to effectively share the data narratively. Narrative reporting (Bassey, 1999) presents the study chronologically, dividing it into sections according to stage of the research that are differentiated because each stage involves a period of time during which relative events occurred. The sections of my study included discussions of both participants. While the study began with Sheila, the second grade teacher, the findings were organized according to the themes that emerged rather than my experiences week to week. The pattern continued in that way and the experiences of Sheila and Greg can be compared throughout the study. The quality of a narrative report that is different than some types of case study reports is that writing about the “data collection, analysis and interpretation are intermingled” (Bassey, p. 87). Following the narrative reporting style, my study closely observed how the teachers learned about their students academically.

While Bassey’s (1999) diagram of progressing from research questions and raw data to analytical statements and empirical findings is more general, Stake (1995) identifies two different tactics of data analysis, depending upon whether the research is intrinsic or instrumental. The difference between the two is not reliant upon when the data analysis begins, both types of study call for analysis to be embedded throughout the research. The difference is the type of interpretation. For intrinsic studies, the “primary task is to come to understand the case…The case is complex, and the time we have for examining its complexity is short…we will try to spend most of our time in direct interpretation” (Stake, 1995, p. 77). On the contrary, instrumental case studies serve “to help us understand phenomena or relationships. . . the need for categorical data measurements is greater. . . we will forego attention to the complexity of the case to concentrate on the relationships” (Stake, 1995, p. 77). Therefore, my research was an instrumental collective case study and the case study report was written narratively.

Case Studies in Mathematics Education Research

Based on the definitions of Case Study methodology, it is a common and appropriate methodology among mathematics education researchers. Case Study Researchers in mathematics are seeking to closely examine mathematics teaching and learning. The examination serves to identify specifics about how one teacher or small group of teachers, one student or group of students or one school or a few schools teaches and/or learns mathematics. Within the numerous studies which use case study methodology, there are three main approaches: (1) teachers as subjects, the most common of the three; (2) students as subjects; and (3) teachers and students as subjects. I will focus on teachers as subjects.

Teachers or Schools/Instruction as Subjects

When seeking to learn more about mathematics instruction, researchers look to the classroom teacher to find some answers. One such case study involves a teacher who found herself in the midst an instructional dilemma. Smith (2000) explains the teacher was faced with the dilemma of negotiating her "past practice of structuring learning opportunities so that students could experience success and the new view that students needed to engage in complex problem solving that often was accompanied initially by feelings of being unsuccessful" (p. 358). The students were experiencing the implementation of QUASAR – Quantitative Understanding: Amplifying Student Achievement and Reasoning. It is "a national project aimed at improving mathematics instruction for students attending middle schools in economically disadvantaged communities by reforming instruction in order to emphasize thinking, reasoning, problem solving and communication" (Smith, 2000, p. 354). The specific curriculum was Visual Mathematics, which "emphasized the themes of problem solving, communication, reasoning, and mathematical connections. . . teacher is viewed as the facilitator of knowledge rather than as a dispenser of knowledge. . . students are seen as active constructors and explainers of mathematics" (Smith, 2000, p. 355). Throughout her study, Smith (2000) implemented several data collection methods, including videotaped observations, audiotaped interviews and teacher completed surveys. Summaries were written to accompany the videotaped observations and the audiotapes of the interviews were transcribed.

At the beginning of the year, the complex tasks were frustrating for the students. The teacher would modify them to relieve frustration, but in doing so she removed a lot of the challenging, thought-provoking components of the problems. She found that students were engaged when given simpler tasks. When tasks required more thought and perseverance the students had a tendency to give up and disengage. This problem further exacerbated the teacher's dilemma – maintain engagement or improve students' ability to solve difficult problems? Throughout the experience, the teacher became more reflective. She would watch the videotapes of her classroom and determine changes she needed to make to accomplish her goal of helping her students to become better problem solvers. Those changes included giving the students more opportunities to share their problem solving strategies, remaining silent when they did so, and giving students more time to solve problems.

The work of Eisenhart, Borko, Underhill, Brown, Jones, and Agard (1993) provides insight regarding the teaching experiences of teachers new to the profession and those educators who have helped to prepare them. Their purpose was "to reveal some of the tensions and pressures that face novice teachers and teacher educators who attempt to teach for conceptual knowledge and that makes it difficult for them to move beyond procedural knowledge to conceptual knowledge in their classrooms" (Einsenhart et al., p. 10). Their analysis of observations and interviews enabled the researchers to address "ideas and practices for teaching procedural knowledge and ideas and practices for teaching conceptual knowledge" (Eisenhart et al., p. 9). These ideas and practices were exhibited during lessons taught by the student teacher, Ms. Daniels, involved in their case study while she was completing her student teaching in a middle school. Furthermore, Eisenhart et al. examined the messages Ms. Daniels received from her teacher education professor as well as the teachers in the school in which she was placed to determine which was emphasized more – procedural knowledge – "knowledge of the format and syntax of the symbol representation system and knowledge of rules and algorithms" (p. 9) or conceptual knowledge – "knowledge of the underlying structure of mathematics – the relationships and the interconnections of ideas that explain and give meaning to mathematical procedures" (p. 9).

Based on interviews with Ms. Daniels, Eisenhart et al. (1993) found that she understood the necessity of teaching both procedural knowledge and conceptual knowledge. However, when explaining the two, she seemed to have a stronger understanding of teaching procedurally. Furthermore, her knowledge as a mathematician was stronger procedurally. When observed in the classroom, Ms. Daniels's teaching of procedural lessons occurred more often than did conceptual lessons. The frequency of the conceptual lessons depended on her comfort level with the concept. Additional factors which influenced her choice of lesson were "her knowledge of mathematics and mathematics pedagogy related to the specific topic being addressed, the importance she placed on curriculum coverage, the type of lesson taught, her desire to provide sufficient practice, her perceptions of students' ability levels and interests, and her perceptions of the cooperating teacher's instructional focus" (Eisenhart et al., 1993, p. 18).

Eisenhart et al. (1993) discovered that outside influences existed that prevented Ms. Daniels from teaching conceptually. Some of the pressures were from her placement school –

"pressure to prepare students for tests, to cover designated topics in the curriculum, and to use school time for review and practice of procedural skills" (p. 24). Other pressures emerged during her teacher preparation experience. For example, in her methods course, Ms. Daniels was frustrated because she felt like she was not learning realistic lessons she could teach her students. Her methods professor incorporated a great deal of conceptual lessons and Ms. Daniels was having a difficult time including those in her student teaching experience. The messages received at both the district level and local level where Ms. Daniels was placed were conflicting. The administrators explained that the texts were mandatory, but that teachers must be sure to develop conceptual knowledge. The major conflict was that the text focused on procedural understanding.

Similar findings are evident in Boaler's (1998) work at two different schools which implemented two very different approaches to mathematics instruction. While the teaching style of one school was traditional and encouraged procedural learning (Amber Hill), the other school approached mathematics teaching by presenting students with open ended problems to solve which encouraged conceptual understanding (Phoenix Park). Boaler (1998) "was particularly interested to discover whether different forms of teaching would create different forms of knowledge, which might then cause students to interact differently with the demands of new and unusual situations" (p. 42). More specifically, she juxtaposed the process-based mathematical approach to the content-based mathematical approach to determine if "either approach served as an encouragement for students to use their mathematical knowledge in new and unusual situations" (p. 43).

To capture these practices as participant observer, she observed 80-100 lessons. During that time, Boaler (1998) observed the students at Amber Hill working independently on booklets. The booklets contained procedural type problems where students would exhibit rule following behavior such as algorithms, rules, steps and the like. While working, students may receive individual assistance from their teacher. In stark contrast, students at Phoenix Park "worked on open-ended projects and in mixed-ability groups at all times" (Boaler, 1998, p. 49). Students were responsible for their own learning and expected to manage their own time in order to complete tasks.

Upon completion of the observations, Boaler (1998) interviewed students from both schools. She found that for the most part, Amber Hill students were critical of the school's approach to teaching mathematics – viewing it as monotonous, boring and non-engaging. While some Phoenix Park students appeared to be less disciplined so they didn't respond well to the format, many students liked it. Furthermore, Boaler selected students to participate in a performance based assessment. The selected students from Amber Hill were among the top performing 50% of their school. The selection from Phoenix Park was more random. Knowing this, "The fact that the Phoenix Park students gained higher grades in applied realistic situations may not be considered surprising, given the school's project-based approach. However, in traditional closed questions the Amber Hill students did not perform any better than the students at Phoenix Park. In a set of seven short written tests of numeracy I devised, there were no significant different in the results of the two schools" (Boaler, 1998, p. 55).

Teachers and Students as Subjects

While studying a group of 40 – 50 students ranging in age from six years old to eight years old in a metropolitan area of Western Australia, Wood and Frid (2005) were seeking to answer the question, "What is the nature of numeracy teaching and learning practices in a multiage classroom?" (p. 81). More specifically, they hoped to provide

important information regarding teaching practices and learning environments to

> support young children's numeracy learning. . . . The findings have direct applications to curriculum practices nationally and internationally because they provide information relevant to implementation of outcomes based education. . . . They provide insight into the ways in which teaching practices can be enacted to cater for diverse levels of achievement within one classroom. . . . The findings have both practical and theoretical implications for the professional development of teachers (p. 81).

The researchers provide evidence they are knowledgeable regarding multiage classrooms, but would like to expand their understanding of how it works. Their broad view, the unit of analysis, is mathematics instruction. The sub categories are student to student interaction, teacher to student(s) interaction and knowledge acquisition. These subcategories are evident in their findings. Each of the four areas identified in their findings promote the numeracy of the students. The first area was "teacher planning. . . the specific curriculum as planned by the teachers within this case study was conducive to the students becoming numerate" (Wood & Frid, 2005, p. 87). Secondly, Wood and Frid found the area of "teacher assisted performance," (p. 88) which refers to the ability of the teacher to determine when to follow a direct instruction format vs. when to give students direction, but encourage independence. During those times when teachers were observing students to determine their progress with a task or when students requested assistance, "the teachers used questioning, paraphrasing, and suggestions as alternative strategies to guide the children to solve the problems by themselves" (Wood & Frid, p. 88). The third area was "peer sharing and tutoring" (Wood & Frid, p. 92) during which there was a great deal of interaction between students which supported the notion that "the children were scaffolding each other's learning. . . they took a leadership role, as teachers or peer tutors, to provide information or guide procedures to support the numeracy learning of their less knowledgeable buddies"

(Wood & Frid, p. 92). Finally, "peer regulation. . . teachers explicitly fostered a family or community atmosphere in which teachers and students work together. Respect for peers, tolerance and non-competiveness were valued. . . children saw themselves as responsible for assisting and supporting others" (Wood & Frid, p. 95).

Application of Case Study Methodology

Why Case Study?

Based upon the aforementioned definitions, case study methodology is quite suitable for my research. The focused question to answer is "How do classroom teachers use mathematics assessment to inform instruction?" Analysis will include *in-depth descriptions* and *interpretations* that will be a result of interviews, focus groups, observations and collection of artifacts. Originally, I was planning a single case study where the two involved teachers represented one case. However, I envision it now as a multicase study, a mix of exploratory and descriptive approaches. Stake (2006) indicates, "For multicase research, the cases need to be similar in some ways" (p. 1). The similarities between the two cases are that the participants are both teachers that teach at the same school, which leads to additional similarities, and they both administer mathematics assessments in their classrooms. All of these similarities allow the two teachers to be a multicase study.

Data Analysis

After each interview and observation, time will be devoted to begin data analysis, which will actually be ongoing throughout the study. Hays (2004) states, ". . . all of the data needs to be taken apart while the researcher is looking for relationships and then reassembled to tell the story of the case. . . most researchers develop a system for sorting and categorization that results in a coding system" (p. 232). To do so, the interviews and de-briefings will be transcribed and coded to identify patterns. The identified patterns will serve as a guide toward determining the teachers' ideas and beliefs about assessment. In addition, identification of the patterns will enable me to assign themes, which "preserve the main research questions for the overall study" (Stake, 2006, p. 40). The patterns and themes will in turn lead to assertions and eventually findings (Stake, 2006).

Throughout observations, fieldnotes will be recorded in a field log. The fieldnotes will include what the teacher does during instruction, what she says to the students and how the students respond. Since the research question focuses on assessment and how it informs instruction, detailed descriptions will be included about the teacher's teaching style, her instructional format – small group, whole group, etc., use of instructional strategies and implementation of necessary interventions. After each observation, I will write a detailed narrative, using fieldnotes as a resource. Esterberg (2002) suggests to "read and reread your field notes and write memos or notes to yourself" (p. 80). In doing so, the researcher can become very familiar with the notes and can continue the analysis process. Furthermore, she recommends a researcher "read with a questioning mind" (Esterberg, p. 80). After much reflection, the fieldnotes will be transformed into written narratives, which will be coded in the same format as the transcripts.

At the conclusion of the analysis process, consideration will be given to questions offered by Esterberg (2002): "Why is your research interesting or important? Why should people care about it? What is the larger sociological significance of your study?" (p. 79). Not only will these questions provide a focused direction, but they will be helpful in determining implications of the research.

CHAPTER 4

CONTEXT OF THE STUDY: STATE, DISTRICT, POLICY, SCHOOL AND PARTICIPANTS

The Big Picture

When I was a child, we had many rainy day activities, things that we did on a rainy day to quietly occupy our time that did not involve the television. Whenever I think about the multiple nuances of education, I am reminded of one of those activities – building a house with a deck of cards. The task seemed simple enough. . . lean playing cards against each other in such a way to create a multi-level tower resembling a house. The key to a strong, effective house of cards was the foundation. Similarly, the key to a strong, effective education is the teacher. However, just like a single card cannot stand alone, a teacher cannot stand alone. The other cards – the school, the district, the policies, the standards – when put together, create one structure. Greg Jenkins and Sheila Moreno are two cards, two critical cards, who contribute to the tower of education in their school district.

Greg and Sheila teach in the Burton County Public Schools district, one of many districts in a large metropolitan area of the southeast United States. Their state and their district have undergone many changes over the last few years. The most prevalent modification is the change in the standards set forth by the state department of education and the assessment implemented by the state to identify student learning and provide accountability. The state curriculum involves a comprehensive set of mathematics standards that are published on the state's website and are provided to the schools. The standards are organized according to mathematical strand and explicitly state what students are expected to learn.

To encourage accountability, the state implemented a standardized end-of-year assessment (EYA) for all students in grades first through eighth. Based upon the students' performance on the EYAs, and other factors such as attendance, schools and districts are identified as having met "Adequate Yearly Progress" or not having met "Adequate yearly Progress" (AYP). AYP refers to the state's perception of a school's success in meeting goals previously set by the state in order to be in compliance with No Child Left Behind. For the EYA, those goals are related to a particular percentage in each of three categories of the assessment – exceeds standards, meets standards and does not meet standards. Each year the state identifies the requirements schools and districts must meet in each category in order be deemed as a school and district which has made AYP. Furthermore, the state increases the percentage requirements for the number of students in the exceeds standards and the meets standards categories and decreases the percentages for the number of students in the does not meet category. Therefore, each year the state expects more students to meet or exceed standards and fewer students to not meet standards than the year before. If districts satisfy the requirements set forth by the state then they are considered to have met AYP. Schools and districts which do not meet AYP develop a plan for doing so the following year.

The EYA is based on the state standards. Burton County School District has developed their own standards, which have the state standards embedded within them. The teachers in the district are provided with an instructional calendar (aka, curriculum map) for each subject area. The calendar explicitly states the standards for each instructional unit, approximately when the unit should be taught and about how long the unit should last. The calendar also identifies resources teachers can use when planning instruction for each unit.

There are approximately 110 schools in the Burton County Public Schools district, which are home to nearly 160,000 students. Within the district, 42 schools operate Title I programs, a federally funded program for schools that have a high population of economically disadvantaged students. As part of a diverse metropolitan area, 28% of the students in the Burton County Public Schools district are African American; 10% are Asian; 22% are Hispanic; 4% are multiracial and 35% are white. Close to half of the students, 46%, are economically disadvantaged. There are about 17,600 students, 11% of the population, who are identified as students with disabilities. Fifteen percent of the students in the Burton County School District receive services for English language learners. As noted in the table, Chestnut Hill's demographics represent a slightly more diverse population than do the demographics of the entire school district.

Table 1

Demographics of the District vs. the School

	Burton County School District (percentage of student population)	Chestnut Hill Elementary School (percentage of student population)
African American	28%	35%
Asian	10%	12%
Hispanic	22%	33%
Multiracial	4%	6%
White	35%	14%
English language	15%	12%

learners		
Free and reduced lunch	46%	68%
Special education	11%	12%

Chestnut Hill Elementary School

Chestnut Hill Elementary School is one of 71 elementary schools in the Burton County Public Schools district and has 1,362 students enrolled. The percentage of students who are economically disadvantaged is higher than that at the county level, reporting 64%. The number of students with disabilities is aligned with the county percentage – both at 11%. Finally, the number of students who qualify as English language learners is 29%, almost double that of the county. However, of that 29%, only 11% received services by means of ESOL, an English class for students whose native language is not English. Another program provided to students in grades k-5 is EIP, or Early Intervention Program. There are 269 students, or 20% of the population, enrolled in this program which serves to provide services to students who have been identified as academically at risk.

There are 106 teachers which make up the faculty, seven of them male, 99 female. The teacher ethnicities are as follows: 20 African-American, 85 Caucasian and one Asian. The range of experience is six first year teachers, 65 teachers with 1-10 years of experience, 21 teachers with 11-20 years of experience, 11 teachers with 21-30 years of experience and three teachers with more than 30 years of experience.

The primary classrooms, those for students in kindergarten, first grade and second grade, account for the most classes, having 11 classrooms on each grade level. There are a few less upper elementary school classrooms-11 third grade classrooms, nine fourth grade classrooms and nine fifth grade classrooms. The classroom size of primary classrooms averages 20-22 students while the classroom size of upper elementary school classrooms averages 24-26 students.

One significant difference between the kindergarten, first grade and second grade classrooms and the third, fourth and fifth grade classrooms is the level of support the classroom teachers receive from the specialists in the school. There are three math specialists at Chestnut Hill, one for third grade, one for fourth grade and one for fifth grade. The specialists offer support to kindergarten, first grade and second grade teachers upon request. If a primary teacher would like support or assistance from a math specialist regarding lesson planning, student understanding of a concept, or any other concern related to mathematics teaching and learning, she contacts the specialist who serves her grade level and coordinates a time to work together to resolve any issues or concerns.

The support for kindergarten, first grade and second grade teachers is not scheduled, like it is for teachers in grades three, four and five. For those grade levels, the teacher works closely with her math specialist at least once a week during the mathematics block. Chestnut Hill has implemented a co-teaching model during the 2009-2010 school year where all support personnel, including math specialists, serve as a team teacher of sorts with the classroom teacher. The model varies slightly from class to class, depending on the needs of the students. For some classrooms, the classroom teacher and math specialist teach a lesson together, interjecting when necessary and clarifying ideas set forth. In other classrooms, either the classroom teacher or math specialist teaches a mini lesson, then both teach the remaining mathematics block in small, homogeneous groups. The students who receive special education services are clustered in two or three classrooms on each grade level. The majority of those students receive support within the classroom by their special education teacher, a model referred to as inclusion. The mathematics specialists at Chestnut Hill are also certified in special education, so they not only serve to support the classroom teacher, but also the students in the classroom who have disabilities.

Not only do the math specialists at Chestnut Hill work closely in the classroom with teachers regarding mathematics teaching and learning, they also offer professional learning to the teachers each year based on their instructional needs. During the 2009-2010 school year, the math specialists organized a book study involving the book *Teaching Student Centered Mathematics* by John Van de Walle. Choosing the book was a result of numerous conversations the specialists had with classroom teachers regarding their comfort level in teaching mathematics. The specialists wanted to find a way to increase the teachers' conceptual understanding of the mathematics concepts they taught, hence their comfort level, thereby equipping them with the tool to deepen students' conceptual understanding of mathematics.

Teachers at Chestnut Hill, as well as throughout the Burton County Public School District, are invited by the district to many other professional learning opportunities during the year. Some of the classes meet only a few times, while others are ongoing throughout the year. All of the offerings are optional and meet after school hours. However, there are a few sessions, considered tutorials, which are offered online. These courses can be viewed anytime, anywhere and are new to the district this year.

Greg and Sheila teach third grade and second grade, respectively. There are 11 teachers on each grade level. Despite the fact that Chestnut Hill has a diverse population of students, that diversity is not reflected in the ethnicities of the second and third grade teachers. Of the 22 teachers on both grade levels, 86% are White, compared to 14% of the students.

Table 2

Grade Level Comparisons

	2nd grade	3rd grade
Number of teachers	11	11
African American	2	1
White	9	10
Taught < 5 years	6	4
Taught 5 – 10 years	3	4
Taught > 10 years	2	3
Only taught current grade level	6	7
Taught another grade level	5	4
Only taught at Chestnut Hill	7	8
Taught at another school	4	3
Bachelor degree of education	4	6
Master of education	6	3
Specialist degree of education	1	2

Participants

When selecting participants for my study, I considered the trends in assessment data at Chestnut Hill, the elementary school where I am a mathematics coach. The significant trend that I discussed with teachers and administrators when we met each month to discuss assessment data was that most students (more than 85%) scored well (met standards or exceeded standards) on the end-of-year state mandated exam in first and second grades. However, in third grade, there was a noticeable decrease in the percentage of students who met standards or exceeded standards. Since we had focused many of our discussions on this trend, I had become very knowledgeable about the second and third grade curriculum; I had developed strong relationships with teachers in second and third grades as a math coach and I had had the opportunity to teach lessons in both second and third grade classrooms. I had become more familiar with second and third grades than any of the other grades. My familiarity with the two grade levels provided me with the ability to discuss all aspects of both grade levels. These experiences led me to choose Sheila Moreno and Greg Jenkins as participants for my study. In choosing a second grade teacher and a third grade teacher, our conversations about curriculum and assessment would actually be a continuation of similar conversations we had already begun based upon the previously mentioned trend in the significant change in student achievement from second to third grade. Further, I had worked extensively with both Greg and Sheila in other capacities and had established a strong relationship with both teachers based on mutual trust and respect. Having those relational components already in place enabled me to begin collecting data immediately without having to begin with establishing a relationship.

Sheila Moreno, Second Grade Teacher

On a warm summer day in August, just a few days before the pending 2009-2010 school year began, I sat at a local restaurant, anticipating my imminent conversation with Sheila Moreno. The conversation was going to provide me with the opportunity to learn more about Sheila the mom, Sheila the wife, Sheila the student and Sheila the educator. Having known Sheila professionally for a few years, I had worked closely with her in numerous capacities – planning mathematics lessons, analyzing data and creating mathematics assessments.

Sheila is currently a second grade teacher in a metropolitan area of the southeast United States. Teaching is her second career, her first career being in information technology at a local industry. Around the end of the 1990s, Sheila's main responsibility was ensuring that the industry's computer system was compliant with the turn of the century, Y2K. It was soon discovered that the system was in fact not compliant and the industry decided to outsource the task of upgrading the system to make them Y2K compliant to a company in Israel. For Sheila, that meant she found herself without a job. Therefore, she was forced to find another career.

"I had always wanted to be a teacher," she stated. After much reflection on her possible career choices, she decided to return to school to pursue a degree in education. Sheila found a local school that offered a program where she could attain her Master's degree in education as well as her certification in education at the same time.

During her two year pursuit, Sheila worked as a paraprofessional in a classroom for pre-kindergarten children who were identified as emotionally and behaviorally disturbed. In lieu of her student teaching experience, Sheila was able to teach at a Head Start facility. After a year teaching at Head Start, Sheila applied for and was offered a second grade teaching position at Chestnut Hill Elementary School in the Burton County Public Schools district, where she is currently teaching and was involved in my research about mathematics assessment and instruction.

While Sheila's interest in teaching mathematics was strong, that strength was not a result of her experience as a student. She attended elementary school in a metropolitan area in northern United States. Sheila shared that her experiences in mathematics in elementary school were very different than what she does in her classroom today. She explained

> No manipulatives at all. . . the teacher got up, she would teach, you did worksheets. Sometimes if you were lucky, you got picked to come up to the board to work a problem.

> Other than that, there were no manipulatives, no math games; it was just teacher teaching and doing worksheets to reinforce it.

She recalled that she was able to learn “just from repetition.”

As Sheila was about to enter fifth grade, her family moved from the north to a metropolitan area of the southern United States. At that time, her new school system did not have middle schools, as they do today, so she attended an elementary school through seventh grade. Then, she went to high school for the remainder of her public schooling experience, eighth grade through 12th grade.

When discussing her experiences as a math student, Sheila did not have many vivid memories, either positive or negative. She accepted that

> Math was just something that kinda made sense to me. And it was something that I learned early on that I had to keep up with it. Because, especially in algebra in high school, I just knew that it built on the lesson before so if I didn’t get it then I wouldn’t get it the next day.

Her statement indicated that she recognized the importance of her own understanding, but she did not share many memories of her teachers – their instructional practices, how they supported her learning and how they determined her understanding.

Once Sheila had experienced the outsourcing at her place of employment and returned to school for her Master’s degree in education and her certification in education, she was able to participate in a class for teaching mathematics. She explained how useful and informative the class was, that the professor modeled how teachers “can use math manipulatives to reinforce student learning.” The professor also shared with Sheila and her peers how they could differentiate instruction in their classroom to meet the needs of all students. While Sheila enjoyed this class and learned many effective strategies, she explained that

> to tell you the truth, I just don't think that any classes you have in college are enough. . . it was a good class, but I could have taken 10 classes about teaching math and you just never know until you actually get in front of the students. . . you just don't know what you're going to need.

It was evident from this comment that Sheila had developed the understanding that students have varying needs and those needs must be met in different ways.

After Sheila had been teaching for a couple years, she returned to graduate school for her Specialist degree. During that process, Sheila was required to complete a research project. The project was quite thorough, involving a literature review and data collection. Sheila chose a mathematics project on automaticity, or the ability of a student to recall a math fact quickly and accurately. While reviewing the literature, Sheila learned that much of the research indicated that if students have a strong automaticity, they are able to spend their time solving more complex problems rather than on the computation involved in those problems. Based on this finding, Sheila devoted instructional time helping her students to develop automaticity by incorporating daily activities to support that development.

Sheila's experience during her research project is reflected in her philosophy of education. She believes that if students can accurately recall math facts quickly, then they are more effective problem solvers. She also believes that teachers must observe their students while they're working in order to determine which students need additional support in learning. Finally, Sheila believes in a "spiraling curriculum." This means that she often reviews concepts students learned earlier in the year to ensure they have a deep understanding of the concepts and can apply those concepts to newly introduced concepts. Sheila's incorporation of this theory into her philosophy of education was based upon her experience teaching Everyday Math during her first year at Chestnut Hill. A significant feature of the Everyday Math curriculum is that it *spirals*, standards are taught and reviewed again and again throughout the year. When Sheila taught this curriculum, she felt that the spiraling format was effective for ensuring her students were successful. However, after Chestnut Hill had implemented Everyday Math in first and second grades for a few years, the curriculum was abandoned due to budget cuts. It was not one of the adopted district curriculum, so Chestnut Hill had to purchase it out of the local budget. That became too costly, so the teachers were unable to use the curriculum.

Sheila was one of eleven teachers on the second grade team at Chestnut Hill Elementary School. Sheila's grade level was considered to have less experience than other grade levels with six teachers having less than five years experience, three having taught five to ten years and two of the 11 teachers have taught for more than ten years. Furthermore, over half of the teachers, six of the 11, had only taught second grade. The other five teachers had experience teaching other grade levels. Finally, only four of the 11 teachers had taught at a school other than Chestnut Hill.

Sheila had 22 students in her second grade classroom, 13 boys and 9 girls. However, her classroom looked very different on the first day of the 2009-2010 school year compared to at the conclusion of my study. Since day one, two students had withdrawn and five new students joined Sheila's class. Her classroom was slightly noisy, with several active children. The students were respectful and energetic. Sheila's diverse classroom had eight African American students, one white student, four Asian students and nine Hispanic students. Almost 75% of Sheila's students, 16 of the 22, received free or reduced lunch. That statistic aligned with Chestnut Hill's Title I status.

Greg Jenkins, Third Grade Teacher

As I sat in a local coffee shop, preparing to interview my participant and colleague, Greg Jenkins, I reflected upon how long I had known Greg. He began teaching at Chestnut Hill after my first year there, so we had been colleagues for nine years. During his first four years at Chestnut Hill, I taught first grade and Greg taught third grade. In a large school with approximately 1,300 students, we had very little interaction during that time. However, just before Greg's fourth year, I became a math specialist and our relationship changed significantly. We began to work more closely collaborating with Greg on various areas of mathematics – lesson planning, analyzing data and differentiating instruction. That brought us to the 2009-2010 school year. . . co-teaching daily, lesson planning together each week and analyzing assessment data.

However, Greg's teaching career did not begin at Chestnut Hill. He has been a teacher for several years. His experience includes a variety of grade levels, in both private schools and public schools. Furthermore, he has taught in different areas of the United States. Currently, he teaches third grade in a large metropolitan elementary school in the southeastern United States. The 2009-2010 school year was Greg ninth year at Chestnut Hill Elementary School.

Greg followed a traditional route while working towards his degree in education in that he majored in education with the hopes of securing a teaching position after graduation. In fact, not only did he pursue his teaching career in a traditional style, he went to the country's first Normal teaching college.

However, going back several years, Greg's education began in a rural area of the northeastern United States. There were 500 students in his graduating class. He attended a public elementary school for six years, kindergarten through fifth grade. Then, he was enrolled in what is currently referred to as a middle school, a school with grades six, seven and eight. His sixth grade experience was very similar to his experiences in elementary school. It was not until seventh grade that his schooling began to change. During that school year, students were assigned a class based upon their academic ability. Greg explained that

> The best performers were in 7-1. . . I was surprised I ended up in the 7-1 and I was like are you kidding me? But, I was in 7-2 for math. It was horrible. . . the next year [I was in] 8-1 and I did a little better in math that year.

The next step in Greg's education was high school. His family continued to live in the same community, so he went to the local high school where the majority of his peers had been with him since elementary school.

Greg recalled vividly his experiences as a math student. "It was basically rote memorization, the times tables were drilled into you, you totally have to memorize them and that was all there was to it. There was not understanding of what was going on." This description sharply contrasted how Greg approached mathematics instruction in his classroom. "[In] today's mathematics we stress way more do they understand what they're doing." As a student himself, he received the strong message from his teachers that "this is what we're doing, you need to learn how to do it this way."

When Greg graduated from college, officials at the Normal teaching college told him that he either needed to find a career outside his field or relocate. For Greg, finding another career was not an option. He had longed to be an educator, so he decided to relocate to the Midwest. He became a substitute teacher in a metropolitan area which was quite transient. Near the end of his first year substitute teaching, he took a long term substitute teaching position. Unfortunately, the district was unable to offer him a teaching position the following year, so he moved again, to the west coast. He continued to substitute teach and after a year acquired a teaching position in a private school. This first teaching position was very different than the majority of Greg's other teaching experiences. He taught in a first grade classroom and had only seven students. When he first shared this with me, I was sure that I had misunderstood him! While Greg was teaching first grade in this small private school, he attended a local university and received his Master's degree. Greg held the position at the private school for two and a half years.

At that point, Greg relocated to the metropolitan area where he lives today. Once again, he was thrown back into the world of substitute teaching. He chose the district where he lived then, which is the same district where he lives today. Shortly after returning to substitute teaching, he was offered a second grade position in a new school that was set to open the following fall. Greg accepted the position and proceeded to teach second grade for three years at the new school. At the end of his third year, he interviewed for a third grade teaching position at Chestnut Hill. He was offered and accepted the new position. With the exception of one year that he worked in the computer lab, Greg has taught third grade at Chestnut Hill for nine years.

Entering the 2009-2010 school year, Greg was one of 11 third grade teachers at Chestnut Hill Elementary school. He had the most experience of all the teachers on his grade level, having taught for 19 years. Four of Greg's colleagues had taught less than five years, another four had taught five to ten years and three teachers, including Greg, had taught for more than ten years. Greg was the only male teacher on his grade level and one of ten white teachers. There was one African American teacher on the third grade team, but no other ethnicities were represented. Four of the third grade teachers, all of those with less than five years of experience, had only taught third grade. All of the other teachers had taught at least one other grade level.

Greg had a class of 24 third graders. Teaching at a somewhat transient school, four of those students enrolled throughout the school year, while two of Greg's students withdrew previously. There were 14 girls and 10 boys in Greg's class. The diversity associated with Greg's school was evident in his classroom, with eight African American students, six White students, five Asian students, three Hispanic students and two students of mixed ethnicity, as classified by the district. Furthermore, it was not surprising that 13 of Greg's students received a free or reduced price lunch, since Chestnut Hill is a Title I school and almost 70% of the students fit into this category. Finally, three of Greg's students received special education services.

Chestnut Hill used a computer program which created the class lists each year. As part of the computer program, each student's information regarding gender, ethnicity and additional services received was entered. The system used that information to create classrooms that are diverse and balanced. Sheila's and Greg's classes were evidence of the effort Chestnut Hill put forth to ensure groups of students were equally represented in each class.

Table 3

Classroom Comparisons

	Sheila	Greg
Grade level	2nd	3rd
Number of students	22	24
Boys	13	10
Girls	9	14
African American	8	8
White	1	6

Asian	4	5
Hispanic	9	3
Bi-racial	0	2
Free or reduced lunch	16	13
Special Education	0	3

CHAPTER 5

FINDINGS

Overview

In the never-ending age of accountability, assessment has become a significant topic of conversation for educators. The assessments range from federal, state and district mandated, standardized assessments to informal classroom assessments. Each assessment has a different purpose and therefore is used by classroom teachers in different ways.

My study explores the ideas two elementary school teachers, Greg and Sheila, have about mathematics assessment. More specifically, the study focuses on how each teacher connects assessment with instruction and learning and the tensions they negotiate while searching for a balance between their philosophies of education and the real world classroom expectations they face as educators at Chestnut Hill Elementary School in the Burton County Public Schools district.

The discussion will begin with an explanation of how each of the teachers define mathematics assessment, including examples of mathematics assessment in their classrooms. Then, I will share my classroom observations during mathematics instruction in order to gain a better understanding of Greg and Sheila as teachers. Next, I will discuss their uses of mathematics assessment, including assessments administered for the purposes of establishing baseline student data, formative assessments and summative assessments. That discussion will also involve the teachers' reflections about and responses to the assessments and my analysis of the assessments – did they seem to assess what they were meant to assess in the ways that the teachers intended? Finally, I will share how Greg and Sheila enacted the assessments in their classrooms, how they negotiated tensions they dealt with and how each was influenced by the administration at Chestnut Hill as well as in the Burton County Public Schools district. With the term *tensions,* I am referring to instances when Sheila and Greg were required to meet requirements set forth by the school and district that they felt conflicted with their philosophies about teaching and learning. My analysis of the data I collected will answer the following questions:

- How do one second grade teacher and one third grade teacher construct relationships among mathematics assessment, mathematics instruction and student learning in their classrooms? How do they analyze the assessments and how do they use the subsequent results of their analyses in mathematics lesson planning?
- How do these elementary school teachers define mathematics assessment? Why do they use mathematics assessments in their classrooms? What are some examples of mathematics assessment from their classrooms?
- How are mathematics assessments enacted in their elementary school classrooms?

The beginning of each school year begins with a mix of emotions for teachers – excitement, anticipation, stress, and more. Teachers have a wide array of responsibilities, one of the most important being student success. That responsibility alone can be quite overwhelming for teachers and often elicits numerous questions: What are my students' academic levels? How will I meet each student's needs? What should my lessons look like to ensure they are effective? What will I do for students who are struggling? The list could go on and on. Let's see how Greg and Sheila address these concerns as they relate to their students' mathematics learning.

What is mathematics assessment?

When discussing the idea of "mathematics assessment" with Greg and Sheila, the terms *conceptual understanding* and *student learning* continued to surface. While analyzing assessments, Greg and Sheila tried to determine if students conceptually understood the standard and if there was strong evidence of student learning. They explained to me throughout our interviews and debriefings that conceptual understanding and student learning served as the lens through which they looked to analyze the students' work. The goal of using assessments to view student conceptual understanding and student learning of mathematics seemed to be implemented as evidenced in their talk during interviews and during debriefing sessions.

Greg and Sheila shared their perceptions of the what mathematics assessment is, including types of assessment, how they indicate student learning, implications for future instruction and its use as a tool for reflecting on their own teaching. When asked about assessment in an interview, Sheila said that she administered assessments in order to "determine how well students understand a math concept that's been taught." Her main goal was to ascertain the students' "understanding of a concept." Throughout our discussions, she emphasized these beliefs repeatedly. However, in the classroom Sheila's actions were influenced by school policies and pressures in addition to her own ideas about the purpose of mathematics assessments. I will first explore Sheila's explication of her ideas about mathematics assessment and its role in her classroom, shared in an interview. The discussion will include parallels between hers and Greg's ideas about the purpose of assessment.

Sheila explained that after administering a mathematics assessment to her students, she reviewed the students' responses and determined if their responses indicated that they understood her lessons and had developed their own mathematical understandings of the concept. Her subsequent mathematics lessons reflected those determinations. Commonalities could be seen between Sheila's and Greg's definitions of mathematics assessment in Greg's explanation that, "I think for county purposes my idea for assessments are paper and pencil multiple choice questions and answers for the [teachers] to assess to determine how much information the students have gained of certain concepts." It was apparent from Greg's statement that he saw the purpose of Burton County Public Schools mathematics assessments as being aligned with his purposes for mathematics assessment; that they "determine how much information the students have gained of certain [mathematical] concepts." However, his own ideas about mathematics assessment went beyond "paper and pencil multiple choice questions" to include other types of assessments.

"Assessments really drive the curriculum," Greg shared. This belief was evident in his classroom with his implementation of pre-tests as well as frequent formative assessments. Once Greg knew the concepts that would be assessed, he was ready to plan how he would teach those concepts. In advance of teaching a mathematics lesson, Greg referred to assessment instruments provided by the district and those he planned to conduct in order to ensure that his instruction included all the concepts students should learn. Without first referring to the assessments, Greg's instruction may not have served to fully develop the necessary mathematical concepts for students. Using the curriculum map as his only resource for planning instruction may have resulted in lessons that did not fully address the standards. By lesson planning according to the curriculum map *and* referring to the assessments throughout each unit, Greg could ensure students would be fully prepared for the assessment.

The similarity between Greg's and Sheila's definitions of mathematics assessment was the strong emphasis on conceptual understanding. Both Greg and Sheila emphasized that students must understand the mathematics behind the skills they taught. For example, when teaching concepts related addition, Sheila believed students must understand they are composing numbers rather than just performing an algorithm. If second grade students are solving 28 + 12, Sheila wants them to call upon their number sense and apply ideas they have developed. So, for the problem 28 + 12, one strategy would be to recognize that 30 is 2 more than 28 and 40 is 10 more than 30. During our interview, Sheila explained the assessments she administered to students helped her to identify "how well the kids understand the concept." As part of her philosophy of mathematics education, she was conscientious that students developed a conceptual understanding during her lessons in order for them to continue to build upon that knowledge. During debriefings with Sheila, her beliefs about the importance of conceptual understanding were apparent when she described the analytical process she followed after administering an assessment. By monitoring the students' responses to each question, she was able to determine their conceptual understanding of the skill.

Similarly, when Greg's students are solving 6 x 3, he wants them to recognize the expression represents the model of six equal groups of three rather than just recalling the product 18. He explained that, "Multiplication is more than learning the facts. They have to know what it means – putting equal groups together. We build arrays with cubes, make equal groups with tiles, lots of hands-on activities." Further, when Greg assessed his students regarding their understanding of multiplication, his questions were not simply fact recall. They required students to apply their understanding of multiplication to particular contexts. An example of this assessment practice can be seen in the *formative assessment* section when Greg shared about Exemplars. This explanation Greg shared during our multiplication unit debriefing illustrated his concern that students have a conceptual understanding of the mathematical standards.

Not only did Sheila review assessments to gauge students' progress, but she also analyzed the assessments as a reflection of her instruction. While discussing assessments during our interview, Sheila stated if the students "all missed the same problem, then I don't count that problem because that tells me that's something that I haven't taught them well." If the majority of students did not do well on a concept based on their responses on the assessment, Sheila analyzed the assessment further. Her further analysis helped her to determine if the students' lack of understanding of a concept was related to instruction or if their misunderstanding was the result of something else. Regardless, Sheila would "go back and re-teach that whole thing, that whole concept." It was not unusual for her to conclude that the lesson or lessons were ineffective or that they did not accomplish the goals she had set out for them to accomplish. It may be that the lessons were too abstract. If she deemed that to be the case, Sheila planned new lessons that were more concrete and incorporated manipulatives that were effective for supporting student learning. By incorporating manipulatives, Sheila was integrating her ideas regarding the importance for students to have experiences with manipulatives related to mathematical concepts.

Sheila was thoughtful when considering the assessments to administer to her students. She shared that her main goal was to select items that served to identify student learning. She considered the concepts she had taught and chose questions and tasks that would enable her students to show their mathematical understanding of the concepts. She explained that some of the questions were more involved than others and gave students the opportunity to put their ideas in writing and communicate their thinking on paper. Quite often, those kinds of assessment tasks had multiple solutions. However, when observed Sheila's instruction during the data analysis unit, I did not see her include those types of tasks in her assessments. While mathematics tasks that asked students to put their ideas in writing were common practice throughout a unit and during instruction, they were omitted in assessments. This discrepancy between Sheila's admission that "I really prefer problem solving type assessments" and the lack of evidence of their implementation in the classroom could be linked to the tension Sheila expressed of feeling the need to adhere to the practice encouraged by the administration of offering students plenty of opportunities to complete assessments that had similar format to the district EYA (End of Year Assessment). The district EYA only included multiple choice items and did not include any tasks that required students to write and explain their thinking.

The two teachers described assessments as tools they used to gauge their students' learning and also monitor their own teaching. An assessment tool could take many forms – oral responses, written work and observations during a hands-on task. Sheila considered observations she made of her students to be an informal type of assessment…

> I walk around and make sure they are actually, they understand, I check to make sure the work is correct and that's like an informal assessment. I can tell from that if I need to go back and revisit any of the concepts and this is where it gets kind of hard because you have some kids that buzz right through it and do things right then you have those that don't get it. Those kids you have to pull to work with one-on-one, you know like a small group to work with them to make sure they get the concept.

While the form of the assessments could vary, so could their length. Some assessments were short and focused on one skill, for example the relationship between repeated addition and multiplication. While other assessments were more cumulative, involving problems for students to apply multiple concepts, for example, geometric figures, including their similarities and differences. Regardless of the length or type of assessment, Sheila and Greg used them to gauge student learning. Greg compared assessments to a thermometer, "It's kinda like gauging the temperature of our students – do they understand this, are they behind, how can we help them?" Though the two teachers explained their assessments as serving the same purpose, to show students' mathematical understanding, they assigned different values to different assessment instruments and approaches. When analyzing the assessments, Greg and Sheila both believed that some assessments were more informative for teaching purposes because they involved higher order thinking skills and offered students greater opportunity to show their thinking by recording their ideas and strategies. For example, Greg was emphatic about his preference for assessments that challenged students to share their ideas.

> Once I started seeing these kinds of 'show me your thinking' and prove your answer and how you got it, I like that idea. I think students need more of that kind of assessment. You know, really deep thinking and being able to describe to another person how they came about their answer. So, Exemplars [context embedded problems to solve that are related to the current standards on the curriculum map] have now morphed into…twice weekly lessons in my class.

Sheila and Greg both shared their ideas about formative assessment and summative assessment. They were in agreement about the definition and purpose of each. However, Sheila elaborated that summative assessments also served to help her critique her teaching.

> Greg: Summative is kind of overall information…
>
> Heather: Yes.
>
> Greg: Maybe the end of the nine weeks or the end of the year. Formative is as you're going along; you're doing those little assessments.

Heather: Based on what you said about CQI [Continuous Quality Improvement – a teaching model implemented several years ago at Chestnut Hill that emphasized frequent assessments, remedial groups of students and enrichment groups of students], it sounds like maybe you prefer the formative?

Greg: Yes.

Heather: Do you feel like there's still a place for summative or…

Greg: I think so because that's another piece. When you do the summative, are they retaining information and are they holding it in their long-term memories and [will then] be able to use that, because that's great for scaffolding for next year…

Sheila: So, formative would be like teacher observation and things like that. Things that you do on a day-to-day basis. And then, summative would be like at the end of a unit the test to see like what, like how well they've learned it.

Heather: Which do you think is more valuable – the formative assessment or the summative assessment?

Sheila: Well, I don't know because it's like, it's almost like that they're equally, they're both important because the formative it just, it drives your daily teaching and then the summative is how well you did.

Based on our debriefing, Sheila explained that she considered formative assessments and summative assessments to have equal value in regards to teaching and learning. However, the three assessments that Sheila shared with me were summative assessments. She mentioned two tasks during our debriefing regarding her unit on addition, but she did not consider them to be assessments. This inconsistency between her shared beliefs about assessment and what she practiced in the classroom could be the result of the tension she felt to align her classroom with the expectations of the school.

It was apparent through my conversations with Greg and Sheila that mathematics assessments were an integral part of their teaching and planning. They discussed how assessments made a strong connection between teaching and learning in their classrooms. The assessments allowed Greg and Sheila to analyze student progress to determine if the students had a conceptual understanding of the mathematics in the classroom. From those analyses, the teachers were able to make decisions regarding additional teaching that might be necessary as well as modifications they needed to make to their teaching. These assessment-guided decisions were evident during our debriefings. When Greg and Sheila shared with me assessments they administered, they explained how they determined if the assessments indicated to them that students had learned the mathematics concepts covered on the assessment. These interactions between me and both teachers suggested that they saw that their beliefs about assessment practices in their classrooms as being aligned.

A Glimpse into the Classrooms

Through the interviews and debriefings, Sheila and Greg provided a glimpse into the assessment practices in their classrooms. In order to have a better understanding of their beliefs about instruction and the connection they make between those beliefs and their assessment practices, they also shared instructional experiences.

I visited Sheila's classroom several days during the second nine weeks of school while she was teaching the data analysis unit. Sheila had referred to the curriculum map to plan for her mathematics block (see Appendix D). The map explicitly stated the standards related to data analysis and a suggested timeline for completing the data analysis unit. For second grade, the proposed length of time for this unit was three weeks. The curriculum map also provided Sheila with additional resources other than the adopted curricula she could use to teach data analysis. After reviewing the map, she decided she would begin her unit with a lesson on Venn Diagrams. During my visits, I made notes regarding her instructional practices and tasks her students completed during her teaching of this unit.

As I entered Sheila's trailer on the first visit, she was giving students an index card and instructing them to write their name on it. The students were intent on her directions and seemed excited about the beginning of a new mathematics unit. Her lesson allowed students to work as a group and interact socially. She used two large pieces of yarn to create a double Venn Diagram on the floor in front of the students. Sitting in a large circle, the students began to sort their names in the Venn Diagram according to Sheila's directions. First the task was to sort according to how many letters were in their names. The label of the first circle was *less than seven letters* and the label of the second circle was *an even number of letters*. After sorting their names and discussing the results, the students then sorted according to their pets – *cats* and *dogs*. Their final sort was according to their siblings – *brother* and *sister*.

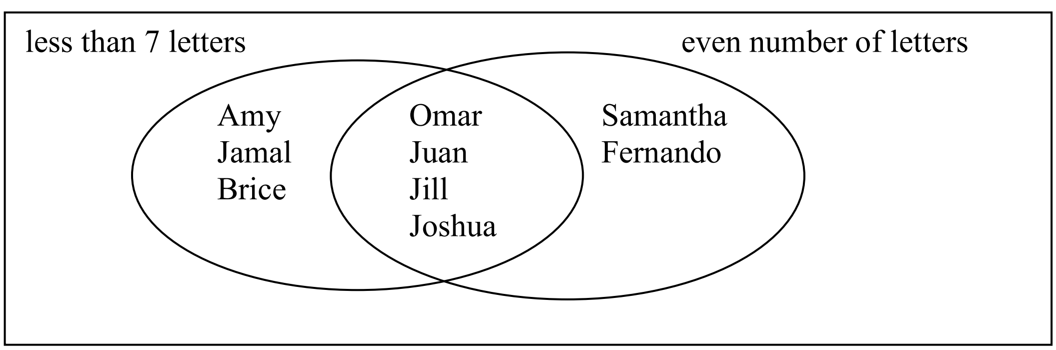


Figure 1. Venn Diagram.

After each sort, Sheila posed questions such as:

Which is more?

How many students have ______ but not ___________?

What do the names in the overlapping part of the diagram mean?

I'm surprised there are so many more in the _________ circle than in the _________ circle.

Did anyone notice that or something else?

This sorting, hands-on part of the lesson occurred over a 20-minute period. As students worked, Sheila observed their behaviors and how they responded to her directions. While the questions she posed provided an opportunity to elicit some discussion of their work, there were not any higher order questions that would challenge the students to interpret the Venn Diagram on their own, without prompts from Sheila. During our debriefings and interviews, Sheila had mentioned the importance of providing those opportunities to students, but she neglected to do that during this task. When we discussed that contradiction, she explained that, "Since we were just beginning the unit, I tried to keep it simple. I'll ask harder questions as the unit goes on." The lesson concluded with the students completing a practice page on Venn Diagrams in their math textbook.

The next lesson in Sheila's data analysis unit was a review of Venn Diagrams. Sheila shared with me that after observation of the group lesson on day one of the unit, Sheila determined most of the students were able to discuss the differences in the groups, what they noticed about the groups and what the overlapping of the Venn Diagram meant. She was confident they were ready to practice the concept independently on day two. However, as she observed their independent work on the math textbook page, she realized that was not the case. This conclusion was an example of Sheila's observations that she considered to be informal assessments. She had shared during our interview that she often observed students while they were working to determine how well they understood the concept. Based on her conclusion, she decided to revisit Venn Diagrams the next day.

When I joined her mathematics lesson on day two, Sheila was explaining to the students, "When you were working on this page yesterday, several of you had a hard time with the bottom." Then, she proceeded to teach a mini lesson on the task at the bottom of the page – sorting polygons. As she instructed the students, they sat quietly at their desks, most of them following along in the book, glancing at Sheila periodically while she talked. There were three students who seemed a bit distracted. With a quiet tap of my finger, I pointed to where Sheila was teaching from in their math textbook. They responded immediately and redirected their attention to the textbook. Her first question was, "What can you tell me about this Venn Diagram?" The diagram displayed how a set of different colored polygons had been sorted. The left circle of the Venn Diagram had several different red polygons. The overlapping portion of the Venn Diagram had several different sized red triangles, while the right circle of the Venn Diagram had different colored triangles. Her opening question seemed effective at encouraging students to share their ideas and interpretations of the Venn Diagram. The lesson continued with Sheila facilitating a discussion about the Venn Diagram and students responding to questions she posed.

Once again, when Sheila felt like the students had a strong understanding of the concept based on the discussion, she moved on to the next task – a page in their textbook about collecting data by surveying their peers and using a tally table to record the collected data. Sheila began her explanation of their next task by posing the question, "Who can describe what this word is?," while pointing to the word survey that she had written on the board. She allowed several students to respond and finally wrote 'ask for a person's opinion' next to the word survey. Then, she proceeded to explain how the students would collect data based on the survey question.

After a thorough explanation of her expectations, Sheila encouraged the students to begin collecting the data while she observed. As the students worked, Sheila and I took the opportunity to briefly discuss Sheila's observations to this point and what her plans were for the next few days. During our impromptu conversation, I asked her why she chose that particular task/book page – collecting data – for her students to complete. She explained that the curriculum map includes that chapter in Harcourt as a resource for teaching data analysis and that it's her primary instructional resource. Her statement made me wonder, however, if the book page was the best choice for providing students an opportunity to show conceptual understanding of data analysis and if she would truly be able to determine student learning of the concepts. Both of those goals – conceptual understanding and student learning – were mentioned by Sheila during our interviews and debriefings when she explained the purpose behind tasks she assigned and assessments she administered. While her motivation for assigning that particular page to the students could have been to determine student learning, she did indicate it as such, but rather to follow the resource suggestions identified on the curriculum map.

The next lesson in Sheila's data analysis unit provided the students with an additional experience collecting data and using that data to create a bar graph. To engage the students in the task, she began a brief discussion of birthdays, a popular topic for most second graders. After the discussion, Sheila explained she was going to give each student an index card where they were to write their name and their birth date or birthday. Then, the students worked together to post their cards next to the corresponding month on the graph that Sheila had created on the board. Finally, Sheila gave students a piece of paper that had a blank bar graph template on it and instructed them to transfer the data displayed on the board to their bar graph template. As the students began to work, Sheila asked, “What do we need at the top of the graph?” One of her students eagerly responded, “A title!” Sheila then added, “Why do you think it’s important to have a title?” The class discussed the purpose of a title briefly. Students then proceeded to work independently completing the assignment.

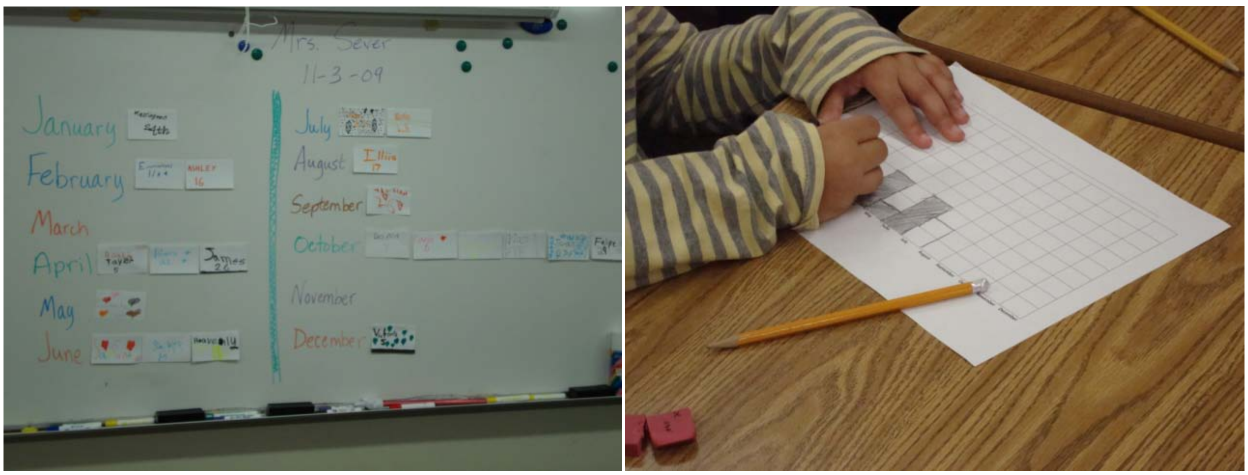


Figure 2. Bar Graph, Initial Exercise.

Intrigued by Sheila’s progress with the data analysis unit and my ongoing interest in assessment, I asked Sheila, “Will the work they’re doing be collected and analyzed as an assessment?” To this Sheila responded, “Honestly, it just depends on which I need – skills grades [activities for students to practice skills] or assessment grades.” This was yet another example of the pressure Sheila felt to fulfill the required grading guidelines set forth by the administration at Chestnut Hill.

On day seven of Sheila’s data analysis instruction, I entered a room where students appeared to be anxiously awaiting Sheila’s direction for the task at hand. The students were seated at their desks, which were cleared of books, papers and pencils. Sheila was busily gathering materials from her desk. As she returned to the group of students, she carried a stack of coffee filters and a tub of beads. She asked me to give each student a coffee filter. Happy to be of assistance, I put one coffee filter on each student's desk. The students seemed curious about the filters, asking, "What is this? Why do we need this? What will we do with this?" Their inquisition made me smile, always happy when students are excited about something in the classroom. As I worked, Sheila put a spoonful of small colorful beads in each coffee filter. When all of the students had their materials, Sheila gave them a piece of paper with two graphic organizers – one for recording a tally chart and one for creating a bar graph. Sheila explained they were going to create a tally chart and a bar graph of their beads. Her directions were brief and other than a quick clarification of a tally chart, she offered little guidance. After several days of data analysis and observing the students' work, Sheila determined they would be able to complete the task independently. However, she soon realized this was not the case. One of the students created the following chart to represent his bar graph:

Red	2						
Blue	8						
Green	7						
Yellow	7						
Black	1						
white	9						

Figure 3. Sample Student Bar Graph Misrepresenting Data.

This realization prompted Sheila to have a quick mini lesson regarding creating a bar graph. She proceeded to show students two options for creating a bar graph, either horizontally or vertically.

Figure 4. Horizontal and Vertical Bar Graphs.

After Sheila modeled how to create the bar graph based on how the beads were sorted, she instructed the students to complete their work. Appearing more confident than before, the students followed Sheila's directions and returned to completing their work.

Figure 5. Bar Graph, Follow Up Exercise.

Had the lessons helped the students to develop a deep understanding of data analysis? Sheila would soon find out when she administered the assessment.

It was evident that Sheila followed a more traditional style of instruction, including teacher guided tasks. There were instances in her classroom where she provided information for her students as the knowledgeable other, such as the direct instruction during the data analysis unit, as well as interactions with manipulatives/physical objects, such as the hands on graphing tasks she planned. These experiences suggested the impact reform teaching had on her instruction practices.

Greg implemented a Math Workshop instructional model in his classroom which offered students opportunities to discuss their learning with each other, investigate new ideas about learning and make connections to old ideas. Math Workshop was also referred to by some teachers as guided math and was similar to guided reading, each unit beginning with a short pre-test.

Greg's mathematics block looked different than Sheila's. The premise for the Math Workshop was that it had four components – a mini lesson, small group work with peers, small group lesson with the teacher and summarizing discussion. The first component, the mini lesson, began the mathematics block. The content of the mini lesson was based upon the current standards on the curriculum map. Quite often the lessons involved manipulatives and emphasized conceptual understanding of the mathematical ideas. The involvement of manipulatives to emphasize conceptual understanding reiterated the teaching and learning goals Greg shared during debriefings and interviews as well as his ideas about students interacting with manipulatives.

After the mini lesson, students worked independently, in pairs or in small groups, which was all dependent upon the task for the day. There were four tasks to complete each week – a project, a page from the math textbook, a math game and a task which reinforced the mini lesson. The students were assigned to heterogeneous groups when working on the tasks. While students completed the assigned task each day, Greg pulled small groups of students. Those groups were homogeneous based upon the pre-test Greg administered prior to the beginning of the unit. He assigned a scoring range for each group. For example, students who scored 85% – 100% on the pretest were grouped together for small group instruction. Students who scored 65% – 85% on the pretest were grouped together while the third group included students who scored less than 65% on the pretest. Greg explained that those pre-tests "really drive the instruction, especially when we're trying to figure out the schedule for the math workshop." The sole purpose of those particular assessments was to provide data for grouping students homogeneously. Greg did not use the pre-tests to determine student progress or assign a grade, which would not align with his philosophy of teaching since the content of the pre-tests had not been taught. Basically, Greg was assessing the students' prior knowledge of the concepts. He explained that "however they performed on that little mini assessment lets me know are they ready for the higher enrichment or are they ready for remediation."

The lessons during small group were also based upon the curriculum map. However, the depth of the lesson depended upon the students' levels. For example, during the multiplication unit, Greg taught a lesson with his struggling students about the "power of 10." He began by having students model the expressions 5 x 1, 5 x 10 and 5 x 100 using base-10 blocks. The inclusion of base-10 blocks further illustrated what Greg shared about conceptual understanding and student learning during our debriefings. He believed that in order to support those two goals, students needed opportunities to investigate mathematical ideas with manipulatives. After the students had used the manipulatives to represent the products 5, 50 and 500, Greg questioned the students about what they noticed about the size of the groups. Two of the students commented that they were "getting bigger." Greg continued the discussion with the students. After several minutes, he wrote the equations 5 x 1 = 5, 5 x 10 = 50 and 5 x 100 = 500 for the students to see and again asked what they noticed. The students shared their observations about the equations and Greg explained to them the "power of 10." They did several more guided examples until

Greg felt that they had a developing understanding of the idea based on their work with the manipulatives and involvement in the discussions. Greg shared during a debriefing that the small group setting allowed him to monitor student learning much more closely than if he taught the same lessons in a whole group setting.

Greg taught the same standard to another group of excelling students. However, the lesson looked very different. It did not involve manipulatives. Based on the students' pretest results, Greg had determined that their understanding of number and of place value was significantly more developed that the previous group. That determination led him to the decision to eliminate the use of manipulatives with this group of students. He posed a similar question to this group after writing the equations 5 x 1 = 5, 5 x 10 = 50 and 5 x 100 = 500 on the board. His challenge was, "How are these equations related?" The group studied the equations and then began to share ideas and suggestions for the mathematical rule represented by the equations. Greg supported the discussion, posing questions when necessary and offering alternatives to encourage the students to defend their ideas. He was trying to get them to see beyond the rule of "adding 0 to the product since one of the factors has a 0." He was trying to encourage them to have a mental picture of the equation and recognize the magnitude of the numbers and how they are increasing. While both groups were learning about the same standard, Greg differentiated the teaching based upon the students' needs. Eventually, the first group would be involved in a similar conversation as the latter group. Greg explained that "those students need the pace of the curriculum to be a little slower and they need have the opportunity to use the manipulatives to completely understand the concept."

Math Workshop served to introduce new concepts and provide instruction for students according to their mathematics understanding. However, Greg included additional instruction throughout the day which provided an opportunity to review previously learned skills. During one of our collaboration sessions, we discussed how to ensure that Greg's students maintained the skills he had taught thus far. This notion of maintaining skills originated with the curriculum map that Greg utilized to plan instruction. The length of the mathematics curriculum map for third grade is 11 pages and at the top of each page were the following notes for teachers: "Ongoing Instruction: calendar, vocabulary, data collection, fact fluency, time, money, measurement, problem solving, patterns, and process standards ([county standards] 1-19). Skills to Maintain: place value, +/- of whole numbers, +/- fact fluency, skip counting." Based on these instructional suggestions for teachers, Greg implemented various strategies throughout the year that he considered to be maintenance instruction. His theoretical underpinning for incorporating these strategies was that students must revisit concepts and skills to ensure they have a deep understanding of the concepts and can continue to apply them in different contexts.

One of those instructional strategies was Greg's weekly calendar block. Twice a week, Greg reviewed several place value and number sense concepts using his posted calendar. The calendar changed each month and was on display throughout the year to reflect the current day. Each day, the next card was turned over to show the date. From the first day of school, students tracked the each day by adding a two inch by two inch square piece of paper with the corresponding day of school on a number line. For example, on the 12th day of school, the numbers one through 12 were displayed on the number line. On the 42nd day of school, the numbers one through 42 were displayed on the number line. There was a key to accompany the number line which indicated how students recorded multiples of some of the numbers that were less than ten. For example, numbers that were multiples of three had a triangle in the bottom right corner of the piece of paper. Greg explained that the purpose of the key was to encourage students to recognize patterns in number sequences that identified multiples of various numbers. After students had completed calendar, Greg began a discussion of the day's findings. The discussion usually included having students predict upcoming multiples on the number line based on the patterns thus far. Students would share their predictions as well as how they determined what the next numbers would be. These discussions were another example of Greg's belief that it was important for students to listen to each others' ideas and sharing those ideas may clarify misconceptions students may have.

Another component of calendar was SPEW (see Appendix C), an acronym which stood for Standard form, Picture, Expanded form and Word form. The students were introduced to SPEW during the first few weeks of school while Greg was reviewing place value and number sense standards as a result of the students' performance on the STAR test, an assessment that Greg administered to his students to collect baseline data. It will be discussed further in the baseline data section. Initially, Greg included two digit whole numbers during the SPEW activity. He filled in one of the four sections of the SPEW chart and asked the students to complete the missing parts of the chart. By midyear, after Greg had taught the fractions and decimals unit, he began to incorporate decimals and larger, four and five digit whole numbers into the SPEW activity.

The final component of calendar was patterning. The students were required to create a pattern which matched the pattern displayed on the calendar. The pattern varied month to month; it was either a repeating pattern or a growing, algebraic pattern. In order for students to copy the pattern, they first had to identify the pattern. This task proved to be particularly challenging the first few days of the month when there were only a few cards turned over. I observed Greg's students complete calendar on Tuesday, October 6. Greg wrote the number 305 in standard form in the “S” section of the SPEW chart. Having plenty of experience with this task, Greg’s students knew to complete the other three sections – picture, expanded and written.

After the students completed the SPEW chart, they studied the calendar to determine the pattern represented on the date cards. The numbers one through six were shown on the calendar to indicate the first five days of the month had passed and the current day was October 6. Each date card had a plane figure as the background. At first, many of the students suggested the pattern was a repeating pattern. The first card of the month had a square as the background. The background of the second card was a triangle. The third card had a pentagon surrounding the number. The students recognized that the fourth card had a square as the background, just like the first card. The fifth card repeated the same plane figure as the second card, a triangle. They were not surprised to find that the card for October 6 had a pentagon. Based on these observations, the majority of the students predicted the pattern was an ABC pattern – square, triangle, pentagon, square, triangle, pentagon, and that the next time they did calendar a square and a triangle would be displayed. At Greg’s suggestion, I returned Thursday, October 8, to determine if the students’ predictions were correct.

When I returned to Greg’s class two days later, calendar began the same way. The students were working on their SPEW chart. Greg had written *seven hundred five* in the “W” section of the chart. Two of Greg’s students were adding numbers to the number line to represent two additional days of school since October 6. Those same students had already turned over the cards for October 7 and October 8. Shortly after I arrived, I noticed that the students were beginning to whisper to each other about the cards that were displayed on the calendar. I heard one student exclaim, “It’s NOT a repeating pattern!” while others argued, “Yes, it is.” Greg allowed all of the students to complete their calendar task and encouraged them to continue to discuss what they noticed about the calendar. By the time all of the students had finished, the majority of the students had decided that the pattern was a growing pattern, but a few students were not convinced and maintained that the pattern, square, triangle, pentagon, square, triangle, pentagon, pentagon, square… was a repeating pattern. Greg involved the students in a brief discussion of the pattern presented on the calendar.

Figure 6. October Calendar.

This vignette regarding calendar provided another example of Greg's practice of incorporating strategies for reviewing previously taught standards. As previously indicated, the curriculum map guided teachers to continually review identified skills. Greg used the map to guide his decisions regarding tasks to include on the calendar as well as results from administered assessments.

Greg and Shelia had varying instructional practices in their classrooms. Much of Sheila's instruction focused on whole group lessons with limited interaction between students. She provided guided instruction to students while they worked independently after the lesson. Greg's classroom involved small group lessons based on students' needs as well as opportunities for students to work together on tasks.

Alignment of Beliefs and Practices

Greg and Sheila shared various assessments they used in their classrooms. Each assessment had a specific purpose. Those purposes included gathering data prior to a unit to determine students' prior knowledge and current mathematical understanding (baseline data assessment), determining student understanding of a concept and making instructional adjustments accordingly (formative assessment) and identifying student learning at the conclusion of a unit and assessing the effectiveness of instruction (summative assessment). Collecting baseline data and administering formative assessments were areas where Greg and Sheila had autonomy to make their own decisions regarding how to best implement those practices. Conversely, when planning for, administering and analyzing summative assessments, Greg and Sheila began to experience challenges to their beliefs due to reduced autonomy and increased demands linked to summative assessment and grading, the curriculum map and administrators. Based on this division between baseline data assessment, formative assessments and summative assessments, the remainder of this chapter will address baseline data, formative assessments and how the two were enacted in Greg's and Sheila's classrooms. Chapter six will address summative assessments and the related topics, including the aforementioned challenges.

Baseline Data Assessment

Baseline data assessments provided teachers with information that enabled them to determine students' prior knowledge of a concept. Greg implemented baseline data assessments regularly in his classroom, whereas Sheila indicated that she did not incorporate any assessments in her classroom that allowed her to determine students' mathematical understanding of a concept prior to a beginning a new mathematics unit. Her assessments occurred throughout the mathematics units or at the conclusion of the units. On the other hand, it was common practice for Greg to include such baseline assessments. In fact, at the beginning of the year before he met his new class of students, Greg reflected upon his experiences thus far as an educator in order to make decisions for the fast approaching 2009 – 2010 school year. He contemplated: What did his students learn last year? How will he help a new group of third grade students learn this year? What could he do as their teacher to provide a safe, effective learning environment? He also included time for students to work together on tasks in order to build a sense of community. While doing so, he observed and intervened when necessary. The interventions provided an opportunity for Greg to keep the students on track with their task as well as begin to develop a positive relationship with them. He knew that very soon the students would have invested what he considered to be a great deal of time becoming a community of mathematics learners, enabling them to devote the rest of the year to maintaining those relationships while learning the third grade curriculum.

As Greg carefully and thoughtfully proceeded through the first few days of the 2009 – 2010 school year, he began to make decisions regarding the most effective ways to determine his students' mathematics knowledge. After much reflection concerning assessments he had used previously, assessments available to him during the 2009 – 2010 school year, and which assessments he felt would be both informative regarding students' ability and efficient in terms of instructional time spent on assessing, he determined that the STAR test would provide him with the data he needed to make the first steps in meeting the needs of his students.

The STAR test was a computerized mathematics assessment. Students completed the twenty-four question assessment independently. There were three initial questions which served as a practice test and to determine a beginning level. After the practice test, students began the actual assessment. One multiple-choice question and the accompanying answer choices A, B, C, and D were presented on the screen at a time. Occasionally, "not given" was the choice for D. The student read the question and selected his choice by selecting the corresponding letter. After doing so, the next question appeared on the screen with no indication of whether or not the previous response was correct.

The questions posed to the students on the STAR test fell into one of two categories – numeration objectives or computation objectives. The numeration objectives related to the students' conceptual understanding of place value and how well that understanding had developed. The questions began with basic place value questions for a third grader (ex. Which digit is in the tens place?), becoming progressively more difficult if the student was successful (ex. 10,209 rounded to the nearest thousand is which number?). On the diagnostic report that Greg printed for each student, there was a spectrum reported for the numeration objectives. The student's ability was plotted along the spectrum based upon their progress on the numeration questions.

The computation objectives referred to the four mathematical operations – addition, subtraction, multiplication and division. The questions began with simple, whole number computation questions (ex. What is the sum of 5 + 4?). Like the numeration objectives, the computation objective questions became more difficult (ex. What is the difference of 12.1 – 6.8?) if the student responded correctly by including expressions involving fractions and/or decimals. Once again, the diagnostic report used a spectrum for the computation objectives to report the students' mathematical development.

As previously indicated, when students responded to each question, the question difficulty decreased or increased depending upon their success. If they accurately answered a series of questions, the difficulty level, hence the mathematical level of the questions, increased.

During the testing process, students were allowed to use paper and pencil to help them analyze and solve the problems. However, these papers were not collected or included as part of the analysis of their levels.

I had an opportunity to observe one of Greg's students, Jamie, take the STAR assessment that Greg used as a baseline assessment at the beginning of the year and for any new students who arrived. In the first few weeks of the school year, up to this time, I had been in Greg's classroom every day during the mathematics block, so my presence was not new for the students nor for me. In fact, I provided support to Greg and his students daily during his mathematics block in the fall of 2009. Having recently received my certification in special education, I worked closely with two of Greg's students who each had an Individualized Education Plan (IEP) in mathematics. However, Jamie was not one of those students, so I had not worked with her on a daily basis.

As Jamie logged into the computer and prepared to take the assessment, she sat alone at the classroom computer in the back of the room. I was impressed with the level of engagement in the rest of the classroom. Most students were working quietly on a task Greg had assigned. Those students who were talking were sharing with their neighbor how they had solved the problem. In order to concentrate and to reduce distractions, Jamie wore earphones, which served no other purpose than to help her focus because she had to read the questions independently; the computer did not read the questions aloud to the student. Jamie seemed to be very focused during the assessment. She appeared to read each question carefully and thoughtfully select the choice she deemed to be correct. For some of the questions, Jamie used paper that Greg provided to work out the problems. After doing so, she would select the corresponding answer. Of the 24 questions, Jamie only used the paper to work on six of the questions. Jamie's behavior provided an example of how a student may respond to completing the STAR test. The glimpse of her working on the STAR assessment in the midst of her peers helps us to get a sense of Greg's classroom community.

An additional example of collecting baseline data was the pre-tests Greg administered to his students prior to many of the mathematics units. The pre-tests were usually short, having five to ten questions that broadly covered the concepts that Greg was going to teach in the upcoming unit. Students worked independently on the pre-test for 10 – 15 minutes. Greg wanted a true reflection of their understanding of the concepts. He felt that if he allowed too much time the students' responses may be the result of plenty of time to ponder and not an accurate representation of their current mathematical knowledge of the concept.

After administering the pre-test, Greg checked each one for accuracy and placed the students in one of four homogeneous groups based upon their performance on the pre-test. The criteria for the groups based on the percentage correct was as follows: group one – 85 – 100% correct responses, group two – 75 – 85% correct responses, group three – 60 – 75% correct responses and group four – less than 60% correct responses. The percentages offered Greg a guideline for grouping the students. However, once Greg began to work with the small groups, he shifted students from group to group as necessary. For example, if a student was originally placed in group four, but displayed to Greg during small groups or on a formative assessment that he understood significantly more than indicated on his pre-test, Greg would move the student to another, more appropriately leveled group. After Greg organized the students according to the results of the pre-test, he planned for math workshop. The daily math workshop model included a brief mini lesson at the beginning of the mathematics block followed by a 30 –

40 minute block of time for students to work on tasks independently or with a partner while the teacher worked with small groups of students on concepts related to the mini lesson.

One of the pre-tests that Greg administered was at the beginning of the division unit (see Appendix C). The pre-test was a short, five question assessment where students would respond to multiple choice questions related to division. Greg wrote five multiple choice questions, including the answer choices, on the board. For example, one of the questions was: Ms. Neighbors has 14 stickers to share between Seth, Taylor and Tremaine. How many stickers will be left over? A. 3 B. 2 C. 14 Students were instructed to write their responses in their journal. While they worked, Greg and I circulated around the room and checked their work. On a list of students' names, we recorded the questions they missed. After the students recorded their answers and we listed their missed responses, we went over each question as a class. The discussion offered many teachable moments since each question was missed by at least five students. During the discussion, common misconceptions that students had about division became apparent. Greg made notes of those misconceptions in order to plan for upcoming lessons.

A final example of Greg incorporating assessments to serve as baseline data involved a one-on-one performance assessment. For this example, the administration of the assessment was in response to my collaboration with Greg regarding a dilemma he was facing with one of his students. Shortly before beginning his multiplication unit, a new student, Alexis, enrolled in Greg's class. At the time of her enrollment, I was notified she would be added to my caseload of students who have an IEP. Having joined Greg's class several weeks into the school year, Alexis did not participate in any beginning of the year assessments Greg administered to his students to determine their mathematical level. Because this lack of data concerned Greg, he and I collaborated to make a plan for assessing Alexis and meeting her academic needs. After much discussion regarding our assessment options, Greg and I decided I would administer a performance assessment (see Appendix C).

The performance assessment was a locally created mathematics assessment used by the mathematics specialists and some teachers at Chestnut Hill to identify students' mathematical understanding of number. The content of the questions focused on the number sense strand of the state performance standards. The assessment had six stages. Stage one was indicative of kindergarten level knowledge, stage two was aligned to first grade number sense understanding, and so on. Based on a student's current grade level, a stage would be chosen accordingly. For example, if assessing a third grader, the teacher would begin the assessment with the stage four questions. When administering the assessment, the teacher would read the task and the student either verbally answered the question or completed a task with manipulatives depending on the question. There were indicators throughout the assessment that guided the teacher to another stage, if necessary. For example, when administering a stage four assessment, if the student missed any of the first five questions, the teacher would refer to a stage three assessment after the fifth question. On the contrary, if the student was successful, the teacher continued moving on to the next stage if necessary, until the student was unable to successfully answer the questions.

Since Alexis was a third grader, I began the assessment with stage four. At that point in the year, she should have been able to successfully complete at least one third of the assessment, but she was unable to do so. In fact, she was unable to complete any of the assessment, so stage three was administered, which correlated to the mathematical performance of a second grader. That assessment was also quite difficult for Alexis. She was unable to get through the first two questions. Finally, a stage two assessment was administered. Alexis was able to complete the first half, indicating she was on about a mid-first grade level. While this information seemed vague without the assessment to refer to, the questions were actually quite specific and were all related to number sense, as seen in the following excerpt from stage 2 of the performance assessment:

Heather: Please read this equation (90 – 70 = 20)

Alexis: 9…90 (long pause)

Heather: minus

Alexis: 90 – 70 = 20

Heather: (The minus symbol was removed, the cards were mixed up and the addition symbol was inserted) I'm going to remove this symbol, mix up the cards and give you a new symbol. Put the cards in order to make a true sentence.

Alexis: (She arranged them: 90 + 70 = 20)

Heather: Read the equation please.

Alexis: 90 plus 70 equals 12. I mean 20.

Heather: Please read this equation (12 + 40 = 52)

Alexis: 12 plus 40 equals 52

Heather: (the addition symbol was removed, the cards were mixed up and the minus sign was inserted) I'm going to remove this symbol, mix up the cards and give you a new symbol. I want you to put them in order to make a true sentence.

Alexis: (She arranged them 12 – 40 = 52) 12 minus 40 equals 52

Heather: Count by 2s starting at 14.

Alexis: 14, 13, (long pause)

Heather: Start at 14 and count on by 2s

Alexis: 14, 15, 16

Heather: 14 and 2 more would be…

Alexis: (long pause) no response

This performance assessment was not an assessment that Greg routinely administered in his classroom. While it provided useful data regarding students' number sense, the one-on-one format was not conducive to the classroom setting. We used it to determine Alexis's mathematical strengths and weaknesses and to identify her instructional needs. We chose this assessment rather than the STAR test because Greg had already concluded his initial instruction based on the results of the STAR test. Also, we were trying to determine Alexis's number sense rather than her progress on third grade standards, so we felt this assessment would provide us with that information.

Baseline data assessments provided Greg with useful data regarding his students' mathematical ability. He was able to analyze the assessment results to determine where to begin instruction with his students, how to group them for instruction and possible gaps in their understanding.

Formative Assessment

Greg offered a greater variety of types of assessments in his classroom. While some of the assessments served to provide him with baseline data, other assessments were implemented throughout the year to determine how well students were developing mathematically, including their ability to communicate their ideas and record their problem solving strategies effectively. He referred to this type of assessment as Exemplars, mathematical problems that students had to solve based upon a particular context. When first introduced at Chestnut Hill as a commercially produced program, Exemplars were one of several choices for professional development opportunities for teachers. Like Greg, teachers at our school who were involved in the Exemplars professional development have come to use the idea of Exemplars and begun to develop their own problems. Prior to administering an Exemplar, Greg reviewed the standards he had been teaching in his classroom in order to develop a problem for students to solve related to one of the standards. He clarified the process…

> Twice a week I take 20 minutes out of our day. I write up a problem, a word problem, some kind of problem-solution deal where it correlates to what we're learning. So, if we're doing place value I'll probably throw up a question about place value…we had an exemplar yesterday in class that had to do with patterning, odd and even patterning, it was about flowers. Some were red. Some were yellow. So, what is the 5th colored flower, what is the 27th colored flower, and that gives me and idea of what they understand, so I can see who needs extra help with odd/even patterns, who doesn't understand patterning, and who gets it and can try an even harder pattern.
>
> Heather: How do you collect that information?
>
> Greg: We just received our brand new math journals which are composition notebooks which have an area at the top for pictures and then some sentence areas down at the bottom. So they have a place to show their thinking and do their work out there. So, I give them the question. They copy it down from the board into their notebook…Then I give them maybe 20 minutes to work on it. This year I'm trying to step back and not give them so many answers, but I'm trying more to guide them to think about what they already know, what could they use to solve it, how are they thinking about these problems.

When Greg first introduced Exemplars in his classroom, he gave students a list of steps to follow for solving the problems. The steps were to circle the data, draw a picture and record your solution in a complete sentence, including how you solved the problem. The picture they drew could be a traditional picture or it could be a chart, table or graph. Greg also required that the students to solve the problem two different ways.

Eventually, students were encouraged to begin to try their own strategies to solve the problems. By the time Greg began to challenge students to try something new, he had included discussions with his students at least twice a week for several weeks regarding their approach to solving problems he had presented as Exemplars. In addition, students had been given opportunities to discuss with their peers how they had solved problems each time he posed an Exemplar. Greg felt that students needed to be able to not only record their ideas and how they solved problems, but they needed to be able to articulate their ideas. These examples of including social interactions between students were commonplace for Greg's classroom.

As students worked on Exemplars, he circulated around the room and monitored their progress. Greg may stop and interject a suggestion, but he tried not to change the student's idea. His interactions with the students served to address misconceptions, clarify misunderstandings and encourage independent work. During these interactions, he said things like, "Tell me how you chose that strategy," "How did you figure that out?" and "How do you know that will work?" After allowing the students ample time to work, he initiated a short discussion of the Exemplar. Volunteers explained to the class how they solved the problem. During this exchange, Greg emphasized to students the importance in developing the ability to verbally explain their thinking and justify their answer. Students were encouraged to question one another and ask for clarification on any part of the explanation that was confusing. Greg admitted that if he was given the freedom to make a classroom plan for assessment that he "would probably do more open ended questions, pencil and paper where they have to show their thinking a lot, a lot more exemplars. I do assessment that way, but that's not what they're looking for on our report cards for assessment." This declaration provided a glimpse of one tensions Greg experienced and shared about often. It will be discussed at length in another section.

One such exemplar that Greg required of his students read, "Selena has 9 puppies and 1 mama dog. Each dog has 4 legs. How many legs in all?" (see Appendix B) During this particular mathematics lesson, I entered a very quiet room. As I looked around, all of the students appeared engaged and working fervently on the problem Greg had posted on the board. After observing for five or six minutes, I noticed one of the students, Tracy, look up from her work and peer onto her neighbor, Natasha's, journal. This was not unusual for Tracy. She was confident in her mathematical ability and often challenged her peers regarding their work. Tracy proceeded to explain to Natasha that the solution she had written was wrong. At first, Natasha questioned her own work, but as she studied it she became more confident and proceeded to defend her work. As Tracy listened and Natasha passionately explained what she had done and why she had done it, Tracy became convinced that she may have made a mistake and that Natasha was correct. Greg encouraged this behavior by suggesting that his students discuss their mathematical ideas with each other. In fact, he modeled this behavior earlier when he probed a student by saying, "I'm not sure I understand what you did here (pointing to part of the student's drawing). Could you tell me what you were thinking?" This scene was a common one in Greg's class. He emphasized communication between his students in addition to what they wrote in their journals. It was apparent that social interactions between students regarding their mathematics learning were a frequent occurrence in Greg's classroom. He talked about the value of listening to students' conversations about their mathematics thinking as a way to informally assess their understanding.

Like Greg, Sheila continually reflected upon her students' learning. She questioned how well they were developing a conceptual understanding of the standards she was teaching. She knew that the assessments she administered would help her to answer that question. Whether the assessments were informal observations she made during a lesson or more formal assessments where students completed a task on paper, she was confident that she would have the data to move forward and make effective, appropriate instructional decisions.

Within the first few weeks of the beginning of the school year, Sheila had concluded her unit on addition, specifically various strategies students could use when solving addition problems. Throughout the unit, she gave the students short tasks to complete to determine their mathematical understanding of the concepts she was teaching. While she considered these tasks informal assessments rather than formal assessments, she did use them to determine how well students were understanding addition. She explained that, "…an informal assessment is how [well] I can determine how well students understand a math concept that's been taught. Like an informal assessment may be observation…" Sheila went on to share that she felt like observing students was effective for quickly determining their understanding on the current standard based on how they were completing the task at hand, but she did not record anecdotal notes of the observations. If she noticed any misconceptions the students had while working, she addressed those misconceptions immediately.

Sheila shared two of those tasks she gave for determining the students' mathematical understanding of addition during a debriefing session. We met early one morning, an hour or so before the school day started. That time worked well for Sheila because her afternoons were often busy with grade level meetings, lesson planning, staff development and family obligations.

The first task we discussed involved writing equations (see Appendix B). Students were to write eight equations with two addends, each having a sum of eight. In addition, they were to draw pictures of chocolate chips on two cookies to represent the equations. For example, for the equation 2+6= 8, they drew two chocolate chips on the first cookie and six chocolate chips on the second cookie, for a total of eight chocolate chips. To Sheila's dismay, when she reviewed the tasks and analyzed the students' work, she realized they did not do well. The students made errors with their drawings, were unable to accurately record the equation represented by the cookies or they neglected to connect the drawings and equations to having a sum of eight. Some students wrote equations in the appropriate area, but did not represent the equation with a picture. Other students drew pictures of the cookies and corresponding equations, but they did not have a sum of eight. However, she was able to determine that their lack of success was not due to a misconception about addition nor a misunderstanding of representing equations with pictures and vice versa. Sheila said…

> I found with this that on the *Eight Chocolate Chips* they are really, really bad about reading directions and I had to tell them several times because they would come up to show me what they had done and it was wrong… I'm like, well, all of these things if you look up here that you have to have a sum of 8 on each of these things. I said, 'You could do, like for example, here's 1 + 7, you could also use the turnaround fact. You have to show it in the way that you draw it and they're like 'oh.'' So, they were trying to make it really harder than it really was.

This episode revealed Sheila's ability to examine her students' work and identify why they may not do well – lack of understanding of the directions, misconceptions about the concept or little to no background knowledge. In this case, she recognized they merely misunderstood the directions. As soon as she explained the expectations more thoroughly, the students were able to successfully complete the task. Therefore, when Sheila planned her next steps in instruction, she was confident that she did not have to include additional lessons on writing a variety of equations that have the same sum. After having explained the directions again, more clearly, if the students continued to struggle, Sheila would have concluded that students did not understand the concept. At that point, she would have planned a lesson involving manipulatives. She explained that a possible lesson would involve providing students with the opportunity to build same sized groups of manipulatives using different colors to represent the different addends. For example, she said, "The students could use two red tiles and six black tiles to show 8 eight or five black tiles and three red tiles to show eight." As I reviewed Sheila's thoughts while analyzing the discussion, I began to question her inclusion of lessons using manipulatives. As an educator who often discussed the importance of conceptual understanding, why did she choose to utilize manipulatives after students continued to struggle with a concept rather than during her instruction in order to support students' understanding? Had Sheila introduced the activity with the use of counters and concrete materials to represent the cookies, her students may have understood the task more quickly. Then, once they demonstrated understanding, Sheila could have considered having the students complete the last part of the task without manipulatives.

The other task that Sheila shared from the addition unit also involved writing equations (see Appendix B). However, rather than creating equations that all had the same sum, the students created equations based upon information given in the directions. For example, 7 toy puppies, 5 toy kittens would be recorded with the equation 7 + 5 = 12. After the students had completed the task and Sheila analyzed it, she determined that:

> These little simple word problems…none of these were tricky. They just knew, like for instance with number 1, 7 toy kittens, I mean toy puppies and 5 toy kittens, how many toy animals are in the store? They just knew 7 + 5. So, really, they didn't have to read the problem. They just could, they were lucky with this one because all they had to do was go and do the basic addition problem for all of these.

These observations of the students' work showed how they were able to do the mathematics involved in the task and were not distracted by confusing directions. Therefore, Sheila determined they had an understanding of representing simple word problems with equations, then finding the sum. Once again, if students hadn't been successful, Sheila would have planned additional lessons accordingly. The lessons could be for a small group, if only a few students were struggling, or for the whole class, if the majority of the class did not understand. Sheila considered these options when looking at student work.

These two tasks were just two examples of student work that Sheila analyzed prior to administering the assessment at the conclusion of her addition unit. According to the grading and assessment guidelines at Chestnut Hill, Sheila was required to record three to five assessments in the computerized grading system each grading period that were reflected in the students' grades. Sheila had the flexibility to administer more than five assessments if she chose to, but was only required to include three to five as part of the students' grading record.

While Greg included Exemplars as a tool for assessing his students to determine their mathematical development, he also administered assessments to determine progress his students were making on standards he was teaching according to the curriculum map. Early in the school year, Greg's mathematics instruction included a unit on place value which reviewed standards from second grade as well as introduced third grade standards. After the instructional focus had been place value for a couple of weeks, he decided to administer a short place value assessment in order to determine how much progress they had made with their understanding of place value.

On that particular day, Greg gave the assessment at the beginning of the mathematics block (see Appendix C). The students worked independently on the five multiple choice questions. Most of the questions did not require any computation or additional note taking to solve the problems, they were basic recall questions. This assessment format was an example of Greg's practice of incorporating a range of assessments in his classroom. He preferred assessments that involved questions similar to the Exemplars he administered in his classroom, but he valued the importance of variety. Furthermore, there were times when he wanted to assess their understanding as quickly and as efficiently as possible and he felt Exemplars were too time consuming for that.

As the students read the questions and marked their answers, I decided to observe Jamie, the same student I observed during the STAR test. Jamie seemed to read each question and answer choice very slowly, marking her selections thoughtfully. She appeared to be confident in her answers, never hesitating to mark which one she deemed to be the correct choice. My observation of her allowed me to see how a typical student would complete the assessment.

Another example of Greg's implementation of formative assessment was during his multiplication unit (see Appendix C). Throughout the unit, he administered short, frequent assessments. Those assessments differed from the pre-tests he administered. One of the primary differences between the assessments was that the purpose of the pre-test was to use that data to form homogeneous groups for small group instruction. On the other hand, when Greg administered the assessments throughout the unit, the groups had already been formed. However, the assessments did provide Greg with the necessary data to shift students between groups as needed. For example, if a student appeared to be struggling with the concepts based upon one of the frequent assessments, Greg would move the student to a different group, one that may move at a slower pace and better address the needs of that student. In addition, if a student did very well on the assessments, Greg moved the student to another group that would provide the student with more challenging lessons. Greg's small groups were flexible, he changed the groups periodically based upon the students' needs.

Sheila's and Greg's assessment practices included formative assessments which served to provide them with necessary data to determine students' understanding of mathematics standards. Greg also included baseline data assessments in order to identify where to begin with individualized instruction. After administering formative assessments and, for Greg, baseline data assessments, the teachers proceeded to analyze the assessments in order to instructional decisions.

Analysis of Assessments

Greg and Sheila analyzed assessments in similar ways. They both had a system for scoring the assessments and recording notes regarding the students' performance and possible modifications that needed to be made regarding instruction. Though the purposes for formative assessments, summative assessments and assessments for baseline data assessment aimed at providing varying data to Sheila and Greg, their analysis was the same. After the students complete each assessment, the teachers reviewed the assessments and recorded the errors students made in order to look for patterns that would enable them to determine reasons for students' mistakes.

Once all of Greg's students had completed the STAR test, he generated a summary report (see Appendix C). For Greg, the most useful piece of data on the report was the grade equivalency, abbreviated with GE. If students struggled with any of the questions and did not answer correctly, the difficulty of the questions decreased. Consequently, this decrease in question difficulty resulted in a decrease in GE. On the other hand, if the students answered the questions correctly, the questions became increasingly more difficult, and the GE would increase. There were additional reports that were available to teachers who used the STAR test. For example, there were individual reports that teachers could generate which offered significantly more details than just the grade equivalency. The individual reports provided teachers with data regarding areas in which students needed improvement. Jamie's individual report suggested that she needed to "keep practicing adding, subtracting, multiplying and dividing larger numbers; estimate by rounding numbers; and begin work with fractions" (see Appendix C).

Greg decided to generate individual reports for his students who scored grade level or below grade level. For the beginning of third grade, grade level equivalency was considered 3.0. The first number corresponded to the grade level and the number following the decimal indicated how many months at that level. For example, Jamie scored a 2.7, which meant the STAR test indicated she performed at the level of a student in second grade during the seventh month. Once Greg had decided that he would review an individual report for students at or below 3.0, he printed 13 reports. Those reports gave Greg information regarding the students' ability to work with numbers – specifically computation and place value. From the information provided on the reports, he grouped the students based on their individual needs. Students who needed additional work with computation were put in one group while students who needed additional instruction regarding place value were put in another group. There was some redundancy with the groups because some students were placed in both groups, meaning they needed additional support with both computation and place value. This overlap was not surprising to Greg based on his comment that "computation and place value are closely related. It's difficult to be successful with third grade computation if you have a weak understanding of place value." After assigning the students to their respective groups, Greg and I met to plan for the small groups. We determined the most effective strategy was to incorporate hands-on materials that students could manipulate. We would guide the students through some activities with the manipulatives, monitoring their progress by observing how they solved the problems we posed.

Once Greg reviewed the reports, analyzed the data presented on the reports and organized the students into homogeneous groups, we planned the lessons. When the lessons were planned, we were ready to work in the designated small groups. To ensure all students had an equal opportunity to work on a mathematics task according to their indicated level, Greg assigned an individualized mathematical task to each student. For students who needed additional support with the upcoming mathematical concepts, Greg assigned a task that reviewed second grade concepts. He explained that these students who needed more time with the second grade standards "don't conceptually understand how to take manipulatives to abstract...they're not thinking that way yet." When he recognized that a student still needed to work with concrete objects, he provided those experiences.

Other students were assigned tasks that challenged them to develop their own problem solving strategies, according to his observations of their strengths. All of the students were given the option to complete the task independently or with a partner. While the class worked on the task, Greg and I each worked with a previously organized small group. During the first small group lesson, we began with a brief assessment to clarify students' needs as indicated on the STAR report. Then, we taught a mini lesson that involved manipulatives on the designated concept. The remaining small group lessons included mini lessons focusing on the concepts that we confirmed were weak areas for students. Throughout the next two weeks, we followed this same process periodically assessing the students during small group time to identify student learning. Once we had completed the series of lessons, Greg was ready to move forward with his plans for the mathematics lessons for the remainder of the semester.

When talking with Greg, he explained that the STAR test was useful for planning individualized mathematics lessons based on each student's individual needs. It provided the necessary beginning of the year data to work with his students' on their developmental level. However, he also administered the STAR test again midyear to determine students' growth.

Greg's analysis of Exemplars varied greatly from how he analyzed other assessments. He was not able to create a spreadsheet as easily, so he resorted to anecdotal notes. Greg created an Exemplar record for each student. Each time he administered an Exemplar, he identified three students with whom he would confer. During the conference, he reviewed their work and discussed it with them. After the conference, Greg suggested improvements the students could make and strategies he could try. These suggestions were included in Greg's record for each student and at the next conference with the student, he would refer to the previous notes to determine if the student had made the changes that Greg had suggested. Greg's notes also included observations he made regarding areas of weakness that he planned to address with the student at another time.

The Exemplar that Greg shared earlier was, "Selena has 9 puppies and 1 mama dog. Each dog has 4 legs. How many legs in all?" He proposed this problem to his students after he had already begun his multiplication unit. The county standards related to multiplication identified on the third grade curriculum map were

explain the relationship between addition and multiplication

describe and extend numeric and geometric patterns that may also occur in a table or graph

identify and apply commutative and associative properties of multiplication and verify results

identify and apply identity properties of zero and one

Based upon the strategy that students applied when solving the problem, Greg could determine their understanding of the first two county standards, “explain the relationship between addition and multiplication and describe and extend numeric and geometric patterns that may also occur in a table or graph.” If the students chose a strategy which correlated to either of those two standards, he would have evidence of student learning. The students’ work on the Exemplar would not provide Greg with the necessary data to determine student learning of the mathematical properties related to multiplication. However, throughout our discussions of assessment, Greg communicated several times the emphasis he place on students’ experiences interacting with each other and their ability to “explain” and “describe” as indicated in the county standards.

Greg also included necessary assessments to identify student learning of the county standards. However, many of the assessments he shared focused more on students’ individual progress and mathematical development as opposed to meeting county standards. The place value assessment that Greg administered was an example of that type of assessment. As the students completed the place value assessment (see Appendix C), they gave their work to Greg.

He who used a blank copy of the assessment to record data regarding the students' responses. As he checked each paper, he would put a tally mark next to any questions the students missed on his blank copy of the assessment. After he had reviewed all of the papers and made the appropriate markings, he found that while 14% of his students missed the questions on word form and 25% missed the question on expanded form, more than 50% of his students missed the questions on place value. Greg shared,

> At first, I was surprised because I thought the students knew the places – ones, tens, hundreds and so on. Then I realized when we did SPEW and worked with base-10 blocks, we never really talked about place AND we focused on three-digit numbers. The questions on the test are about four and five digit numbers. Now I know I need to work with them on place.

While Greg's analysis of assessments such as the place value assessment involved recording data regarding students' errors, the analysis of baseline data differed. For the STAR test, Greg generated a report in order to analyze student learning. However, the performance assessment that I administered to Alexis was analyzed differently than both of these assessments. Greg and I met to analyze the results of the performance assessment and to identify Alexis's specific needs and make a plan to meet those needs. As mentioned earlier, Alexis joined Greg's class several weeks into the school year. He was concerned about her academic level and requested that I assess her. The example shared in the previous section was just three tasks presented to Alexis. Based on the second equation task, Greg concluded that Alexis did not seem to have a deep understanding of the operations of addition and subtraction because she did not recognize her errors with the problems 90 + 70 = 20 and 12 – 40 = 52. His first plan of action to improve her conceptual understanding of composing and decomposing numbers and eventually the connection to equations was to guide Alexis through a series of lessons with concrete manipulatives. Once he had evidence she was beginning to understand the concepts, he would teach her how the models represented equations.

Greg also determined that Alexis had insufficient experiences with rote counting whether it was counting forward by ones, backward by ones, forward by twos, etc. He was concerned that this lack of experience with counting would prevent Alexis from recognizing number patterns and employing a counting strategy when multiplying or dividing. To provide Alexis with the necessary counting experiences, he communicated to Alexis's mother what the assessment revealed about Alexis's number sense, specifically his concerns about her counting ability, and suggested she have Alexis practice counting various number sequences at home. Greg provided Alexis's mother with a detailed list of the sequences Alexis should practice, including examples. He and I also decided I would work with Alexis daily one-on-one for five to ten minutes on the gaps in her mathematical understanding that were identified by the performance assessment.

We have seen that not only did the types of assessments vary between Greg's and Sheila's classrooms as well as from assessment to assessment within their own classrooms, but we have seen how the analysis of the assessments also varied. This variation was not surprising due to the fact that the purposes for the assessments were also different.

Assessments Informing Instruction

After Greg and Sheila administered an assessment and analyzed the results of the assessment, they were prepared to use the results to make future instructional decisions, if they chose to do so. While I observed Greg's students work on an Exemplar, I had the opportunity to listen to Greg confer with Jamal during an Exemplar task and see his anecdotal notes system for myself. While Greg and Jamal conferred, I noticed that during a previous conference Greg had written that Jamal was not attending to the context of the Exemplar. Each time he saw numbers in a problem, he would add them together, regardless of if addition was the appropriate choice of operation. When Greg first made this observation, he discussed with Jamal how to identify an effective problem solving strategy to use when working on Exemplars and how to choose a suitable operation. Based on that previous interaction, Greg chose to begin the conference with Jamal by saying, “I noticed that you chose to subtract these two numbers. What made you decide to do that?” Jamal responded to Greg’s question and they discussed the problem for a while. In the end, Greg said to Jamal, “I can see you read the problem closely and carefully chose your strategy. That helped you to solve the problem correctly.” Jamal’s face beamed.

When Greg analyzed his students’ results on the STAR test and their work on the first few exemplars he assigned, he determined that several of his students did not have the conceptual understanding of place value necessary to be successful on the current third grade curriculum. Based on that conclusion, he planned a short place value unit that would bridge the gap between their place value experiences in second grade and those he would be teaching in third grade.

One of his lessons included a daily practice task called “SPEW.” Greg explained, “The s stands for standard form, p for picture, e for expanded and w for word.” Greg displayed a chart with four sections, one for each component of SPEW, and proceeded to complete one of the sections himself and then instructed the students to complete the rest. Initially, the practice task involved two-digit numbers. The first time I observed the students completing this task, Greg had written *fifty-two* in the W section of the chart and had asked the students to fill in the missing information. As I watched, most of the students were confident with the standard form section and had written *52*. The picture section also appeared to be relatively simple for the majority of the students. They drew a picture of five long sticks which represented the five tens and two small squares which represented the two ones. After Greg had allowed the students seven minutes to complete the task, he discussed the solutions with the students. Excited to share their ideas, several students waved their hands frantically when Greg asked, "Who can tell us about the first section of the chart, S?" Greg often worded his questions this way to encourage students to explain what they did and what they were thinking rather than just stating the answer. The sections P and W proceeded this way also, but when Greg asked for volunteers for the E section, the students were much less enthusiastic. Greg shared later

> as simple as it may seem, asking for volunteers can sometimes help me figure out what students are having a hard time with. Lots of students wanted to talk about S, P and W, but not very many wanted to tell me anything about E. I know that's a concept we need to work on.

This observation was consistent with Greg's original findings about his students' lack of understanding of place value which led him to begin his place value unit in this way. In addition to the SPEW chart, Greg incorporated lessons involving opportunities for students to use manipulatives to represent numbers. Eventually the students were challenged to assign values to the manipulatives and record their work using equations. These lessons served to help students better understand the "expanded" form on the SPEW chart.

After analyzing the place value assessment and debriefing about the results, Greg shared that the students seemed to have some misconceptions about *place* and that's not what he had expected. This example of Greg's revelation was just one of many that were evidence of how he used assessments to gauge student learning and critique his own teaching. He did not simply teach place value, assess the students and move on. As he checked their work, he made notes regarding how many students missed each question – indicating to him concepts he needed to review with individual students, small groups of students and with the whole class. Furthermore, after he had checked the students' work and collected the necessary data, he reviewed the assessments a final time to identify students who had not made any errors. The data he gathered helped him to plan for future instruction. As he suggested, he planned to include additional lessons on place value for many of the students. The lessons would be taught in a small group format. In addition, the students that appeared to have a clear understanding of place value would be given tasks that would allow them an opportunity to deepen their understanding of place value and apply that knowledge to problem solving tasks. However, it was the time of the year when Greg must begin to implement math workshop, the instructional model he would use during his mathematics block the remainder of the year.

This chapter has provided an opportunity to understand how Greg and Sheila aligned their beliefs about mathematics assessment with their practices of administering formative assessments and baseline data assessments. The experiences they shared illustrated how they analyzed the assessments and how those analyses informed their instruction. Greg and Sheila felt they had the independence to make their own decisions regarding those assessments. However, that independence felt threatened when they began to discuss summative assessments. Chapter 6 will discuss summative assessments and tensions Greg and Sheila negotiated in regards to grading, the curriculum map and their administrators.

CHAPTER 6

FINDINGS

Overview

Greg's assessment practices included collecting baseline data, formative assessments and summative assessments while Sheila's included formative assessments and summative assessments. In this chapter, I will share findings that give us a picture of the challenges that Greg and Sheila encountered in trying to coordinate their beliefs about teaching of mathematics and assessing students accordingly with administering summative assessments and the related school and district mandates. Having more choice and autonomy in relation to the baseline data collection and the formative assessment practices, the transition to summative assessments required them to negotiate tensions.

Alignment of Beliefs and Practices

Summative Assessment

Greg's and Sheila's assessment practices included the administration of summative assessments at the conclusion of a mathematics unit, as well as formative assessments and baseline data assessments. After the four week multiplication unit, Greg administered a cumulative multiplication assessment to the students (see Appendix C). The assessment was more extensive than those they had completed thus far.

On the day of the assessment, the students sat at their own desks. Greg gave each student an assessment and read the directions aloud. After reading the directions, he instructed them to begin. The students were very quiet and appeared to be quite focused. Within two minutes of starting the assessment, Jamie, the student I had observed complete the STAR test, as well as the place value assessment, had begun to draw pictures on her test to help her solve the first problem. Another student drew a number sequence as his strategy for solving the problem. While the students worked, Greg circulated around the room to ensure all of the students were on task. Once he had determined they were working and did not have any questions, he settled into his seat at his desk to plan lessons and allow the students time to work on the problems.

I pulled aside two of Greg's students, Jasmine and Alexis, and administered the assessment to them. Though Alexis had recently joined Greg's class, I worked with her and Jasmine daily during the mathematics block. Both girls had Individualized Learning Plans (IEPs) based upon identified learning disabilities. Their IEPs specify accommodations the girls received on assessments, one of which was having assessments read to them. As quietly as possible, with as little disruption as possible, I read each question to the girls. They listened intently and made any necessary pictures on their test that they felt would help them answer the question. Finally, they reviewed the answer choices and made their selection. As the girls worked, I observed the rest of the class. The students' focus and concentration was evident throughout the whole assessment. One by one, as they finished, they gave their assessments to Greg. As he collected the assessments, the students returned to their seats and worked quietly on a task – reading silently, playing an independent math game, and the like. The assessment took the entire 50 minute mathematics block for the majority of the students. It actually took less time for Jasmine and Alexis, probably because I read it to them. This was an illustration of the numerous roles I played in Greg's classroom – special education teacher, math coach and co-teacher.

A couple months into the school year, Sheila had concluded the second grade unit on data analysis and prepared to administer a summative assessment to her students. The students were sitting quietly at their desks as I entered Sheila's classroom on that warm, sunny November afternoon. She had requested that the students use their office for privacy. The office was simply two file folders stapled together that stood upright during an assessment so that students could focus on the assessment and were not distracted by another student nearby.

Sheila gave each student page one of the assessment, which was the part of the assessment that she created (see Appendix B). There was tally chart at the top of the page that included data regarding favorite school vacations. The three choices, Thanksgiving vacation, winter vacation and spring vacation had three tally marks, five tally marks and two tally marks, respectively. The directions stated, "Jeff asked his classmates what their favorite vacation was. Use the tally chart to create a pictograph." Below the tally chart was an empty grid for students to use to create the pictograph.

Favorite School Vacation						
Thanksgiving Vacation						
Winter Vacation						
Spring Vacation						

Figure 7. Pictograph Template.

After the students created the pictograph, there were six questions for students to answer based on their ability to interpret the data. As students worked, Sheila noticed that many of them were creating a bar graph rather than a pictograph as indicated by the directions. She immediately stopped the students and thoroughly explained what they were to do. In fact, she drew a tally chart indicating students' favorite ice cream flavors as well as a pictograph to represent the data in the tally chart. She used a picture of an ice cream cone in the pictograph, one for each tally mark. As she drew the chart and graph, she explained to the students the difference between a pictograph and a bar graph. After her explanation, many of the students who had created a bar graph erased it and created a pictograph to represent the data in the tally chart. However, some of the students continued to create a bar graph. Even though they created a different type of graph, they were representing the data correctly. Their bars matched the data in the tally chart. This episode revealed Sheila's attentiveness to her students' work. Her dedication to analyzing assessments to identify students learning resulted in the quick mini lesson of transferring data from a tally chart to a pictograph. Without her explanation, she may have concluded their mistakes were based on their lack of conceptual understanding rather than misunderstanding the directions.

A few weeks after Sheila completed her data analysis unit and had begun her measurement unit, Greg was nearing the end of his five-week division unit and planning the administration of his division assessment. The assessment served to provide Greg with information regarding the students' progress on their understanding of division. In addition, he planned to use the assessment to satisfy the requirements on the grading guidelines provided by the administration at the school which indicated that each teacher must record three to five assessment grades in his computerized gradebook.

Greg's division unit began with many hands-on, manipulative based lessons to ensure students conceptually understood division, that is, what it meant to divide a group of items. After a thorough investigation of division, students began to work on different strategies for division and eventually worked on problem solving involving division. Each day, Greg taught a mini lesson on division. Then, students worked on division related tasks – independently, with a partner or in a small group. Each day involved a different task, with all students completing the same four tasks by the end of the week. This format followed the Math Workshop model Greg implemented in his classroom.

I arrived in Greg's room around 1:40 on the day of the assessment, which coincided with when his daily math block began. He had already given the assessment to the students and they were working independently at their desks. The assessment consisted of 18 questions, 6 multiple choice and 12 fill in the blank (see Appendix C). It was based upon the lessons Greg taught during the division unit. He retrieved it from the shared drive, a local network shared by the teachers at Chestnut Hill where documents were available to everyone. Greg purposely chose an assessment that involved some multiple-choice questions. That was a common practice at Chestnut Hill and the reasoning was that it gave students the opportunity to answer questions that were in the same format as the questions that will be on the EYA.

While most of the students worked alone, Jasmine and Alexis did not. As with the cumulative multiplication assessment, Jasmine, Alexis and I sat at a table in a quiet area in the back of the room so that I could read the assessment to them as identified in their IEP. The girls worked to solve each problem, marking their answer choices on the test. As they worked, I periodically glanced at the other students. All of them appeared to be working fervently on each question. I noticed that some students seemed to solve the problems mentally, then make their answer choice, while others made markings on their test in an attempt to solve the problems. I did have an opportunity to walk around the room a couple of times during the assessment and observed that some of the markings students made involved detailed pictures reflecting elaborate arrays or equal groups of markings.

Greg allowed the students the full math hour to complete the assessment. Students who completed it early could choose a quiet math game to play. There were a few students who completed the assessment in what seemed to be a relatively short amount of time, about 30 minutes. Incidentally, Greg told me later that those students who completed the assessment well before the other students were enrolled in the focus program at Chestnut Hill, a program for students identified as gifted learners. During the 2009 – 2010 school year, Greg had a disproportional amount of gifted learners in his classroom. The administrators clustered groups of students into classrooms in an attempt to eliminate many scheduling issues. He explained that this skewed range of abilities in his classroom confirmed for him the necessity to implement the math workshop model.

Analysis of Assessments

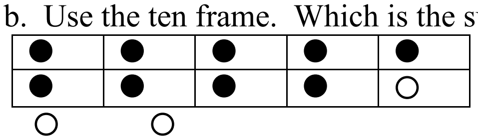
After administering assessments, Greg and Sheila analyzed the assessments in order to determine student learning. During analysis of an assessment, Greg and Sheila made decisions regarding how well students understood concepts based on their responses to the questions. They made notes regarding these determinations and would sometimes refer to the notes during planning for additional instruction. However, referring to the notes was less common for summative assessments than for formative and baseline data assessments.

Sheila also shared with me her experiences analyzing assessments. One of her first mathematics units was the addition unit, including strategies for solving various addition problems. Several days after administering the addition unit assessment to her students, Sheila and I met to debrief. It was a cool autumn morning, around 7:00 AM. Sheila’s afternoons filled up quickly with other professional and personal obligations, so she preferred to meet before school. She explained to me that her class did very well on the assessment. Based on their scores, it indicated to her that “They basically know these math facts – the addition strategies that we had worked on with this chapter.” However, after analyzing the assessment to determine its effectiveness in identifying student learning, there were discrepancies between the standards the questions were suppose to assess and what they actually assessed.

Sheila used the assessments that were available as part of the Harcourt curriculum, including the assessment she chose to administer at the conclusion of her addition unit. As part of the format of the assessment, the state standard for each question was identified on the document. The challenge for teachers was to correlate the state standard to the county standard because teachers and students were accountable to county standards. While the state standards were embedded in the county standards, they were organized and labeled differently.

The Harcourt addition assessment had ten multiple choice questions. The following question was one example.

6. M2N1b. Use the ten frame. Which is the sum?



$$\begin{array}{r} 9 \\ \underline{+3} \end{array}$$

○ A. 12
○ B. 13
○ C. 14

Figure 8. Sample 1 Addition Assessment Question.

According to the resource guide, the question assessed the state standard (M2N1b) which correlated to the county standard “use 10 as a unit, 100 as a unit, or 1000 as a unit to explain relative magnitude of numbers." However, the question did not explicitly assess students' knowledge of this standard. A student's correct response could indicate understanding of the concept, but it could also indicate that the student could perform basic addition computation. While the representation using the ten frame was an effective way to model for students how to utilize benchmark numbers such as 10 to solve problems, a teacher could not be sure that students referred to the model to solve the problem. Without providing students with an opportunity to show how they solved the problem, teachers would be unable to discern the students' strategies, and therefore, would be unable to discern student understanding of key concepts related to place value and relative magnitude.

There were additional questions in the Harcourt addition assessment that Sheila selected which appeared to assess students on standards that were not included on the curriculum map for the first nine weeks of second grade.

3. M2N5a. Which is the missing number?

$8 + \square = 13$

$\square + 8 = 13$

- A. 4
- B. 5
- C. 6

5. M2N2d. Which is the sum?

$6 + 1 = \square$

$1 + 6 = \square$

- A. 5
- B. 6
- C. 7

8. M2N2d. Which is the sum?

$0 + 12 = \square$

- A. 1
- B. 12
- C. 13

Figure 9. Sample 2 Addition Assessment Question.

The assessment questions in figure 2 assessed students on the state standard that correlated to the county standard, “use basic properties of addition to simplify problems (commutative, associative, identity).” However, that county standard was not actually on the curriculum map until the third nine weeks. This discrepancy was not necessarily problematic because the students were able to solve the problems according to the standards that Sheila taught during the addition unit. Therefore, the questions actually involved multiple county standards and a variety of problem solving strategies. While the most obvious seemed to be using the properties of addition, students could also apply strategies Sheila taught during the addition unit, independent of the county standard related to the properties of addition.

The addition assessment that Sheila administered to her students was selected to determine if students had developed an understanding of the four standards identified on the curriculum map.

County Standard	Possible assessment question correlation
add four one digit numbers and develop fluency with basic number combinations	
recognize, copy, predict, extend and describe both repeating and growing patterns	
model and describe equivalent and nonequivalent sets	
use boxes or ___ to represent a missing value	2, 3, 4, 5, 6, 7, 8

Figure 10. Addition Assessment Analysis.

Sheila completed other tasks with her students throughout the addition unit. Those tasks included examples like the *Eight Chocolate Chips* task that Sheila referred to in the *Formative Assessment* section where students had to draw pictures to represent equations and the writing equations task where students had to read a story problem and write an equation to solve the problem presented in the story. It was possible that the other tasks assessed the standards that did not seem to be assessed on the addition assessment. Figure ten indicates that three of the four county standards for the second grade addition unit were not included on the addition assessment. However, it could be that Sheila gathered data from student work other than the identified addition assessment which indicated student learning of the standards. Further, Sheila administered an assessment at the end of the nine weeks that may have included these standards as well. Sheila explained that her students did well on the addition unit assessment, which is indicative of student learning. However, there is a lack of evidence of student learning of the specific identified standards on this particular assessment.

A dilemma for teachers was assessing standards that involved describing a concept. For example, one of the standards listed above, "model and **describe** equivalent and nonequivalent sets" would be quite difficult to assess in the manner that Sheila chose. When choosing an assessment, Sheila did have multiple resources available to her. She could refer to the assessments provided by Harcourt, those included on the shared network at Chestnut Hill, assessments that she created herself and assessments available on the Burton County Public Schools website for teachers.

The next summative assessment Sheila shared was the data analysis assessment (see Appendix B), she and I discussed her students' performance on the assessment. Sheila and I often met before school in her trailer. This meeting time was her preference because she reserved her afternoons for grading papers, lessons planning and preparing for the next day. Occasionally, Sheila left school soon after the students due to family obligations, but those occasions were rare. It was much more common to find Sheila working at school in her classroom long after students had gone home for the day.

I arrived at school the morning of our debriefing a little early. The extra time allowed me to unlock the trailer I shared with two other math specialists and collect my materials I needed to meet with Sheila. As our planned time approached, I gathered my supplies, including my digital audio recorder and headed to Sheila's trailer.

When I walked into Sheila's trailer, it appeared she had already been at school for a while. There was a paper on each student's desk and a message written on the board which explained what students were to do as they arrived. We greeted each other and sat together at an empty table near her desk to discuss the assessment.

Before I said anything, Sheila began by addressing the confusion with the directions on the assessment. We have had a strong, professional relationship for several years, so she was comfortable enough to begin the conversation on her own. She shared…

> looking back on that…I can see why they got confused because the way that it is in Harcourt is that you talk about Venn diagrams first, then it's the tally table, then it's the pictograph, then it's the bar graph. We talked about all that, bar graphs was the last thing that I had actually taught and then I gave them that test and it had about to using a pictograph, even though they should have read the directions. I mean I read the directions to them, but you know I could see why they got confused.

Based on Sheila's comment to me as I left her classroom on the day of the data analysis assessment, one of the first questions I asked her was about her final decision regarding the assessment – would it be a skill grade or an assessment grade? She explained that she decided to label the work as an assessment because she had included a page from the student math textbook which created a total of 20 points on the assessment. Mathematically, the pictograph, which was the item that caused confusion for the students, had minimal value, two of the twenty points, or 10% of the grade. Sheila was confident the resulting grade accurately reflected how well students understood data analysis.

Throughout the debriefing, Sheila commented that the students did well on the assessment and she felt like they had a strong understanding of the data analysis county standards. Our discussion also included a brief analysis of the questions on the assessment. Burton County Public Schools district emphasized the importance of moving beyond knowledge based questions to higher order thinking questions. Sheila and I reflected on the questions on the assessment and she identified them as knowledge based. Though Sheila's conclusions were thoughtful and based on her analysis of the assessment, the assessment did not seem to be as thorough as Sheila had intended in regards to assessing the standards. The majority of the questions, specifically those from the Harcourt assessment, seemed to accurately assess the county standard "interpret picture graphs, Venn diagrams and bar graphs." However, the Harcourt assessment did not include any additional components to assess student learning of the other two data analysis county standards "pose questions and collect, organize and interpret data about self and surroundings" and "collect and organize data by creating simple tables, picture graphs, bar graphs and Venn diagrams." The additional assessment tasks that Sheila created and included as part of the data analysis unit assessment allowed Sheila to determine if her students could create a pictograph, part of the third second grade data analysis county standard. The concern was that while the assessment was thorough in including questions which assessed student learning of "interpret[ing] picture graphs, Venn diagrams and bar graphs," that particular county standard was the least performance based of the three county standards. Students who were able to "pose questions and collect, organize and interpret data about self and surroundings" and "collect and organize data by creating simple tables, picture graphs, bar graphs and Venn diagrams" were more likely to have a deeper understanding of data analysis. Evidence of these two county standards was non-existent on Sheila's data analysis assessment.

However, she said that throughout the unit, her goal was to incorporate lessons and activities that were performance based and required students to show their thinking. Based on the students' progress throughout the data analysis unit and their performance on the assessment, Sheila was confident that their data analysis knowledge had increased and each student had successfully met the standards. She planned to include data analysis questions periodically in her students' homework and as part of their morning work so that she could continue to monitor their understanding.

Sheila also administered a summative assessment at the conclusion of the first nine weeks, end of the 1st nine weeks assessment (see Appendix B). Sheila reviewed and graded each one in order to analyze the results of the assessment and determine how well her students understood the concepts. After doing so, she made notes regarding which students missed which questions. Her notes revealed that the majority of her students did very well…

> I only had about I think about two [students who missed some of the questions], but the thing is that they didn't get them all wrong. They just maybe got one or two wrong, so you know I worked with them on those and I just really think that that was them trying to rush through it and not being very careful with what they were doing.

This analysis description was an illustration of Sheila's dedication to ensuring all of her students understood the mathematical concepts presented to them. If the majority of her class struggled with a concept, she took the time to review the concept, often with hands-on manipulatives. If there were only a few students who needed additional support, she worked with those students one-on-one or in a small group to address their needs. Regardless of her students' differing abilities, Sheila included lessons which met all their individual needs.

According to the second grade curriculum map (see Appendix D), during the first nine weeks of instruction there were eight county standards divided among two mathematics units. At the conclusion of the first nine weeks, Sheila was to gather evidence of student learning of those eight standards. As Sheila indicated, she reviewed the concepts that she taught throughout the nine week period in order to determine questions she would include.

Of the eight standards, it appeared that four of them were included on the eleven question assessment. However, one of the standards, "use boxes or ___ to represent a missing value" was not necessarily indicative of student learning and was the primary county standards addressed in six of the questions. Students who successfully answered those questions may have displayed an understanding of the mathematics concept involved in the question or they may have understood the convention of the "boxes or ____." For example, figure 11 could provide Sheila with data to indicate if her students had an understanding of equivalence and composing and decomposing numbers if it had been posed differently. However, as presented on the assessment the question could not clearly indicate learning of either of those concepts. Correct responses by the students could simply indicate they understand the pattern of the "fact family" including two addition equations and two subtraction equations and that each equation must include the listed digits.

Write the fact family for:
6 3 9

______ + ______ = ______

______ + ______ = ______

______ - ______ = ______

______ - ______ = ______

Figure 11. End of Nine Weeks Assessment Question.

The final two questions on the assessment, “Show a repeating pattern” and “Show a growing pattern” were effective questions for assessing student understanding of the county standard, “recognize, copy, predict, extend and describe both repeating and growing patterns.” The wording of the standard seemed purposeful in that expectations began with recognizing, the first step in understanding patterns, and ending with describing, the most advanced evidence of learning. By allowing students to create their own repeating and growing patterns, Sheila could determine their understanding of recognizing, copying, predicting and extending patterns. The only determination she was unable to make was if students could describe a pattern. While the assessment provided Sheila with useful data for identifying student learning of some of the second grade county standards, she would have to include additional student work to ensure the students had a deep understanding of all of the concepts.

County Standard	**Correlating Question**
26 - add four one digit numbers and develop fluency with basic number combinations	
50 - recognize, copy, predict, extend and describe both repeating and growing patterns	**2 questions**
51 - model and describe equivalent and nonequivalent sets	
54 - use boxes or ___ to represent a missing value	**6 questions**
20 - use multiple representations of numbers to connect symbols to quantities	
21 - represent numbers using a variety of models, diagrams and number sentences	**4 questions**
22 - use 10 as a unit, 100 as a unit, or 1000 as a unit to explain relative magnitude of numbers	
23 - represent two digit numbers with drawings of tens and ones and three digit numbers with drawings of hundreds, tens and ones	**1 question**

Figure 12. End of the Nine Weeks Assessment Analysis.

By the end of the first nine weeks of the school year, Sheila has administered summative assessments to determine student learning of the county standards. Greg’s inclusion of summative assessments which focused on county standards began to emerge during the third grade multiplication unit. At the conclusion of the unit, he administered an assessment (see Appendix C). After collecting all of the multiplication unit assessments, Greg graded each one. When they were all graded, he created a spreadsheet. The top of the spreadsheet listed each question and the students' names were listed along the side vertically. He went back through each assessment, question by question. If a student missed a question, Greg placed an X in the box next to the student's name under the corresponding question number. He followed the same procedure for each assessment. When all of the assessments had been entered on the spreadsheet according to incorrect responses, Greg analyzed the spreadsheet. He decided that if there were any questions that were missed by more than 13 students, which equated to over 60% of the class, he would re-teach those concepts to the whole class as a mini lesson. Furthermore, he would include additional practice on those concepts during calendar, as part of homework and as one of the four tasks during math workshop. For the remainder of the questions, Greg planned to group the students into small groups of four or five and reteach those concepts. After all of the tallies had been made, there were five questions that were missed by 13 or more students – over half of the class. Based on those results, Greg planned to reteach those skills to the whole class. Six questions were missed by three or fewer students. Those skills would not be retaught, but would be included as part of the weekly maintenance piece Greg had incorporated in his classroom – the calendar. The remaining 10 questions would be taught during small group instruction.

Shortly after my meeting with Sheila regarding her data analysis assessment, I met with Greg to discuss the division assessment he administered (see Appendix C). We met the same day he administered the division assessment in order to debrief regarding the students' performance. Greg collected data from the assessments in the same manner he had for the multiplication unit assessment. He created a spreadsheet which listed each question horizontally along the top and the students' names vertically along the side. As Greg checked each assessment for accuracy, he made a tally mark on the spreadsheet next to the students' names which corresponded to the question number. After recording all of the tally marks, Greg noted the trends in the students' errors in order to plan for additional instruction.

During our debriefing, Greg and I discussed how he chose the questions on the assessments. He explained that he had set a personal goal this school year to emphasize mathematics vocabulary related to the standards throughout his lessons, which influenced his decision to include the first three questions regarding vocabulary. Three additional questions were chosen with explicit directions for students to indicate the problem solving strategy they used to solve the problem.

Finally, the reasons for the last six questions were twofold – present division problems embedded within a story and provide additional experiences for students to answer multiple choice type questions. As Greg had explained numerous times, the EYA was multiple choice format, so he wanted his students to be familiar with questions presented in that way.

According to the county curriculum map which identified the county standards, at the conclusion of the division unit Greg's mathematics lessons would enable students to

> explain the relationship between division and subtraction/ division and multiplication
>
> recognize and explain the two models of division: repeated subtraction and sharing model
>
> recognize problem solving situations in which division may be applied and write

corresponding mathematical expressions

explain the different meanings of the remainder in division problems

use a symbol to represent an unknown and find the value of the unkown in a number sentence

demonstrate equivalent relationships using numbers, objects, pictures, words and symbols

Show your work by subtracting with division, drawing arrays, or the multiplication sentence you used
10. 21÷ 3 = _____ 11. 72 ÷ 8 = _______ 12. 36 ÷ 4 = _______

Figure 13. Sample 1 Division Assessment Question.

The question presented in figure 13 had the potential to provide data regarding the students' understanding of the second county standard in the division unit, "recognize and explain the two models of division: repeated subtraction and sharing model" based on the direction for students to show their work. However, the standard indicated the students must *explain* the *two* models. If the students chose to apply the repeated subtraction strategy and record how they accomplished that, Greg may be able to determine their understanding of that strategy, but it would not be based on their verbal explanation. Their understanding would be expressed via their written explanation. One caveat was that the students may have chosen to apply a strategy that was not included in the county standard, a practice Greg actually encouraged. In doing so, he may have lacked the necessary evidence of student learning to "recognize and explain the two models of division: repeated subtraction and sharing model."

The last six questions on the division assessment provided different contexts for solving division problems. Two of the questions assessed students' understanding of division, but did not explicitly address the county standards. While the remaining four questions did not directly assess the students on the county standards, they involved skills that were embedded in the county standards. For example, the third question required an understanding of remainders, but students did not specifically "explain the different meanings of the remainder in division problems" as indicated on the county standard.

Assessment Question	County standard correlation
There are 24 children going to summer camp. Each cabin holds 4 children. How many cabins with the children use during summer camp?	
Chris cooked 15 ears of corn at the picnic. If each person ate 3 ears of corn, how many people were at the picnic?	
Casey wants to buy some candy bars. He has 63 cents. Each candy bar costs 10 cents. How many candy bars will he be able to buy?	**explain the different meanings of the remainder in division problems**
Cathy is making cards for her friends. She made 18 cards and gave them to 6 friends. Which number sentence shows how many cards Cathy gave to each friend?	**recognize problem solving situations in which division may be applied and write corresponding mathematical expressions**
Stephanie is baking apple pies. She picked 39 apples for her pies. Each pie needs 6 apples. How many apples will she have leftover after making 6 pies?	**explain the different meanings of the remainder in division problems**
Naomi decides to cook dinner for herself and 7 of her friends. She decides to make 24 breadsticks. Which number sentence shows how many breadsticks each person will get?	**recognize problem solving situations in which division may be applied and write corresponding mathematical expressions**

Figure 14. Correlation of Assessment Questions and County Standards.

This assessment format challenged Greg to use it to determine student learning of the concept of division. Several of the county standards indicated that students must "demonstrate" or "explain" in order to show their understanding of the concept. Unless students were given explicit directions to clearly show how they solved the problem, as was the case with the questions in figure 13, these questions may not have effectively allowed Greg to identify students' mathematical development of division.

Assessments Informing Instruction

After analyzing assessments, Greg and Sheila used some of the collected data to make decisions about additional mathematics instruction. During the first nine weeks of second grade, Sheila focused her instruction on number sense – effective strategies for adding numbers, the inverse operations of addition and subtraction, place value and the digits' values in a number. She included tasks she could analyze to determine how well her students' mathematical understanding of number was developing. In doing so, she recognized that students were having a difficult time understanding how to decompose numbers into multiples of tens and ones, known as expanded form. This realization came to Sheila after she assigned a task where students had to solve problems like "29 = ________ tens and __________ ones. 29 = ________ + ___________." The majority of Sheila's students responded "29 = 20 tens and 9 ones. 29 = 2 + 9." She explained, "Glancing at these I could see that they were still having a problem with it…then I retaught it." Her reteaching lessons included guided instruction with base-10 manipulatives. The manipulatives allowed students to build two-digit numbers using long sticks to represent tens and small cubes to represent ones. After the students had experienced building the numbers with the manipulatives, Sheila guided them to decompose the numbers into tens and ones and would then use the model to aid them in writing an accompanying equation. Once Sheila had guided them through several examples, she showed the students how to draw pictures of the base-10 blocks and then use the pictures to write accompanying equations. This process involved five lessons. At that point Sheila, felt more confident that her students had a clear understanding of how to write each number in expanded form. However, it was possible that had she included more experiences for her students to work with base-10 blocks and use them to manipulate numbers related to expanded form, they may have performed well on the task initially. It seemed at times that Sheila would move quickly to the abstract and if her students appeared to struggle she would reteach with the concrete manipulatives. This approach seemed ineffective in terms of student learning.

While both Greg and Sheila shared multiple examples of how formative assessments and baseline data assessments help them to inform future instruction, Sheila's explanation of what she did with data from the addition assessment was the only explicit example either teacher shared of how they used summative assessments to inform their instruction. That decision could be that they felt that had completed a great deal of analysis and instruction modification based on student progress throughout a unit and doing so again at the end of the unit was futile. Or, it could be because the teachers felt a great deal of pressure to maintain the pace of the curriculum map.

Negotiating Tensions

Sheila and Greg were faced with many decisions to make regarding teaching and learning. There were tensions to negotiate that influenced those decisions and effected how these teachers navigated through the process. While working with Sheila and Greg, there were three tensions that were significantly more evident than others – grading, the curriculum map and expectations of their administrators.

Grading

Greg and Sheila reflected upon student learning after daily lessons as well as when reviewing assessments they had administered. However, they were also faced with a constant stress set forth as an expectation by their school administration. Greg and Sheila had requirements they must meet regarding the grades they gave their students. This stress was evident in Sheila's statement regarding the idea of eliminating a traditional grading system, "I'm expected to have so many grades and that would take a lot of pressure off me as a teacher and the kids too, to know that they have to perform on these tests, either they understand it or they don't understand it."

The grading practices at this school significantly impacted the way Sheila and Greg thought about and administered assessments. Quite often the teachers referred to the grading policies and procedures to determine if an assessment would be administered at the conclusion of a unit based upon if they had met the expected quota. Further, a task would be identified as an assessment rather than as a skills grade if the teacher determined additional assessment grades were needed. The tension they felt regarding the grading practices limited their ability to select and administer an assessment based upon the needs of the students. The teachers' flexibility and independent decision making regarding the classroom grading system was reduced when stringent requirements were implemented.

Sheila expressed how this tension arose almost immediately at the beginning of the year. The school year was underway and Sheila had begun the task of getting to know her students, academically as well as personally. There was so much to do to set the tone for a positive and productive year and she was cautious to devote the necessary amount of time to create a sense of community in her second grade classroom. Not only did she want to provide the opportunity for her students to get to know each other, she wanted to be involved in the process as well. She wanted her students to get to know her in order to feel comfortable and trust her as their teacher. Woven within this intricate balance of social times with and between her students, Sheila wanted to include sufficient time to get to learn each student's academic abilities. She explained that "it's really kinda hard, especially at the beginning of the year because there's so much that you do the first few weeks like with the routines and just getting to know the kids." On a separate occasion, during the post-interview, Sheila stated that "you spend the first three weeks or more just trying to learn your kids. It's a lot of review, setting expectations, setting procedures, things like that, so the first nine weeks it's really hard to get that many grades." By taking the time early on to learn as much as possible about her students' academic levels, Shelia felt she would be better equipped to meet their individual needs. Sheila made many of these initial decisions regarding her students' academic levels based upon her observations of their participation on activities in the classroom.

Further into the nine weeks, other factors influenced Sheila's choices of assessment. As I left her classroom the day that she had administered the data analysis assessment, she indicated that she may record the students' work on the assessment as a skill grade rather than an assessment grade. Based upon the confusion she observed during the administration of the assessment, she was concerned the assessment would not accurately indicate the students' learning of data analysis. The difference between the two labels, skill grade and assessment, was that an assessment grade had more weight in the computer grading system. Sheila's statement was evidence of her belief that the students' grades should be a true reflection of their ability. If an incident, such as misunderstanding the directions, caused a misrepresentation of the students' ability, she made changes accordingly.

The Burton County Public School district had a computerized grading system. Teachers assigned numeric grades to students' work and entered the grades into a computer program. Based upon previously set percentages, the computer determined the students' grade depending upon the type of task it was – assessment grade or skill grade. Skill grades were considered tasks that students did often, at least weekly, to determine their understanding of a concept.

Assessment tasks were weighted more heavily, often involved several concepts and only administered a few times each nine weeks. When meeting with Greg and Sheila during interviews and debriefing sessions, the topic of grading requirements always seemed to surface. Sheila shared that “we have to have so many grades” and “last year we had to have either 2 or 3 assessments, then we had to have 7 or 8 daily grades. A daily grade would be more like…shorter assessments.” During one particular conversation, Sheila and I were discussing how often she administered an assessment. She responded, “It’s all driven by how many grades we have to have…it’s like you have to have to some kind of a math grade once a week.”

At the beginning of the year, teachers were given these grading guidelines, which indicated how many items teachers were to enter into the grading system. For the skills category, teachers were to enter nine – 12 assignments during a nine-week period. For the assessment category, teachers were to enter three to five assignments during a nine-week period. The advantage for teachers was they could choose the items they would consider to be “skill” grades. As long as they had at least nine and no more than 12, they had the freedom to choose which tasks they would be entered into this category. Conversely, they were given less flexibility with assessment items because they were required to include the county created benchmark assessment as one of the assessment grades. Sheila described interims…

> Heather: Talk about the interim assessment…
>
> Sheila: It’s something that every single second grader in the whole county takes. It’s more or less how we can see what their progress is. They’re using it for some data analysis so we can determine what students need to work on and it’s an indicator, supposedly, of how well they’ll perform on the [state mandated end of year test].
>
> Heather: So, the county creates it?

Sheila: Yes.

Heather: Do you feel like it's pretty much aligned, is it based on the standards you teach?

Sheila: It is…those were based on the curriculum map, the instructional calendar. Pretty much I have found that if I teach what the curriculum map has, then the interim goes right along with what I've taught.

Heather: And the curriculum map has the standards that are based on the state standards.

Sheila: Right.

Heather: But they're still provided by the county…

Sheila: They're [interims] provided by the county. Everybody in the county is supposed to administer it. Then, we use the results to determine, for data analysis, to determine maybe what my class is weak in and what we need to go back and re-teach.

Greg echoed many of Sheila's comments regarding the interim assessment, specifically the intention of the district for teachers to use the assessment to determine students' progress. However, he also shared that the district is very purposeful with the format of the test. The interims served to prepare the students for the EYA. He stated, "They're [the interims] exactly the same format as the [EYA]. There's no open ended questions. There's 'no explain your thinking.' It's straight multiple choice."

Based on the grading and assessment guidelines, Greg and Sheila monitored their students' progress and analyzed student learning by assigning skills tasks and administering assessments. Those skills tasks and assessments were then graded and entered into the computer system. As the end of each nine weeks drew near, Greg and Sheila followed the process for preparing the computerized gradebook to assign students a grade and produce a report card. At the conclusion of each grading period, Sheila explained that "Once we finalize our grades and everything, then there's a report that we print out to give to our assistant principals for them to check. It's kinda like they're checking to make sure you've given the number of grades we need to give." These guidelines served as tension for teachers and influenced their beliefs and practices about assessment.

Curriculum Map

Prior to planning for their mathematics units, Sheila and Greg consulted the curriculum map (aka. Instructional calendar) provided by the Burton County Public Schools district. It was considered the district curriculum and was based upon the state standards. While the state department of education provided a list of the standards as well as a thorough description of the standards, the Burton County Public Schools district went a step beyond that. The curriculum map they constructed, which was based upon the state standards, was shared with the teachers in a more structured format than at the state level. In fact, many educators in the district preferred the term "instructional calendar" because the curriculum map identified the standards in a chronological order, suggesting that teachers follow the order given. The standards were grouped into units based upon their focus. For example, the standards associated with data analysis were all included in the same unit. The curriculum map also included guidelines for how long to spend on each unit. Sheila explained that the curriculum map…

> …is like a pacing guide. It tells me that during this time I need to teach these concepts. During this other time I need to teach whatever [standard] I need to teach. It's really good to follow that because that way you're not jumping around a whole lot and what the kids are learning, one thing it's really difficult, but it's hard for me to jump around in the book though.
>
> … tells you like for this particular [standard] that I need to teach, it tells me

> where in the Harcourt book what pages I need to go to and also in Think Math. It tells me what Exemplars I can use, it tells me different Super Source activities to do.

Greg explained how the curriculum map organized the county standards into a sequential order for teachers. It provided him with the necessary tool to plan instruction for his students.

> for the first nine weeks we had so many lessons and so many ideas and so many concepts we had to get across to the students in that first nine weeks. That curriculum map was a lifesaver. It really helped cement math for me because I need kinda that guideline that says, in this nine weeks you've got to cover these areas

As Sheila mentioned, the district also included other useful instructional tools as part of the curriculum map. The district adopted two curricula that teachers could use as resources to plan lessons, Harcourt Math and Think Math. The two curricula varied significantly. Many teachers considered Harcourt Math to be the more traditional curriculum, while implementation of Think Math was more prevalent among teachers who preferred more non-traditional lessons. However, by following the curriculum map, teachers who used either of the adopted county curricula had a guideline which identified the corresponding textbook chapters that accompanied the standards identified for each unit.

As both Sheila and Greg explained, the curriculum map was an integral component of their mathematics lesson planning. Many years ago, before its inception, teachers planned according to the county standards, but there was not an available pacing guide. The guidance now provided by the map was appreciated, but could cause unwarranted dilemmas for teachers. As aforementioned, each unit on the map had a suggested length. Greg and Sheila adhered to that suggestion as closely as possible. However, there were times when the curriculum map indicated they should begin teaching the next unit, but their students' performance on selected tasks, during lessons and on assessments suggested otherwise. This conflict created a source of tension for Greg and Sheila. Philosophically, they were not comfortable progressing to the next unit on the map. They felt that in doing so, their students would not have solidly developed the mathematical concepts. Conversely, Greg and Sheila knew the students would have to complete the county benchmark assessment that was aligned to the curriculum map at the conclusion of the nine weeks. If their instruction did not maintain the same pace that the curriculum map did, their students would not be prepared for the assessment. Therefore, Sheila felt like she was trying to keep a balance between attending to her students' academic needs and instructing in accordance with the curriculum map. Greg worked hard to ensure his students were thoroughly prepared for the county benchmark assessment while allowing them time to fully develop their mathematical ideas.

The assessment that Sheila administered to determine student learning of the concept of addition during the first nine weeks was included as part of the Harcourt Math curriculum that she used for the majority of her mathematics lessons. While she followed the curriculum map provided by her district, which identified the county standards to teach throughout the year, when to teach them and about how long to spend on each unit, her main resource for planning lessons was Harcourt Math. She told me, "I follow Harcourt. I mean that's my guide. I throw some other math games and all that stuff in but for the most part Harcourt really is my guide." Harcourt Math was one of two curricula adopted by Burton County Public Schools district. Not only did the curriculum map list the county standards, it also provided the related vocabulary and available teaching resources, including curriculum that teachers could use for lesson planning.

Throughout each unit and at the conclusion of each unit, Sheila was faced with making decisions about assessment. She said…

> If I follow the curriculum map, assessment comes from the county, the big assessments, as long as I follow the map then the assessment, everything that's on the assessment should be covered. I do some other assessments. When I finish a unit in Harcourt, there's an assessment that goes along with that, if I think it's a good assessment I'll use that. If not then I may just use the chapter review that's in the book.

The curriculum map served as a pacing guide for teachers to follow to ensure the taught the standards for their grade level. While it was a useful resource for planning sequence for teaching the standards through the year, it also created a source of external tension for the teachers. The third grade curriculum map indicated two weeks for place value, but it's unlikely that students would come to any real understanding of place value in that amount of time, creating a tension that shows up when children failed this assessment. Teachers were not afforded with time to allow for additional instruction on concepts that were particularly difficult for students.

Administrators

Greg discussed that one of the frustrations he had with mandated assessments such as the EYA was their format. The assessments appeared to be problem-based; however, the format was multiple-choice, eliminating any opportunity for the students to show their thinking. He felt pressure to include multiple choice assessments in his classroom as a result of the perceived message from the administration at Chestnut Hill and from the Burton County Public Schools district that the assessments he administered should be preparing students for the EYA in every way, including the format. While he appreciated the purpose of the state mandated EYA, he did not deem them as valuable as the Exemplars he used for increasing student understanding. Greg did admit, however, that student performance on problems such as Exemplars and the EYA "should correlate. If a child understands concepts and can explain how they got an answer, then it should come out on multiple choice type questions." Even though this observation may be true, Greg did not feel he had the freedom to draw this conclusion and made the decision to eliminate Exemplar type assessments as a basis for an assessment grade in his classroom based on the district requirements. As he explained, he used Exemplars as a mean for assessing students quite extensively, but he did not include them as one of the 3 – 5 required assessment grades.

The administration and leadership team at Chestnut Hill provided support and guidance for teachers during weekly grade level meetings. As part of this support and guidance, many policies and procedures were put in place to ensure consistency among the teachers. The consistency referred to the grades teachers assigned, how they formulated the grades and other school wide expectations. Consistency was not required in how teachers planned lessons or how they set up their classroom. Teachers were allowed some independence and flexibility in that they may create their own lesson plans, including which resources they would utilize. Teachers were professionals and were expected to maintain a classroom aligned with the expectations of the administration and of the school system.

There were numerous resources for teachers to use to ensure they were following the policies and procedures set forth by the administration. The majority of the resources could be found on the local computer network at Chestnut Hill. For example, there was a document, Grading and Assignment Guidelines (2009 – 2010), which was located in the electronic handbook. The guidelines were explicit about how teachers were to organize items they collected from students and assigned as grades. The document stated:

> The guidelines for minimum/maximum assignment requirements must be followed to ensure that grades accurately and statistically reflect student performance.
>
> Assignments/grades should be spaced throughout the 9 weeks period and entered in a timely manner (e.g. weekly).
>
> Students (and their parents) should be kept informed of their grades in a consistent and timely manner (Friday folders, printed or email grade reports, etc.).
>
> The degree of student participation should not be included as part of the assignment or skill grades, but should be reflected in the EFFORT grade given for each subject area.

While this document was helpful, especially for new teachers, it created some confusion regarding student learning. Teachers interpreted these guidelines as an effective way to collect data regarding student work and indicators of how students were making sense of their learning. The caveat was teachers must have a clear understanding of using an assigned task as a true reflection of student learning. Too often, as shared by both Sheila and Greg, teachers began to feel the pressure of satisfying these requirements and would assign random tasks, grade them and enter them into the computer system to ensure they were in compliance with the grading assignment guidelines, regardless of whether or not the assignment was truly reflective of the students' mathematical abilities. Teachers like Sheila and Greg had worked closely with their colleagues, had participated in numerous professional learning classes and had collaborated closely with the math coach and were able to carefully select items that were chosen as grades. Furthermore, they analyzed the items to make instructional decisions.

Burton County Public Schools district prepared its teachers each year to be well equipped educators by providing the necessary resources for instruction. The mathematics resources included classroom manipulative kits, student manipulative kits, textbooks and teacher resource books. Along with those valuable materials, the district expressed its expectations of teachers, published as part of their Quality-Plus Teaching Strategies.

> These research-based proven and effective instructional strategies, when employed consistently in classrooms across subject areas and across grade levels, ensure engaging instruction and assessment that result in [Burton County Public Schools] students achieving world-class standards.

Those strategies were organized into 13 categories, one of which was assessment. The specific assessment strategy that the district expected teachers to implement was to "frequently assess students' learning of the [county standards] and give specific feedback to students and parents." To ensure that teachers clearly understood the strategy, the district provided suggestions that would indicate evidence of the strategy. One such suggestion was for teachers to assess their students on a regular basis so that they could identify specific "progress toward the [county standards] in order to determine next steps for instruction."

Throughout my conversations with Greg and Sheila, it was apparent that they met the expectations of their county as well as their administration. They satisfied the grading requirements of the administration at Chestnut Hill. They incorporated the Quality Plus Teaching Strategies produced by Burton County Public Schools District. Our conversations often had similar themes – student learning, effective instruction and conceptual understanding. In their classrooms, Greg and Sheila had developed intricate, thoughtful plans and procedures for connecting assessment and instruction. Our time together revealed their focused commitment to teaching and learning.

CHAPTER 7

CONCLUSION AND SUMMARY

The data was collected and analyzed…now what? This is the perpetual question on the minds of researchers as they prepare to share the conclusive statements about their research. Questions to consider for this study are: What conclusions can be made about mathematics assessment in Sheila's and Greg's classrooms? What tensions were involved in the decisions Sheila and Greg made about mathematics teaching and learning?

In order to answer these questions, I will first present a review of what we learned from Greg and Sheila, specifically how and why they chose their mathematics assessments, how the assessments were analyzed and how they created lesson plans in anticipation of assessments and in response to their students' performance on the assessments. This discussion will include available resources and expectations Greg and Sheila had to negotiate as teachers of Chestnut Hill as well as of Burton County Public Schools. After the discussion about mathematics assessment, I will explore the relationships between my theoretical framework and the findings of the study. Then, I will consider the implications for my role as a professional learning instructor as well as a mathematics coach. Next, I will examine the tensions that arose in my study and suggest recommended future investigations to address those tensions. Finally, I will propose implications for future research.

Findings Overview

Greg demonstrated the ways that assessments provided him with the necessary information to plan how to bridge gaps in students' mathematical understandings. Carefully selected assessments that he administered enabled him to identify students' understandings of particular concepts, such as multiplication and division. In addition, by analyzing the assessments, Greg ascertained misconceptions his students had of specific concepts, such as place value and multiplication. The results provided by those assessments helped Greg to make instructional decisions, including developing lessons that addressed misconceptions and deepened students' understanding of mathematical concepts.

Sheila explained how mathematics assessments played a vital role in the teaching and learning in her classroom. The assessments allowed her to identify how well her students' understanding of mathematical concepts had developed as a result of her meticulously planned lessons. After she administered an assessment, she analyzed it to determine the effectiveness of her lessons as well as student learning.

Sheila and Greg shared how the assessments they administered served a variety of purposes in their classrooms. The majority of the assessments Sheila administered to her students were purposefully selected in order for Sheila to determine her students' mathematical understanding of concepts she taught during her mathematics block. Based upon the curriculum map provided to Sheila by Burton County Public Schools, she planned lessons that she deemed would enable her students to have a better understanding of the mathematical concepts. After she taught lessons and felt she had adequately addressed the standards, Sheila referred to her available resources to find an assessment. The county adopted curriculum, Harcourt Math, provided Sheila with many assessment options. Quite often, she was satisfied those assessments would provide her with the necessary data to make instructional decisions about her students. However, there were times when Sheila felt that she needed to supplement the Harcourt Math assessments with assessments that she created. Those decisions were made after Sheila had reviewed the assessments and realized they would not effectively tell her if her students had a deep understanding of particular concepts addressed in particular standards.

Sheila implemented the same analysis plan for each assessment she administered. First, she reviewed each student's work, checked for correct responses and assigned a grade. After the grades had been assigned, she reviewed the assessments a second time. During the second review, Sheila made notes regarding trends she noticed in students' errors. For example, if several students missed the same question, she analyzed the assessment further to determine if the errors were a result of the students' lack of understanding or if the lesson(s) she planned was not effective. There were times when Sheila administered an additional assessment that focused just on the concepts addressed by those identified questions. The additional assessment served to help her determine the source of the errors – students' misunderstandings or ineffective lessons. If Sheila determined that the large number of incorrect responses was actually an indication of a lack of understanding of a concept, she searched for ways to reteach the concept to her students. At times, less than 30% of her students missed a question, but it was still a concern for Sheila, so she worked with those students in a small group.

Similarities existed between Sheila's classroom assessment approach and Greg's classroom assessment approach. Greg also administered assessments to his students after he taught a mathematics unit based on his interpretation of the county standards. The length of the unit varied depending upon its content, but at the conclusion of each unit Greg assessed his students in order to determine their mathematical understandings of the concepts. His analysis of assessments was often more elaborate than Sheila's analysis. Greg created a spreadsheet for each assessment that indicated which questions each student missed. At a glance, he was able to determine patterns in the students' errors, specifically if there were questions missed by a significant number of students. Based upon the spreadsheet, Greg identified concepts in the standards he needed to teach again to his entire class and concepts in the standards he needed to address with small groups of students.

While Greg also administered assessments to determine his students' mathematical understanding after teaching a series of lessons related to a set of standards, he had other purposes for administering various assessments. At the beginning of the year, Greg administered the computer-generated STAR test. The STAR test allowed Greg to identify an academic level for each of his students associated with number sense, place value and computation. That assessment data enabled Greg to plan lessons for the first couple weeks of school that would address possible misconceptions or lack of understanding that his students had about number sense, place value and computation. He administered the STAR test two more times throughout the year to determine student growth. However, the initial administration of the assessment was the only time that Greg thoroughly analyzed the results and planned subsequent instruction.

There were additional assessments that provided Greg with data he used to group students flexibly and homogeneously. Greg's mathematics block resembled what Greg called a workshop format. Each day, he taught a whole group mini lesson to his students. The students then worked independently, in pairs or in small groups on an assigned task. While the students worked, Greg pulled small homogeneous groups and continued the mathematics lesson. In order to organize these groups, Greg's students completed an assessment prior to the beginning of a unit. Greg checked the assessments for planning purposes only, not for a grade. Based on the percentage of questions students answered correctly, Greg grouped them into one of four groups – students with less than 60%, students with a score of 60% – 75%, students with a score of 76% – 85% and students scoring 86% – 100% were in different groups. The groups were flexible;

Greg shifted students between groups throughout the unit based on their performance during small group lessons. By utilizing the assessments in this way, Greg formulated his small groups systematically.

Greg implemented another assessment in his classroom, Exemplars, to purposefully challenge his students to solve problems embedded in a context, communicate their mathematical ideas for solving the problems and record those ideas as part of their justification of their solutions. Greg's philosophical beliefs regarding the importance of providing students with the necessary experiences to develop their mathematical ideas were reflected in these tasks. He explained how critical it was for students to deepen their mathematical understanding of concepts by engaging with these problems.

Throughout the implementation of various assessments, not only did Greg and Sheila consider the purpose of the assessments, but they also contemplated what the assessments would look like. Greg used the greatest variety of assessment formats. Some of his assessments were open-ended tasks that involved multiple skills and were linked to his goal of engaging the students in problem solving, while others were basic multiple-choice questions. Greg explained his inclusion of multiple-choice-type assessments by alluding to the fact that for several years it had been the practice of educators at Chestnut Hill to include many assessments and tasks that were multiple-choice, the same testing format on the State Standardized test (EYA). The premise behind this practice was that students would be familiar with the multiple-choice format and comfortable answering those types of questions, hence increasing the likelihood that they would perform well on the EYA. Sheila also administered many assessments that were multiple-choice format. At times she included fill-in-the-blank questions and open-ended questions, but the majority of questions on her assessments were multiple-choice.

When considering an assessment to administer to their students, Greg and Sheila had many resources available to them. Burton County Public Schools had adopted two different curricula, Harcourt Math and Think Math. Teachers were encouraged to use either of the curricula, or both of the curricula, based on their instructional style and the needs of their students. The implementation of the curricula varied from classroom to classroom. Neither Sheila nor Greg accessed Think Math curriculum, one of the two curricula adopted by the county, while planning lessons or assessing students. However, Sheila incorporated Harcourt Math several times a week, while Gary referred to a page in the Harcourt student math textbook once a week or every other week. Neither method was preferred by the county. Teachers were afforded the flexibility to determine on their own the extent to which they would use the curricula.

Both the Harcourt Math curriculum and the Think Math curriculum included assessments. When Sheila neared the end of each of her mathematics units, she referred to the Harcourt curriculum and reviewed the assessments. Then, she chose an assessment to administer that she felt would adequately assess her students based upon the concepts she taught. Or, alternatively she created her own assessment to administer to the students. Though Greg used the Harcourt curriculum sparingly for instruction, he did utilize many of the assessments in his classroom.

Chestnut Hill maintained a strong emphasis on collaboration among teachers. Based on that spirit of teamwork, teachers often shared assessments they had created with their colleagues. There was a common computer network available to teachers where they could save documents and other teachers also had access to them. Greg and Sheila participated in this group effort.

They referred to the assessments on the shared computer network and selected those that were most appropriate for their students.

In addition to the local computer network that Sheila and Greg accessed at Chestnut Hill, the Burton County Public Schools created a website for teachers that provided many resources, including assessments, lesson plans and the curriculum map. The assessments were created by Burton County Public schools teachers and county math specialists. The lessons, which were aligned to the curriculum map, provided teachers with clear, thorough instructional plans that included "quality plus" teaching strategies that were published by the school district. By embedding the teaching strategies within the published lesson plans, the district continued to communicate to teachers the importance of the strategies and the expectations regarding their use. When planning for lessons, Greg and Sheila referred to the website often to access lesson plans and suggestions for effective teaching strategies.

Greg and Sheila explained their beliefs in using assessments to determine student learning and analyze the results to plan mathematics lessons. However, throughout the discussions, they expressed concerns they had regarding various tensions they felt that affected their assessment and instructional decisions. Those tensions included concerns with meeting the expectations of the school guidelines for grading, planning instruction according to the district curriculum map and maintaining the instructional pace demanded by the curriculum map, and , at the same time, ensuring that their philosophies of teaching were reflected in their classrooms.

The teachers were expected to follow the guidelines for grading requirements set forth by the administration at Chestnut Hill. When the teachers received the requirements at the beginning of the school year, the administrators explained that the purpose of the document was to ensure consistent grading practices among the teachers. Prior to the development of the guidelines, there was a large grading discrepancy from classroom to classroom. While one teacher might determine her students' grades in mathematics based on four graded tasks and two assessments, another teacher on the same grade level might make the same determination according to the results of 14 graded tasks and five assessments. Administrators considered these kinds of disparities in numbers of assessments administered across classrooms as problematic. The key argument that was not addressed was that if the tasks and assessments were authentic and were truly effective at identifying student learning, the quantity of items recorded in a teacher's gradebook was irrelevant. We saw with Sheila and Greg that they invested time each week selecting assessments that they felt enabled them to identify student learning. However, Sheila expressed nearly every time that we met to debrief about mathematics assessment that she sometimes included tasks depending upon how many grades she had in her gradebook, rather than selecting tasks and assessments that were reflective of the students' mathematical ability. The concern is that if teachers feel the need to satisfy a certain number of grades, they may lose sight of the purpose of assessment, which is to identify student learning and plan additional instruction according to students' needs.

In addition to the grading guidelines provided to Greg and Sheila by the administration at Chestnut Hill that they were to use as a resource for planning assessments and mathematical tasks, Burton County Public Schools gave each teacher a curriculum map to follow in order to plan instruction. Greg and Sheila explained that the map organized the county standards into units based on six strands – process skills, numbers and operations, geometry, measurement, algebra and data analysis and probability. The curriculum map served as a pacing guide for the teachers. It indicated which units were taught during each nine week period, how long the units should last and resources available to teachers for planning lessons for the units.

While both Sheila and Greg expressed how useful the curriculum maps were, there were tensions they had to negotiate while planning lessons according to the standards identified on the curriculum map. At times, the map indicated that the timeline for a particular unit had expired and it was time to move on to the next unit. However, based upon assessments that were administered to the students, the results indicated that the students were not ready to move on to another unit. They needed additional time developing the concepts presented in the current unit. The caveat was that if Greg and Sheila truly followed the expectations of the school system and used assessments to inform instruction, there would be times that their lessons would not align to the curriculum map, the very map that the county distributed and expected teachers to follow. In fact, they would continue to teach a previous unit on the map rather than the suggested unit. Furthermore, in outlining a uniform pacing guide for all teachers, there were factors that were overlooked that classroom teachers had to face every day. Sheila had a particularly challenging situation in her classroom during the first several weeks of the school year. One of her students disrupted her instruction almost daily, which made it difficult for her to adhere to the curriculum map. She said…

> We have the curriculum map that we're supposed to go by, but then there's so many factors that are involved…I have that little friend in my room that really prevented me from doing a lot of my teaching that I needed to because I had to stop my instruction and redirect. There's too [many] other factors, I mean, honestly, I'm probably behind where I need to be in my teaching because I had to deal with all that since the beginning of the year.

Sheila's predicament was one many teachers encounter each school year. Whether it is a disruptive student, learning new standards, spending additional time on concepts or reteaching concepts, which in turn takes away from instructional time of other concepts, teachers create a balance in their classroom among all of these factors as they make decisions about how much time to spend on teaching and learning each concept for their particular group of students.

An additional limitation to the county expectations regarding the curriculum map was the benchmark assessments. Two times during the first half of the year, the teachers were required to administer a county-created benchmark assessment that aligned to the curriculum map. After administering the benchmark assessments, the data administrator at Chestnut Hill compiled the results of each class as well as of the grade level as a whole. Teachers met as a grade level to review the results and identify areas that needed improvement. If teachers followed the map and adhered to its timeline, students were expected to do well. However, as mentioned earlier, teachers struggled to maintain a balance between following the map and teaching at a pace that suited the needs of their students. If they paced their instruction based on the needs of their students and that pace was not aligned to the pace indicated on the map, their students might not do well on the benchmark. Their performance would affect the grade level results and could skew them to indicate that the third graders were weak in a particular area when in fact their *weakness* was actually because their teacher had not taught that standard yet.

Greg and Sheila were experienced, dedicated teachers. Based upon their own educations and their teaching experiences, they had theoretical underpinnings for their ideas about mathematics assessment. During many of our interactions, they communicated their beliefs that mathematics assessments identify student learning. Effective mathematics assessments enabled Greg and Sheila to determine their students' mathematical strengths and weaknesses. By making those identifications, they planned instruction to meets the needs of all their students. They were able to analyze mathematics assessments in order to make instructional decisions about their students.

However, while working with Greg and Sheila, tensions between their beliefs about mathematics assessment and the expectations of the administration at Chestnut Hill Elementary School as well as of Burton County Public Schools began to surface. They attempted to maintain a balance between their philosophical beliefs about mathematics assessment and the realistic policies and procedures that were part of their daily lives at Chestnut Hill and the perceived messages from their administrators at the local school level and at the county level.

Greg and Sheila felt empowered to plan instruction for their students in response to analysis of mathematics assessments, including choosing which resources they would utilize. However, they recognized that the district administrators expected all teachers to follow the curriculum map. That expectation was non-negotiable. When planning lessons, teachers were to refer to the map that identified which standards to teach, when to teach them and how long to spend on each unit.

Role of Constructivism

There are connections between teachers' understandings about mathematics teaching and Constructivism as well as teachers' understandings about assessment and their practices of assessment that I had not thought about when I began conducting this research. It is complex to help teachers understand the principles of Constructivism, to implement it in today's culture and to make sense of it. There is more to these complexities than I realized when I began this research. As I observed the teachers, closely examining their practices, and as I listened to what they shared about teaching and assessment, I began to recognize the complexities in truly understanding Constructivism. My research design did not address those connections, specifically with the interview questions and the observations of mathematics teaching in the classrooms. Future research would need to include explicit questions regarding teachers' beliefs about student learning and observations of their teaching and interactions with students to determine a clearer picture of their ideas their about Constructivism.

Secondly, in the study I conducted, there were some hints and indications of teachers' practices that mathematics researchers generally assume to be part of an application of Constructivist theory in reform mathematics teaching, but there were missing pieces. For example, I saw some evidence of social interactions among students, in fact, Greg strongly encouraged that practice. However, I did not see evidence of teachers' deliberately scaffolding students' understandings of mathematics concepts and very little evidence of effective use of manipulatives in supporting children's mathematics learning. I recognize now, that in order to develop a deep understanding of teachers' connecting of assessment to instruction in mathematics, that I would need to develop a deeper understanding of teachers' understandings of mathematics teaching and learning, including their understandings of and enactments of reform mathematics teaching approaches that build on constructivist theories.

Professional Learning Implications

As a mathematics professional learning instructor, there are several findings from this research I will draw on in planning my work with elementary teachers in relation to mathematics assessment. Based upon the conclusions I outlined regarding the identified tensions teachers must negotiate at Chestnut Hill, as a professional learning instructor I plan to provide an opportunity for teachers to learn about approaches to assessment beyond those provided by the district and the textbooks, such as analysis of student work and how to utilize it to identify student learning. The professional learning would enable teachers to identify each of their student's mathematical understandings independent of a numeric grade. Empowering teachers in this way could create a more meaningful grading system and the teachers' choices of tasks and assessments to include as part of the students' grades could be more thoughtful.

The professional learning could also include how to effectively observe students' interactions with each other as another approach to assessment. If teachers could observe students through a student learning lens rather than a classroom management lens (i.e., What are the students learning? vs. Are the students doing what I asked them to do?), they would be able to determine the extent of the students' understanding of a concept. This determination could allow teachers to plan for more individualized instruction to meet the needs of all students.

Finally, during professional learning sessions, I would like to model for teachers how to conference with students and scaffold student learning while the students are completing a mathematical task. By learning and investigating effective ways to question students that challenge the students' thinking, teachers could have a better understanding of the students' problem solving strategies and then how to effectively scaffold their development of new problem solving strategies. Teachers could also use the conferencing approach to identify possible misconceptions, as well as students with more advanced understandings and potential for more elaborated understandings of challenging concepts. Furthermore, the conferences could serve to challenge the students to justify their solutions and articulate their mathematical ideas. The conversations between the teachers and students could provide the teachers with richly contextualized information to plan further instruction that builds on particular students' strengths and needs.

By analyzing student work, observing students' interactions and effectively conferring with students, teachers would have a more effective set of the necessary tools to pinpoint student learning. This knowledge could ensure that the teachers would be better equipped to make instructional decisions that are reflected in the students' grades. The grades could then become a more accurate reflection of the students' mathematical performance rather than just a set of tasks recorded to meet a requirement set forth by administration. These tools could also enable teachers to make more informed decisions regarding assessment. Those decisions would include selecting meaningful, engaging assessments that provide useful information for teachers to interpret and use to guide lesson planning. Part of our conversations in professional learning settings would need to address the challenges teachers will continue to face as they choose assessments and negotiate district requirements for assessment and grading that may be difficult to reconcile with teachers' desires to meaningfully assess students' understanding of mathematical concepts.

Mathematics Coaching Implications

The tensions teachers identified also revealed implications for my role as a mathematics coach. Based on conversations with Greg and Sheila, there were contradictions that existed for teachers regarding assessment and grading policies. Clarifications need to be made for teachers regarding these two areas. Both assessment and grading have a significant place in the classroom, but there is a gap in understanding of how the two are related. During my daily work with teachers, I plan to ensure our collaboration includes discussions of how to formulate a grade for each student that reflects the student's mathematical understanding of the standards. My plans as a professional learning instructor will be closely connected to my plans as a mathematics coach, but the major difference is that as a professional learning instructor, my goal will be to teach about observing students' interactions, conferencing with students and analyzing student work. As a coach, my interactions with the teachers will be based on the assumption that they have an understanding of the ideas that I will share during professional learning sessions and are ready to apply that understanding to discussions of assessment and grading.

Investigation of Tensions

There are questions that need to be investigated with further research related to the tensions I identified in my research. First of all, how do teachers follow the map and teach the standards to students who do not exhibit the necessary prior knowledge? Based on the STAR test, Greg identified several of his students whom he felt were not mathematically prepared to begin the place value unit that was on the curriculum map as the first unit of third grade. Greg's philosophy of education would not allow him to ignore what the STAR test had identified about his students' understanding of place value. So, he took a risk and spent some time at the beginning of the year reviewing place value concepts from second grade in the hopes that his students would soon be ready for the third grade standards.

Secondly, while the requirements and expectations set forth by the administration at Chestnut Hill probably had the best of intentions regarding teaching and learning, how could teachers meet those requirements when they did not align with their philosophy of education? There were contradictions in Burton County Public Schools district policies. According to the district's quality plus teaching strategies publication, teachers were to use assessment to inform instruction. However, when they did use assessment to inform instruction and those assessments indicated that students needed additional time to develop concepts, that time was not planned for in the rigid curriculum mapping pacing requirements.

Finally, it was evident when observing Greg and Sheila in their classrooms during mathematics instruction that they believed incorporating manipulatives in their mathematics lessons was critical in order to ensure that students thoroughly developed the concepts presented in the standards. But once again, Greg and Sheila were troubled by attempting to meet the expectations of the administration and adhering to their philosophy of education. The expectation was to record nine to 12 skills grades each nine weeks. Greg and Sheila equated skills grades to paper and pencil tasks where students practiced skills related to the standards. For Greg and Sheila, those paper and pencil tasks did not involve manipulatives. While they felt that students were able to show their learning most effectively by using manipulatives to represent mathematical ideas, Greg and Sheila felt they had to base their students' grades on the paper and pencil tasks that may not be as indicative of student learning.

Contributions to the Field of Mathematics Teaching and Learning

This study adds to the literature regarding mathematics teaching and learning at the classroom level. Eisenhart et. al. (1993) explained Ms. Daniels' experiences as a new teacher of mathematics and the tensions she faced as such. Likewise, we learned about Gary's and Sheila's personal experiences as mathematics educators and the tensions they negotiated in working to link their assessments with classroom instruction in mathematics.

In the mathematics education field, we need to continue to explore the disconnect between what teachers say they believe about mathematics learning, specifically conceptual understanding, and how those beliefs are or are not reflected in their teaching and assessment practices. We also need more research about how to effectively support teachers in making more systematic and meaningful connections between their beliefs about mathematics learning and philosophies about teaching, and their enactments of teaching and assessment with students. Further, we need to explore teachers' understandings of conceptual understanding. Sheila believed that conceptual understanding was important. She even articulated what that meant to her and her students and examples of conceptual understanding in the classroom. However, her belief that automaticity was essential to student learning in mathematics seemed to overshadow her beliefs about the value of students' conceptual understanding. She argued, based on her own studies in mathematics education, that students must have fact fluency in order to effectively develop their conceptual understanding. Beyond this focus on fact fluency, it was not clear what other perspectives about students' conceptual understandings Sheila incorporated in her mathematics teaching and assessment.

There have been separate research studies regarding mathematics assessment and other research studies regarding mathematics instruction, including many recommendations in mathematics reform documents about what the two should look like. But, there is a gap in the reform and research literature that examines *both* mathematics assessment and mathematics instruction and how the two are related. The research connecting the two should include further exploration of the tensions teachers face when trying to grapple with the relationship between mathematics assessment and mathematics instruction.

For teachers, this study could contribute to their understanding of how lesson planning and planning for assessments are not independent tasks. While planning for mathematics instruction, teachers are required to identify and/or create lessons that align with mathematics standards. We need to better understand, and help teachers analyze, the ways in which particular instruments selected by the teachers, or required by district or school policies, effectively and thoroughly, or not so effectively and thoroughly, assess the concepts that have been the focus on mathematics lessons the teachers taught. The pictures I developed of Greg's and Sheila's mathematics assessment and teaching practices, could provide a starting point for teachers and mathematics educators attempting to make more systematic and meaningful connections among their plans for teaching and their plans for assessing mathematics learning.

In addition, the study of Greg's and Sheila's varied purposes for and uses of mathematics assessment can provide an approach for teachers to consider when analyzing assessments. Rather than treating all assessments simply as evaluation or grading tools, teachers could explore ways to use the assessments to evaluate their teaching, as Sheila did, or to get baseline data and ongoing formative assessment data to guide more tailored instruction linked to flexible grouping, as Greg did.

Implications for Future Research

In addition to the questions regarding the tensions at Chestnut Hill that require further research, there are questions that continue to linger after having completed the study. Questions for future research are:

- How would an elementary school teacher implement an assessment plan where the majority of the assessments were embedded in context-based problems?
- How does the assessment process implemented in elementary school classrooms serve or not serve the students?

The first question evolved from my experience learning about Exemplars in Greg's classroom. He repeatedly emphasized how effective the tasks were at challenging students to solve a problem and record *how* they solved the problem. At one point during one of our discussions, Greg indicated his belief that if students were allowed to thoroughly develop their mathematical ideas in response to these types of problems, students would also be successful on the EYA standardized assessments that are multiple-choice. To further investigate Greg's assertion, a study could identify student learning in a classroom involving the implementation of these Exemplar assessments, and examine to what extent student learning evident in the

Exemplar assessment was reflected or not in student performance in EYA multiple choice assessments.

In order to answer the second question, the research would involve assessment from the student's point of view. One possible component would be to include descriptions of instructional decisions made for individual students based on their assessment results. Many of Greg's and Sheila's instructional decisions were made by analyzing the assessments as a whole. From those analyses, Greg and Sheila made instructional decisions for small groups of students or for the whole class. An additional component would be to track students' progress from assessment to assessment as a result of instruction. In Greg's and Sheila's classrooms, each assessment was viewed as independent of the others. Connections were not made between the assessments. By viewing the assessments from the student's perspective, each assessment would be categorized as a piece of the collection of assessments that provided evidence for student learning and could serve as an illustration of the student's mathematical development.

Not only did my study provide ideas for possible future research, it provided insight into areas of my study that could be further developed. As mentioned previously, I specifically chose a second grade teacher and a third grade teacher to participate in my study because the trend at Chestnut Hill had indicated a significant difference between students' performance in mathematics between second grade and third grade. However, my study did not provide much evidence to identify the reason for this trend. Future research focused more specifically and comprehensively on this trend could better support those two groups of students and teachers.

While analyzing the data, I began to notice a shortcoming of the study. During the interviews and de-briefing sessions, Greg and Sheila mentioned the idea of conceptual understanding quite often. However, I did not investigate thoroughly what they meant by conceptual understanding. There were instances when they gave examples to support their interpretation of conceptual understanding, but having reached the end of the study, I have decided that future research should include questioning teachers at length about what *conceptual understanding* means to them, both in terms of their teaching and their assessments. As a researcher and mathematics educator, I need to further develop my own understandings of how "conceptual understanding" is understood in current thinking and research about mathematics teaching and learning in assessment before I undertake further investigations with teachers.

My experience with Greg Jenkins and Sheila Moreno provided valuable insight for me, as a mathematics educator and researcher, as a professional learning instructor and as a mathematics coach. I was able to identify how these two teachers construct relationships among mathematics assessment, mathematics instruction and student learning in their classrooms. Furthermore, Greg and Sheila showed me how they analyze the assessments and use the subsequent results of their analyses in mathematics lesson planning. I learned how Greg and Sheila define mathematics assessment, examples of mathematics assessments they administer in their classrooms and why those assessments are chosen. Finally, Greg and Sheila explained how mathematics assessments were enacted in their elementary school classrooms and showed me the tensions that emerge as they make decisions about assessment and instruction to support their students' learning and negotiate with school and district requirements regarding assessment and grading. As a result of my research with Greg and Sheila, I can share with other educators the story of mathematics assessment and teacher in two elementary school classrooms and can consider with others the implications for supporting effective mathematics assessment and teaching in elementary schools.

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APPENDIX A

METHODOLOGY DOCUMENTS

Data Collection Methods and Collection Dates

Data Collection Method	Date of Collection
Interview 1 with Sheila	8/09
Interview 1 with Greg	8/09
Exemplar assessment in Greg's class	8/26/09
STAR math test in Greg's class (Jamie only), including notes	8/27/09
De-briefing with Greg – Exemplar and STAR math test	9/2/09
Number sense assessment in Greg's class	9/8/09
Planning with Greg – multiplication unit and de-briefing of number sense assessment	9/11/09
Addition assessment in Sheila's class	9/16/09
Addition assessment de-briefing with Sheila	9/24/09
Multiplication pretest in Greg's class, including notes	9/28/09
Observation of calendar lesson in Greg's class	10/6 and 10/8/09
1st nine weeks assessment in Sheila's class	10/7/09
Division pretest in Greg's class	10/13/09
De-briefing of 1st nine weeks assessment in Sheila's class	10/21
Focus group	10/27
Observation of data analysis unit – Sheila's class	10/26, 10/27, 11/3, 11/4, 11/6
Data analysis assessment – Sheila class, 11/5	11/5
De-briefing of data analysis assessment with Sheila	11/9
Division assessment – Greg's class	11/16/09
De-briefing of division assessment with Greg	11/18/09
Performance assessment with Greg's student	11/24/09
De-briefing of performance assessment with Greg	12/2/09
Post interview with Sheila	12/7/09
Post interview with Greg	12/9/09
Grading guidelines for teachers	N/A
Notes on math workshop	N/A
Quality plus teaching strategies	N/A

Interview Protocol

Educational experiences

1. What were your educational experiences like as a child? Private school? Public school? Urban area? Rural area? Attended several schools? Just a few schools?
2. Is there one teacher that stands out for you as being especially influential in your life? What qualities did he/she possess that made him/her memorable for you?
3. What memories do you have of learning mathematics?
4. How did you feel about mathematics as a student?
5. Do you recognize yourself as a math student in any of your students? What qualities of that student remind you of yourself as a student?

Teaching Preparation

1. Tell me about your experience becoming a certified teacher. Was it the traditional route? Did you follow a non-traditional route?
2. Tell me about your teaching experience.
3. In your teacher preparation experience, was there a course or courses that addressed teaching mathematics? If so, how helpful was the course or courses in preparing you to teach mathematics?
4. What staff development courses or graduate school work have you been involved in regarding teaching mathematics?
5. What is your philosophy on how children learn? How did you come to think and believe the way you do about how children learn?
6. What formal professional learning opportunities have you had regarding mathematics? Informal experiences?

Teaching Experience – lesson planning

1. How do you plan mathematics instruction in your classroom?
2. What resources are available to you for mathematics planning?
3. What factors influence your planning?
4. How does assessment fit into your lesson planning?

Teaching Experience – assessment

1. How do you define mathematics assessment?
2. What are examples of assessments you've implemented in your classroom? Why did you choose those assessments?
3. What is the purpose of the assessments you administer in the classroom?
4. How often do students in your classroom complete a mathematics assessment?
5. How involved are you in the creation of the assessments you administer?
    a. What types of questions are on the assessments?
    b. Are the assessments always question/answer format or do you include other formats (ex. portfolio, journal, etc.)?
6. What do you do with the assessments after the students have completed them? How do you analyze them?
7. What do you NOT do with the mathematics assessments in your classroom?
8. Once you've reviewed the assessments, what do you do with that information?

9. How informed are the students of the information you gather from their assessment?
10. What do you consider to be links between mathematics assessment and mathematics instruction?
11. How are the mathematics assessments related to instruction?
12. In the research literature, there are mathematics assessments that educators administer for various purposes, including gauging students' academic progress, making determinations regarding future instruction and measuring students' academic ability? Are any of these purposes applicable to your classroom? If so, how? Are there any additional purposes not mentioned?
13. Tell me about the standardized tests that your students complete each year.
14. How do the standardized tests fit into your ideas about classroom assessments, planning mathematics instruction and student learning?
15. How would you describe what mathematics assessment and mathematics instruction look like in the *ideal* classroom?
16. If you could make any change in mathematics assessment what would it be?

Post Interview Questions

The idea of "reteaching" came up in several conversations we had. What does that mean to you? How do you plan for that?

How do you differentiate, if you do, between assessing students to determine their progress and assessing students to assign a grade?

(Sheila) How would you explain to someone what it meant to determine a student's understanding of a concept based on observation?

(Gary) Do you think you could use Exemplars that students write for the class as an assessment of their learning?

When observing lessons, it seems you incorporate a lot of hands on lessons, yet most of the assessments aren't that way. Talk about that difference.

(Gary) You allow students a lot of time to share their ideas. What's your philosophy underlying that practice? How would it translate to assessment?

How would assessment look different in your classroom if you weren't faced with the pressure of the grading requirements set forth by the administration?

Standards based education identifies the importance of having a set of standards which dictate student teaching and learning and that assessment inform instruction. How prevalent do you feel this practice is at [Chestnut Hill]?

What experiences have you had with discussing assessments with your colleagues?

What they look like
How they're related to identifying student learning
The results once administered

(Sheila) You had mentioned at one point that some of the Harcourt pages and assessments are too easy. When creating an assessment how strongly do you consider the level of questioning – knowledge based vs. application and synthesis (those that are more aligned with standards based education)?

Based on the wording of the [county standards], how well do you feel like the assessments you administer determine if the students have an understanding of the concept? (referring to the idea that the [county standards] is not knowledge based, but strives for more higher order thinking, but many of the assessments don't question students that way)

What support would you need/what changes do you think would have to be made in order to use assessment to inform instruction even more than you already do?

How would your instruction look different if mandated assessments did not exist?

How has instruction changed in your classroom over the years?

When collaborating with colleagues, what percentage of the conversation is about assessment? What is discussed?

What does your administration say about assessment? What are there expectations? Are administrators ever involved in the conversations you have with your colleagues about assessment?

How would you define formative assessment and summative assessment? How do you use the two in your classroom?

How would you define traditional assessment vs. alternative assessment? Which do you use in your classroom and how often?

A researcher by the name of Lorie Shepard promotes that assessment should be something that is integrated with instruction and not an activity that merely audits learning (Shepard, 2000). How do you feel like this statement relates to your classroom?

[Greg] Exemplars seem to come up a lot when I was talking to you and [Sheila], why do you think teachers view them as so valuable?

How do you give students feedback?

How do you explain students' progress with the parents? Just through grades? Through an explanation of standards?

APPENDIX B

SECOND GRADE TASKS AND ASSESSMENTS

Addition Unit Task

Name ____________________ Date ____________

Taking Inventory

Adding: Mixed Facts

It's time to take inventory at the department store. Read each problem. Then write an equation to answer the question. Use the back of the page to show how you got your answers.

1
7 toy puppies
5 toy kittens

____ + ____ = ____

How many toy animals are in the store? ____

2
9 card games
6 board games

____ + ____ = ____

How many games are in the store? ____

3
7 ring floats
6 raft floats

____ + ____ = ____

How many floats are in the store? ____

4
7 chocolate candy bars
9 peanut candy bars

____ + ____ = ____

How many candy bars are in the store? ____

5
6 toy fire trucks
8 toy dump trucks

____ + ____ = ____

How many toy trucks are in the store? ____

6
10 wood chairs
10 metal chairs

____ + ____ = ____

How many chairs are in the store? ____

7
9 talking books
8 pop-up books

____ + ____ = ____

How many books are in the store? ____

8
4 large dog bowls
7 small dog bowls

____ + ____ = ____

How many dog bowls are in the store? ____

Additional Unit Task #2

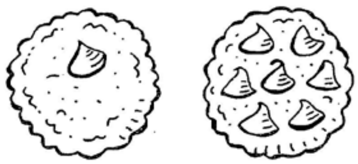
Name ______________________ Date ______________

Eight Chocolate Chips

Adding: Mixed Facts

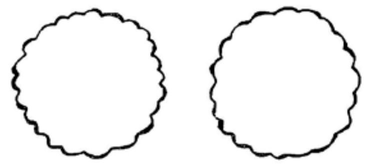
Tanya ate two cookies at a time. Each pair of cookies had 8 chocolate chips. For each cookie pair below, draw a different way that there can be 8 chocolate chips. Then write an equation. The first one has been done for you.

1



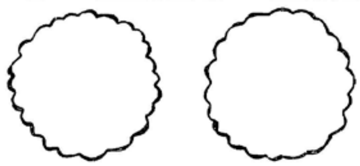
1 + 7 = 8

2



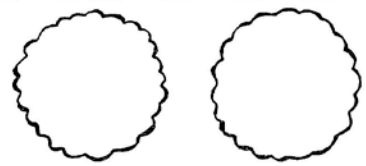
____ + ____ = ____

3



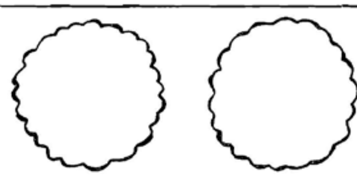
____ + ____ = ____

4



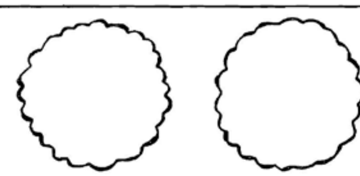
____ + ____ = ____

5



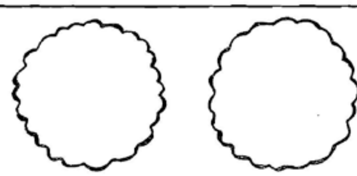
____ + ____ = ____

6



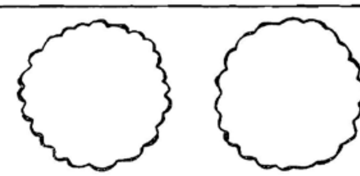
____ + ____ = ____

7



____ + ____ = ____

8



____ + ____ = ____

Addition Unit Assessment

Name ______________________________ CHAPTER 4 POSTTEST

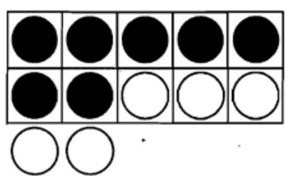
1. M2N5.b Harold has 1 surfboard. He joins a group of friends that has 6 surfboards. Which number sentence shows how many surfboards there are altogether?

○ A. 1 + 3 = 4

○ B. 3 + 5 = 8

○ C. 1 + 6 = 7

2. M2N1.a Use the ten frame. Which is the sum?



$$\begin{array}{r} 7 \\ +\ 5 \\ \hline \boxed{} \end{array}$$

○ A. 10

○ B. 12

○ C. 13

3. M2N5.a Which is the missing number?

$8 + \boxed{} = 13$

$\boxed{} + 8 = 13$

○ A. 4

○ B. 5

○ C. 6

4. M2N2.d Which is the sum?

$7 + 3 + 2 = \boxed{}$

○ A. 12

○ B. 13

○ C. 14

5. M2N2.d Which is the sum?

$6 + 1 = \boxed{}$

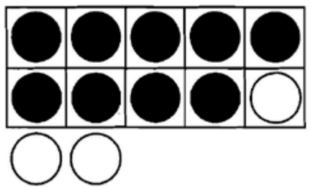
$1 + 6 = \boxed{}$

○ A. 5

○ B. 6

○ C. 7

6. M2N1.b. Use the ten frame. Which is the sum?



$$\begin{array}{r} 9 \\ +\ 3 \\ \hline \boxed{} \end{array}$$

○ A. 12

○ B. 13

○ C. 14

7. M2N2.c. Which is the sum?

$$\begin{array}{r} 7 \\ +\ 4 \\ \hline \boxed{} \end{array}$$

○ A. 11

○ B. 12

○ C. 13

8. M2N2.d. Which is the sum?

$0 + 12 = \boxed{}$

○ A. 1

○ B. 12

○ C. 13

9. M2N1.a. There are 2 children at the park. Then 3 children join them. Which number sentence shows how many children are at the park?

○ A. $1 + 3 = 4$

○ B. $2 + 2 = 4$

○ C. $2 + 3 = 5$

10. M2N5.a. Which doubles fact does the model show?

○ A. $3 + 3 = 6$

○ B. $6 + 6 = 12$

○ C. $7 + 7 = 14$

1st Nine Weeks Assessment

Name: ______________________

Add: 6 + 4 + 7 = ________	Count back: 9 – 7 = ________	Write the fact family for : 6 3 9 _____ + _____= _____ _____ + _____ = _____ _____ - _____ = _____ _____ - _____ = _____
Draw 56 with base 10 blocks.	Write 27 in expanded form:	Write the fact family for : 8 7 15 _____ + _____= _____ _____ + _____ = _____ _____ - _____ = _____ _____ - _____ = _____
Is 20 odd or even? ________________	45 _____ ten + _____ ones _____ + _____ = ______	66 _____ tens + _____ ones _____ + _____ = _____
Show a repeating pattern:		
Show a growing pattern:		

Data Analysis Assessment

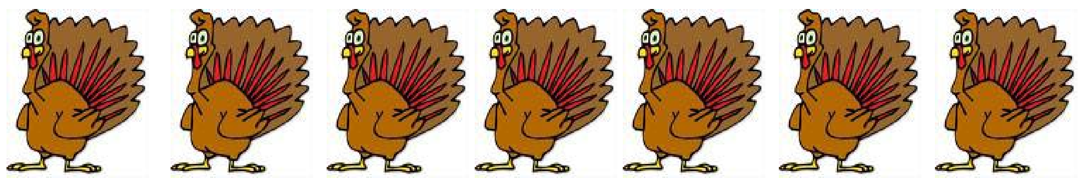
Name ____ #____________

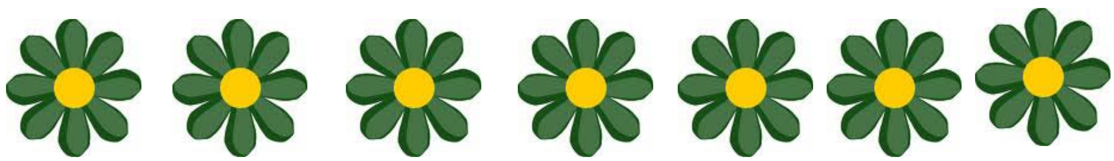
Jeff asked his classmates what their favorite vacation was. Use the tally chart to create a pictograph.

<table>
<tr><th colspan="2">Favorite School Vacation</th></tr>
<tr><td>Thanksgiving Vacation</td><td>|||</td></tr>
<tr><td>Winter Vacation</td><td>~~||||~~</td></tr>
<tr><td>Spring Vacation</td><td>||</td></tr>
</table>

Favorite School Vacation						
Thanksgiving Vacation						
Winter Vacation						
Spring Vacation						

1. How many people chose Thanksgiving Vacation? ___________
2. How many people chose Winter Vacation? ___________
3. How many people chose Spring Vacation? ___________
4. How many more people chose Winter Vacation over Spring Vacation? ___________
5. How many more people chose Thanksgiving Vacation over Spring Vacation? ________
6. How many people were asked about their favorite vacation? _________





APPENDIX C

THIRD GRADE TASKS AND ASSESSMENTS

STAR Report – Class Summary

Summary Report

STAR Math®: Friday, 09/11/09, 02:28 PM
Date Range: 8/10/2009 to 8/1/2010

Page 1

Elementary School — Sorted By : Student Name

Class: 3

Student Name	Grade Placement	Class	Teacher	Test Date	Rank	SS	GE	PR	NCE
B	3.00	3	G	8/25/2009	18	394	1.7	6	17.3
E	3.00	3	G	8/24/2009	6	573	3.4	71	61.7
G	3.00	3	G	8/25/2009	2	685	5.2	96	86.9
G	3.00	3	G	8/25/2009	13	491	2.5	33	40.7
G	3.00	3	G	8/25/2009	19	335	1.2	2	6.7
H	3.00	3	G	8/26/2009	7	528	2.9	50	50.0
H	3.00	3	G	8/26/2009	11	498	2.6	36	42.5
K	3.00	3	G	8/26/2009	4	647	4.5	92	79.6
K	3.00	3	G	8/26/2009	1	693	5.4	97	89.6
M	3.00	3	G	8/26/2009	5	582	3.5	75	64.2
M	3.00	3	G	8/26/2009	8	522	2.8	47	48.4
M	3.00	3	G	8/26/2009	17	431	2.0	11	24.2
M	3.00	3	G	8/27/2009	14	485	2.5	30	39.0
M	3.00	3	G	8/27/2009	15	471	2.4	25	35.8
O	3.00	3	G	8/27/2009	16	453	2.2	17	29.9
S	3.00	3	G	8/26/2009	10	505	2.7	39	44.1
S	3.00	3	G	8/27/2009	12	498	2.6	36	42.5
S	3.00	3	G	8/27/2009	9	506	2.7	39	44.1
W	3.00	3	G	8/28/2009	3	654	4.6	94	82.7

Summary Report

STAR Math®: Friday, 09/11/09, 02:28 PM
Date Range: 8/10/2009 to 8/1/2010

Page 2

Elementary School — Sorted By : Student Name

Score Summary
19 Students

	Grade Placement	SS	GE	PR	NCE
Mean Scores	3.00	524	2.9	48	48.9

Percentile Rank Distribution Summary

Percentile	Students	Percent
Below 25th	4	21.1
25th to 49th	8	42.1
50th to 74th	2	10.5
75th & Above	5	26.3

GE Distribution Summary

GE	Students	Percent
0.0 - 0.9	0	0.0
1.0 - 1.9	2	10.5
2.0 - 2.9	11	57.9
3.0 - 3.9	2	10.5
4.0 - 4.9	2	10.5
5.0 - 5.9	2	10.5
6.0 - 6.9	0	0.0
7.0 - 7.9	0	0.0
8.0 - 8.9	0	0.0
9.0 - 9.9	0	0.0
10.0 - 10.9	0	0.0
11.0 - 11.9	0	0.0
12.0 - 12.9+	0	0.0

STAR Report – Individual Report

Diagnostic Report

STAR Math®: Thursday, 02/11/10, 07:22 AM
Test Date: 8/27/2009

Page 1

____ Elementary School

Grade: 3 **Class: 3**

This report presents diagnostic information about the student's general skills in mathematics, based on the student's performance on a STAR Math test.

Score Summary

SS	GE	PR	PR Range	Below Average	Average 50	Above Average	NCE	Recommended Accelerated Math® Library
506	2.7	39	24-57		--------X---------		44.1	Grade 2 or Grade 3

This student's Grade Equivalent (GE) score is 2.7. His or her math skills are therefore comparable to those of an average second grader after the seventh month of the school year. ____ also achieved a national Percentile Rank (PR) of 39. This score is in the average range and means that scored greater than 39% of students nationally in the same grade. The PR Range indicates that, if this student had taken the STAR Math test numerous times, most of his or her scores would likely have fallen between 24 and 57. It reflects the amount of statistical variability in a student's PR score.

These scores suggest that ____ can likely work with hundreds. He or she is learning to regroup when adding and subtracting two-digit and three-digit numbers. He or she should continue practicing these skills until he or she reaches mastery. At this stage in his or her development, ____ can begin to learn to estimate with simple math problems. He or she can also begin to use a calculator more often.

At this stage, ____ needs to:

- Learn place-value in three-digit numbers
- Use both names and numbers for three-digit numbers
- Learn to round to the nearest 10 and 100
- Keep practicing adding and subtracting two-digit numbers with regrouping
- Begin to learn adding and subtracting three-digit numbers with regrouping
- Begin to learn to estimate with simple addition and subtraction problems

The bar charts below reflect ____ level of proficiency within the Numeration and Computation objectives in STAR Math. The solid black line is pointing to the math skills ____ is currently developing.

Numeration Objectives

Ones	Tens	Hundreds	Thousands	Hundred Thousands	Fractions & Decimals	Advanced Concepts I	Advanced Concepts II

Computation Objectives

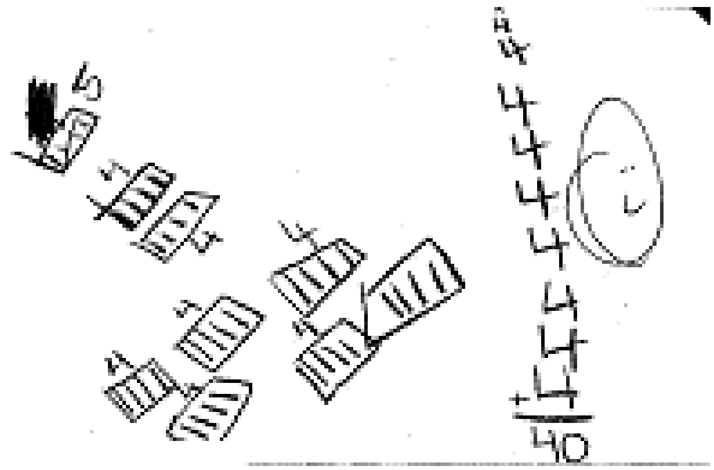
Addition & Subtraction Basic Facts to 10	Addition & Subtraction Basic Facts to 18, No Regrouping	Addition & Subtraction with Regrouping	Multiplication & Division Basic Facts	Advanced Computation with Whole Numbers	Fractions & Decimals I	Fractions & Decimals II	Percents, Ratios & Proportions	Multiplication & Division of Mixed Numbers

If you are using the Accelerated Math® management software system with ____ assign the Grade 2 library. If he or she is not challenged by the difficult objectives in the Grade 2 library, move him or her to the Grade 3 library.

These recommendations rely on analysis of the student's performance on one STAR Math test. Please combine this information with your own knowledge of the student, and use your professional judgment when designing an instructional program.

Printed with Draft Mode preference on.

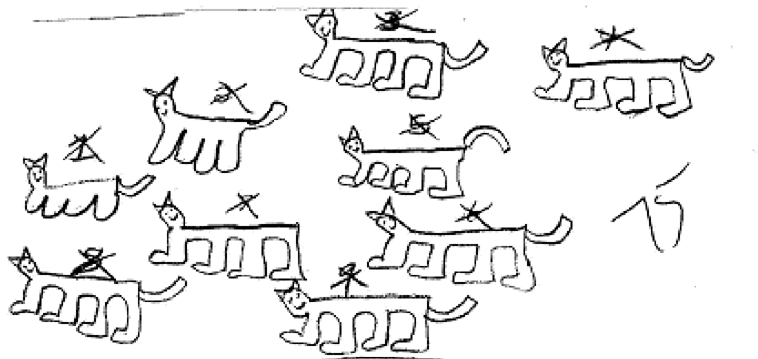
Exemplar



Puppy Love

Selena has 9 puppies and 1 mama dog. Each has 4 legs. How many legs in all?

There is 40 legs in all?



Puppy Love

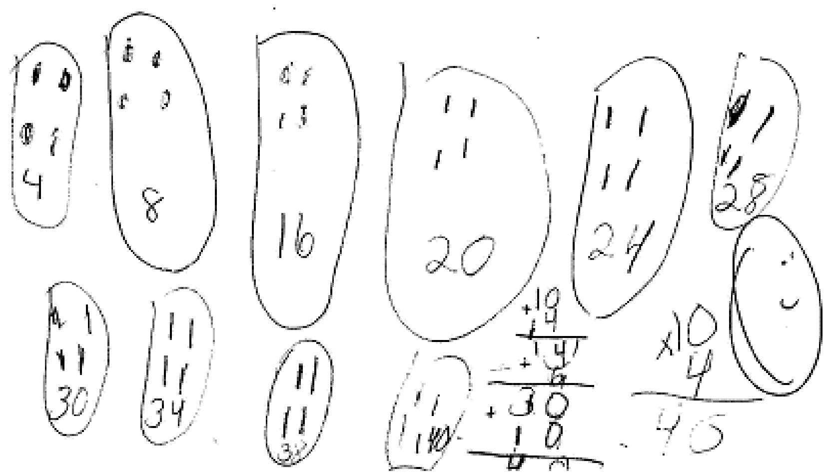
Selena 9 puppys and 1

Mama dog. Each has 4

leags. How meny leag in all

The anser is 36

For me

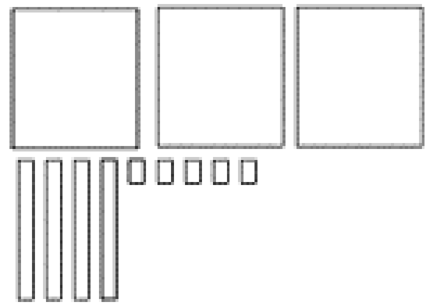


Puppy Love

Selena has [redacted] puppies and 1 mama dog. Each has [redacted] legs. How many legs in all?

It is forty legs in all.

SPEW Chart

S = standard form 345	P = picture 
E = expanded 300 + 40 + 5	W = word form Three hundred forty-five

Division Pre-Test

Which picture shows 21 stars divided into 3 equal groups?

a. ☆☆☆☆☆☆☆ ☆☆☆

b. ☆☆☆☆☆☆☆ ☆☆☆☆☆☆☆ ☆☆☆☆☆☆☆

c. ☆☆☆ ☆☆☆ ☆☆☆ ☆☆☆
☆☆☆ ☆☆☆ ☆☆☆

Which numbers goes in the box?

20 ÷ 4 = □

a. 20
b. 4
c. 5

Mr. Fryns has 66 pencils to share equally between his students. How many pencils will each student get? (there are 22 students)

a. 3
b. 66
c. 10

Ms. Mitchell has 45 apples. She wants to give 2 apples to each students. Does she have enough? (there are 22 students)

a. yes
b. no

Ms. Neighbors has 14 stickers to share between Seth, Taylor and Tremaine. How many stickers will be left over?

a. 3
b. 2
c. 14

Division Assessment

Name: ________________________________ Date:______________

Division Test

Part 1: Vocabulary

For questions 1-5, write the **vocabulary word** that represents each number in this division problem.

$$15 \div 3 = 5$$

Word Bank

Word Bank
Quotient
Divisor
Dividend

1. **15** is called your _______________

2. **3** is called your ________________

3. **5** is called your _______________

Part 2: Fact Families

6-9 Show me the four ways to write fact families using these numbers: **4, 8, 32**

Part 3: Find the quotient or missing divisor.

****Show your work by subtracting with division, drawing arrays, or the multiplication sentence you used****

10. $21 \div 3 =$ ______ 11. $72 \div 8 =$ _______ 12. $36 \div 4 =$ _______

13. There are 24 children going to summer camp. Each cabin holds 4 children. How many cabins with the children use during summer camp?

A. 6 cabins
B. 8 cabins
C. 12 cabins
D. 20 cabins

14. Chris cooked 15 ears of corn at the picnic. If each person ate 3 ears of corn, how many people were at the picnic?

A. 4
B. 5
C. 10
D. 3

15. Casey wants to buy some candy bars. He has 63 cents. Each candy bar costs 10 cents. How many candy bars will he be able to buy?

A. 3
B. 7
C. 6
D. 63

16. Cathy is making cards for her friends. She made 18 cards and gave them to 6 friends. Which number sentence shows how many cards Cathy gave to each friend?

A. 18 + 3
B. 18 – 3
C. 18 x 3
D. 18 ÷ 3

17. Stephanie is baking apple pies. She picked 39 apples for her pies. Each pie needs 6 apples. How many apples will she have leftover after making 6 pies?

A. 6
B. 3
C. 9
D. none

18. Naomi decides to cook dinner for herself and 7 of her friends. She decides to make 24 breadsticks. Which number sentence shows how many breadsticks each person will get?

A. 7 ÷ 24
B. 24 ÷ 7
C. 8 ÷ 24
D. 24 ÷ 8

Performance Assessment

Student's name____ **Grade**____________
Teacher's name____ **Date** ____________
Interviewer____

Performance assessment - Stage 1

Count forward until I tell you to stop (stop student at 35)	
Start at 13 and count forward until I tell you to stop (stop student at 25)	
Ask the following: What number comes after 3? What number comes after 12? What number comes after 6?	
Count backwards from 15	
Ask the following: What number comes before 5? What number comes before 13? What number comes before 27?	
Numeral ID. Flash the number cards and ask, "What number is this?" each time. 5 3 7 18 20 12	
Sequencing numerals Put these cards in order starting with the smallest number here (point to the left edge of the work area) 1-10 7-17	
Counting from a collection Put out a set of counters and ask students to show you… 7 counters 13 counters *** If any errors so far, STOP. If no errors, continue.**	
Show 4 counters, cover with a card, show 2 more, cover with a card. Ask, "How many in all?"	
Show 5, cover, show 3, cover, ask, "How many in all?"	
Show 8, cover, show 4, cover, ask, "How many in all?" *** If error, stop. If no errors, proceed with stage 2 assessment.**	

Student's name______________________________________ **Grade**____________
Teacher's name______________________________________ **Date**_____________
Interviewer____

Performance Assessment - Stage 2

Show me 6 fingers. Show me 6 a different way. (watch to see if fingers are raised in groups or individually).	
Flash regular subitzing cards. Show each card for 1 second. Ask student, "How did you see the dots?" 4 2 6 5 3 8 (this is a "bonus" – don't count it as an error)	
Flash irregular subitizing cards 3 6 4 5	
Display tens frame. Ask, how do you see the dots? (describe – you're listening to see if the student sees the dots in groups or as individual dots) **Remove the tens frame.** How many did you see in all? (This tens frame has 5 on the top row and 3 on the bottom row.)	
Show a pair-wise (4 and 4) pattern on the ten frame for about ½ a second. Ask, "What did you see?" ***If errors, return to stage 1 assessment. If student has been successful, continue.**	
Show the card with 5+7. Ask, do you have a way to work out this problem? If they respond yes, ask them to tell you.	
Repeat with 4+3.	
Show 7 counters. Cover with a card. Take 2 from the 7. Cover those two with a card. Ask how many are left over here? ***If errors, repeat the task, but don't cover the 2. If errors repeat, but don't cover either of the groups. Then, proceed to apples problem.**	
Repeat with 12, removing 4.	
Repeat with 27, removing 4.	
I have 7 apples. How many more to make 10?	
Display and read the cut up number sentence 11 + 6 = 17. Remove + and put out the – card and mix up all the cards. Ask the student to arrange the cards to make the sentence true. ***If student has been unsuccessful, stop. If student has been successful, proceed with the Stage 3 assessment.**	

Student's name____ Grade____________
Teacher's name____ Date____________
Interviewer____

Performance Assessment - Stage 3

Lay down a ten strip and a strip of 4. Ask, "How many dots?" Continue to lay down strips of ten until you reach 8 strips, asking each item, "How many dots?"	
I will say a number. Tell me what goes with it to make 10. 9 5 8 3 *** If errors, stop and do the Stage 2 assessment. If no errors, continue.**	
What goes with these numbers to make 20? 15 12 18 19	
Tell me two numbers that add up to make 100. Tell me two more.	
Display the cards 2, 4, 3 + 3, +, = randomly. Ask the student to put the cards in order to make the statement true.	
Display a number grid. Show the sentence 24 + 33. Ask the students to show you how they can use the number grid to solve the problem. (You're looking to see if the student simply starts at one of the numbers and counts on by 1s or if the student uses a more advanced task. For example, start at 24, add 10 to 34, 10 more to 44, 10 more to 54, then 3 to get 57)	
Repeat with 38+25	
Repeat with 45-24	
Repeat with 62-28 *** If errors with computation, stop. If no errors, proceed with the Stage 4 assessment.**	

Student's name____ Grade____________
Teacher's name_______________________________________ Date______________
Interviewer____

Performance Assessment - Stage 4

Display the cards 90, - , 20, = and 70 in that order. Remove the - , mix up the cards, set out the symbol + and ask the student to arrange the cards to make the sentence true.	
Display the cards 12, + , 40, = and 52 in that order. Remove the + , mix up the cards, set out the symbol - and ask the student to arrange the cards to make the sentence true.	
Count by 2s starting at 14 (to 20)	
Count by 5s starting at 35 (to 70)	
Count by 3s starting at 21 (to 33) ***If errors, return to Stage 3 assessment. If no errors, continue with Stage 4 assessment.**	
Present a pile of 15 counters. Tell the student to use the counters to make three groups with four in each group. Ask, "How many counters did you use?"	
Display a 10x2 array of dots. Say, "Count these dots and tell me how many there are altogether."	
Repeat with a 5x3 array.	
Display a 4x5 array. Ask, "How many rows are there?" "How many dots in each row?" "How many dots altogether?" Turn the array 90 degrees. Ask again, "How many dots altogether now?"	
Put out 12 counters (9 red and 3 yellow) Ask the student, "What fraction of the counters is yellow? What fraction is red?" ***If errors, stop. If no errors, proceed with the Stage 5 assessment.**	

APPENDIX D

POLICY AND PROCEDURE DOCUMENTS

Second Grade Map

2009-2010 Second Grade Math Instructional Calendar 2nd Nine Weeks: 4 Instructional Units

Ongoing Instruction: calendar, vocabulary, data collection, fact fluency, time, money, measurement, problem solving, patterns, and process standards (county standards 1-19)

Skills to Maintain: place value, +/- of whole numbers, +/- fact fluency, skip counting

These suggested instructional materials may be used to teach the county standards. Select the ones that best meet your students' needs.

Unit # 3	County Standards	Vocabulary	Harcourt	Exemplars	Super Source	Hands-on Standards
	The second nine weeks consists of 4 instructional units with 12 total county standards.	Vocabulary lists for grades K-5 are on the math website.	[Barton County] has two adopted texts: Harcourt and Think Math. Use them as a resource to teach the county standards.	Exemplars address multiple county standards and serve several grade levels. They are on the Math website.	Super Source is a manipulative based resource that provides application of the skill or concept.	Hands-on standards is a manipulative based resource to support moving from concrete to abstract knowledge.
3 Weeks This is a suggested pacing guide. It may take more or less time depending on individual needs.	**56** - pose questions and collect, organize and interpret data about self and surroundings **57** - collect and organize data by creating simple tables, picture graphs, bar graphs and Venn diagrams **58** - interpret picture graphs, Venn diagrams and bar graphs	bar graph data picture graph survey table *Venn diagram** **denotes GPS suggested terms*	**Teacher Edition** **County standards 55, 56, 57, 58** 39-54 **Think Math** **County standards 56, 57, 58** 338-340, 344-346, 350-353 **County standards 56** 393-340 **County standards 57** 358-362 **County standards 58** 366-368, 371-377	**PDFs online:** • Piggy Bank • Nests and Baby Birds • Patty's Pennies	**BTB (3-4)** • What's in Between **SC (K-2)** • Red or Blue	**Gr. 1-2 Data Analysis and Probability** • Bar Graphs • Pictographs • Drawing Conclusions

Internet Resources: www.georgiastandards.org www.eharcourtschool.com

Third Grade Map

2009-2010 Third Grade Math Instructional Calendar 2nd Nine Weeks: 2 Instructional Units

Ongoing Instruction: calendar, vocabulary, data collection, fact fluency, time, money, measurement, problem solving, patterns, and process standards (County Standards 1-19)

Skills to Maintain: place value, +/- of whole numbers, +/- fact fluency, skip counting

These suggested instructional materials may be used to teach the county standards. Select the ones that best meet your students' needs.

Unit # 4	County Standards	Vocabulary	Harcourt	Exemplars	Super Source	Hands-on Standards
	The second nine weeks consists of 2 instructional units with 10 total county standards.	Vocabulary lists for grades K-5 are on the math website.	[Burton County] has two adopted texts: Harcourt and Think Math. Use them as a resource to teach the county	Exemplars address multiple county standards and serve several grade levels.	Super Source is a manipulative based resource that provides application of the skill or concept.	Hands-on standards is a manipulative based resource to develop conceptual understanding.
6 Weeks This is a suggested pacing guide. It may take more or less time depending on individual needs.	**29** - explain the relationship between division and subtraction/ division and multiplication **30** - recognize and explain the two models of division: repeated subtraction and sharing model **31** - recognize problem solving situations in which division may be applied and write corresponding mathematical expressions **32** - explain the different meanings of the remainder in division problems **60** – use a symbol to represent an unknown and find the value of the unknown in a number sentence **61** – demonstrate equivalent relationships using numbers, objects, pictures, words and symbols	***divide (÷)**** ***dividend**** divisor equation ***inverse operation**** ***quotient**** ***remainder**** repeated subtraction ****denotes GPS suggested terms***	**Teacher Edition** **County Standards 29** 204-213, 216-218, 221, 244-247, 254 **County Standards 30** 201-203, 217-218, 221, 244-247 **County Standards 31** 217-218, 228-229, 244-247, 253, 255, 258 **County Standards 32** 456-457, 462-465, 468-469 **County Standards 60** 216-218, 234, 255 **County Standards 61** 218, 242-243 **Think Math** **County Standards 29** 154-161, 690-697, 952-957, 958-963 **County Standards 30** 494-501	**Diff. Best of Math 1:** • Ant in the Well • Camping • Equal Snacks • Filling the Pool • I Did A Read • Job Hunting • Portfolio Pizza Party	**BTB (3-4)** • Choose a Place • Clear the Mat • In a Row • 1,000 More or Less **CR (3-4)** • Writing Equations **CT (3-4)** • Sides and Angels • Take Your Pick **PB (3-4)** • Spiney and Other Creatures **SC (3-4)** • Cleared for Take Off • Prize Inside • The Staircase Problem	**Gr. 3-4 Number and Operations** • Exploring Division • Divide by Multiples of 10 • Dividing with One-Digit Divisors

Internet Resources: www.georgiastandards.org www.eharcourtschool.com

Grading Requirements

Grading and Assignment Guidelines (2009-10)

Grading/assignment guidelines and task types/weights have been revised for clarity and consistency and are outlined below:

- The guidelines for minimum/maximum assignment requirements must be followed to ensure that grades accurately and statistically reflect student performance.
- Assignments/grades should be spaced throughout the 9 weeks period and entered in a timely manner (e.g. weekly).
- Students (and their parents) should be kept informed of their grades in a consistent and timely manner (Friday folders, printed or email grade reports, etc.).
- The degree of student participation should not be included as a part of assignment or skill grades, but should be reflected in the EFFORT grade given for each subject area.

READING	%	READING
		70% of the reading grade is based on the student's Instructional Reading Level, Fluency, and Comprehension each of which count as one grade for the term. Thes are "determined" using the Grading Categories and Rubric. Grades should be entered by the midterm. Midterm grades are then replaced at the end of the grading This allows the performance grade to reflect the progress the student has made throughout the grading period.
Reading Level	40	► Reading Level
Fluency	10	► Fluency
Comprehension	20	► Comprehension
Skills Practice	10	► Skills Practice - minimum of three (3) grades and maximum of five (5) grades
Assessments	15-20	► Assessments - minimum of three (3) grades and maximum of five (5) grades
GCPS Interims	1-5	► Interims - entered for Q1 and Q2; 1st Grade = 1%, 2nd Grade = 2%, 3rd Grade = 3%, 4th Grade = 4%, 5th Grade = 5%

WRITING-GRAMMAR	%	WRITING-GRAMMAR
		50% of the writing-grammar grade is based on a minimum of two (2) writing samples being scored using the four components of the Writing Rubric. Each writing generates four (4) grades (Ideas, Organization, Style, Conventions). The grades for one (1) writing sample must be "determined" using the Grading Categories anc and entered by midterm. The grades for at least one (1) additional writing sample must be "determined" and entered by endterm.
Ideas	20	► Ideas counts as two (2) or more grades for the 9 week term
Organization	10	► Organization counts as two (2) or more grades for the 9 week term
Style	10	► Style counts as two (2) or more grades for the 9 week term
Conventions	10	► Conventions counts as two (2) or more grades for the 9 week term
Skills Practice	20	► Skills Practice - minimum of three (3) grades and maximum of five (5) grades
Assessments	30	► Assessments - minimum of three (3) grades and maximum of five (5) grades

SPELLING / WORD WORK	%	SPELLING / WORD WORK - **assignments and % subject to revision based on county recommendations**
Skills Practice	40	► Skills Practice - minimum of three (3) grades and maximum of five (5) grades
Assessments	60	► Assessments - minimum of three (3) grades and maximum of five (5) grades

MATH	%	MATH
Skills Practice	60	► Skills Practice - minimum of nine (9) skills practice grades and maximum of twelve (12) grades
Assessments	35-40	► Assessments - minimum of three (3) grades and maximum of five (5) grades
GCPS Interims	1-5	► Interims - entered for Q1 and Q2; 1st Grade = 1%, 2nd Grade = 2%, 3rd Grade = 3%, 4th Grade = 4%, 5th Grade = 5%

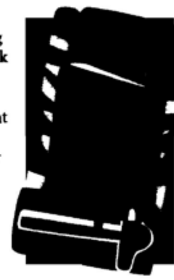
SOCIAL STUDIES	%	SOCIAL STUDIES
Skills Practice	50	► Skills Practice - minimum of three (3) grades and maximum of five (5) grades
Assessments	50	► Assessments - minimum of three (3) grades and maximum of five (5) grades

SCIENCE	%	SCIENCE
Skills Practice	50	► Skills Practice - minimum of three (3) grades and maximum of five (5) grades
Assessments	45-50	► Assessments - minimum of three (3) grades and maximum of five (5) grades
GCPS Interims	3-5	► Interims - entered for Q1 and Q2; 3rd Grade = 3%, 4th Grade = 4%, 5th Grade = 5%

Quality Plus Teaching Strategies

Public Schools
Quality-Plus Teaching Strategies

These research-based, proven and effective instructional strategies, when employed consistentlv in classrooms across subject areas and across grade levels, ensure engaging instruction and assessment that result in students achieving world-class standards.



ASSESSMENT:

Frequentlv assess students' learning of the and give specific feedback to students and parents.

Evidence of effective use of strategy:

- Teacher regularly assesses student progress toward the in order to determine next steps for instruction.
- Variety of valid and effective assessments are used.
- Teacher frequently communicates students' progress to students and parents and provides specific strategies for improvement.
- Students monitor their own progress in learning the

COLLABORATION:

Provide collaborative learning opportunities.

Evidence of effective use of strategy:

- Teacher provides multiple and frequent opportunities for a variety of collaborative student experiences.
- Teacher provides students with individual and group feedback on specific techniques for effective collaboration.
- Teacher acts as a coach and collaborator to model and give feedback on appropriate strategies.
- Teacher grades student individually on their learning of the
- Students move smoothly among whole-group, small group, and individual learning tasks.
- All learners are engaged in the task at hand.

MODELING AND PRACTICE:

Model strategies and skills. Give multiple opportunities for distributed guided practice followed by independent practice.

Evidence of effective use of strategy:

- Teacher's lessons include modeling and guided practice, with checks of students' understanding through independent practice.
- Teacher gives timely and specific feedback to students (individually when possible) on their practice to help them measure their own progress.
- Students complete meaningful classroom practice and/or homework for learning.

VOCABULARY:

Explicitly teach essential content-related vocabulary.

Evidence of effective use of strategy:

- Vocabulary is posted in the classroom and school in meaningful ways specific to grade level and content.
- Teacher previews and presents vocabulary in context through a variety of strategies.
- Students apply their knowledge of vocabulary in their work and writings, and transfer their knowledge to subsequent learning.

NON-VERBAL REPRESENTATION:

Use a variety of non-verbal/visual representations of content and skills.

Evidence of effective use of strategy:

- Non-verbal representations are available and/or visible in the classroom.
- Teacher uses a variety of representations in lessons, depending upon the content and level.
- Students demonstrate their own thought processes and understanding with graphic organizers and other non-verbal representations.
- Students use non-verbal representations to illustrate content.

SUMMARIZING:

Explicitly teach students to summarize their learning.

Evidence of effective use of strategy:

- Teacher explicitly teaches and models summarizing throughout the learning process.
- Teacher demonstrates a variety of strategies to foster student understanding and provides students with opportunities to practice.
- Students summarize learning in a variety of ways throughout the learning process.

LITERACY:

Explicitly teach skills for improving reading and writing proficiency/literacy across content areas.

Evidence of effective use of strategy:

- Teacher teaches literacy skills with students through various texts and student writings.
- Teacher encourages students to read and write for a variety of purposes.
- Students demonstrate appropriate level of proficiency in use of a variety of on-grade texts to acquire content knowledge.
- Students write frequently to respond to, apply and communicate content.

QUESTIONING:

Use and teach questioning and cuing/prompting techniques.

Evidence of effective use of strategy:

- Teacher asks probing questions (to both volunteers and non-volunteers) to develop deeper understanding of content.
- Teacher's cues/prompts and questions require students to restructure information or apply knowledge.
- Teacher gives appropriate wait-time after asking questions.
- Teacher models and teaches identifying cues/prompts for understanding content, i.e., key words, organizational structure.
- Teacher and students use questions and cues/prompts to link to prior and current learning.
- Students effectively pose their own questions and develop cues/prompts to support their learning.

PROBLEM-SOLVING:

Use inquiry-based problem-solving learning strategies with students in all content areas.

Evidence of effective use of strategy:

- Teacher provides multiple opportunities for inquiry-based problem-solving.
- Teacher provides and students are proficient with open-ended tasks.
- Teacher models and guides application of problem-solving strategies.
- Students use a variety of problem-solving strategies to effectively address inquiry-based tasks.

BACKGROUND KNOWLEDGE:

Access and/or build students' background knowledge and experience.

Evidence of effective use of strategy:

- Teacher helps students connect their background knowledge to the current content.
- Teacher previews appropriate vocabulary and links content to real-world experiences/events.
- Teacher varies instructional strategies so as to connect with students' experience and background knowledge.
- Connections are made among content areas.
- Students demonstrate understanding of content's links to their own background knowledge and the real world.

TECHNOLOGY:

Use technology effectively to plan, teach, and assess.

Evidence of effective use of strategy:

- Teacher uses disaggregated data and resources produced by technology tools for planning instruction.
- Teacher and students use technology tools for effective content-based teaching and learning.
- Students rely on technology tools to access content and produce their work.

STUDENT GOAL-SETTING:

Teach and require students to set personal goals for improving their academic achievement.

Evidence of effective use of strategy:

- There is documentation of student goal-setting and monitoring.
- Teacher offers multiple avenues and opportunities for students to establish learning goals and monitor, assess, and discuss their progress on meeting their learning goals.
- Teacher models ways to set goals and monitor progress.
- Students set goals for learning the and monitor their own progress.

COMPARISON AND CONTRAST:

Teach students to compare and contrast knowledge, concepts or content.

Evidence of effective use of strategy:

- Teacher guides the comparison of characteristics.
- Characteristics compared are key elements or components of the lesson.
- Students demonstrate understanding of comparisons and contrasts through verbal, written, and/or visual tasks.

Math Workshop Notes

______________Elementary
Faculty Handbook

Notes on Math Workshop

Room Arrangement
- Manipulatives should be visible, organized and easily accessible to students. This includes personal manipulative kits and math journals.
- The classroom resources such as a Number Line, a Math Word Wall, a Number Grid, and a Problem Solving Strategies Chart should be displayed in a location so that they are easily accessed by students and available to you for instructional purposes.
- Students' work space should be arranged in order to provide an environment where students can easily work with a partner or small group.
- Consider designating an area for students to gather in a whole group, apart from their desks, where mini lessons and discussions may take place, such as a rug and whiteboard area.
- Have a space available for you to work with a small group of students.

Classroom Routines
- Think about Harry Wong's work in regard to routines and procedures as you establish your classroom atmosphere. Regardless of the age, students need be taught how to select, use, and put away materials.
- Also, be clear and specific regarding your expectations of what appropriate behavior looks like during transitions and small group work.
- And remember... just because something is taught, doesn't mean it has been learned. So, allow time to model, review and practice and don't forget to revisit whenever things aren't going as you expect.

Instructional Expectations
- Real world problem solving should be an integral part of instruction on a daily basis. A variety of problem solving experiences should be provided in meaningful contexts.
- Exemplars should be included as part of the math block at least twice a month. Lessons should focus on multiple problem solving strategies resulting in the correct answer. Problem solving strategies need to be taught and modeled. Multiple perspectives are necessary to build important mathematical ideas and diverse thinking that is an essential and valued resource in the classroom.
- Each student should maintain a math journal where math thinking is evident and vocabulary is listed and defined.
- Vocabulary words listed on the curriculum map should be consistently added to the Math Word Wall. The Math Word Wall should be referenced and reviewed frequently.
- Maintenance (calendar, 6 minute math, math for today, morning message, morning work, problem of the day, etc.) of math skills should be provided daily in addition to the math block.
- The Math Workshop, including teacher directed small groups to allow for differentiated instruction based on students' needs, should be part of every day.
- Use the curriculum map to guide math instruction. Think carefully about what students need to learn and how you will support that learning.
- Assessment should be focused on gathering evidence that can inform instruction and provide a variety of ways for students to demonstrate what they know.
- There is an old adage in education that the person doing the talking is the person doing the learning. With this in mind, consider pairing students with a math partner so that students have someone to talk to about their math thinking. Partners could remain the same all year or change periodically. During whole group time (i.e. mini lessons) partners should sit together so that this instructional strategy can be easily implemented at a moment's notice. (Assigned partners do not always have to work together.)

Math Support
Call on your Math Specialist on a regular basis to help with planning, differentiation, problem solving, etc.

This document is located online in the faculty handbook.