

GOALS OF INSTRUCTION:
A CROSS CASE ANALYSIS OF FIVE
SECONDARY MATHEMATICS TEACHERS

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SECONDARY MATHEMATICS TEACHERS

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GOALS OF INSTRUCTION: A CROSS CASE ANALYSIS OF FIVE
SECONDARY MATHEMATICS TEACHERS

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ABSTRACT

Teacher goals are an understudied component of teacher thinking. Teacher goals uncover the composite of knowledge, beliefs, and values and direction that underlie teachers' actions. In this study five experienced secondary mathematics teachers were observed and interviewed over the span of a week to investigate their goals. Findings were developed inductively and led to a presentation of goal themes. Teachers held goals for self-improvement, for the classroom environment, for the direction tasks and activities would go, and also held learning goals in both pure subject matter as well as affect goals such as that students come to value mathematics and perceive it as useful. Teachers monitored the attainment of their goals and were driven to continually work towards goals because they did not think of themselves as ever completely achieving their goals.

The reasoning teachers engaged in related to their goals provided a window into their knowledge and beliefs and how their knowledge and beliefs developed around their goals. This information is beneficial to researchers as well as practitioners and pre-service teachers because this research indicates that teachers' goals can be very useful to uncover teacher knowledge and highlights how influential teacher goals are in the overall learning environment as well as how teachers perceive their own work.

Chapter 1

The history of mathematics education in the United States is one of incessant calls for improvement and change. These calls come from policy makers, researchers, parents, professionals, and other interested parties and have come in times of national crises and conflicts as well as in times of peace. The belief in the power of education to lift one's self to greater levels of peace and prosperity is widespread in our American character (Lottich, 1962). As the United States of America became a great industrial power, mathematics and science education became a natural stepping-stone to attaining one's goals and power over one's future.

Goals of Education—Learning Mathematics

Reports and recommendations regarding mathematics education have been published in every decade for over a century. More recently the National Academy of Sciences again called for change and improvement: "The US system of public education must lay the foundation for developing a work force that is literate in mathematics and science, among other subjects" (2007, p. 112). The authors argued that our economic survival depends on increasing student academic achievement, and that this largely depends on the quality of teaching.

At the foundation of the many calls for improvement is the idea that high quality mathematics instruction is vital for individual and collective prosperity and peace. U.S. students' performance on national and international assessments continues to indicate that we need to improve mathematics teaching for more

students. Further, improvement will not be accomplished without expanding students' opportunity to learn mathematics.

Opportunities to Learn—Decisions that Teachers Make

The National Research Council (2001) asserted, “opportunity to learn is widely considered the single most important predictor of student achievement” (p. 334). The idea is basic: one learns what they have an opportunity to learn. Although opportunity to learn initially referred to topic coverage, researchers became interested in processes in the classroom by which opportunities to learn were mediated.

The National Research Council (2001) defined opportunity to learn as “the circumstances that allow students to engage in and spend time on academic tasks such as working on problems, exploring situations and gathering data, listening to explanations, reading texts, or conjecturing and justifying” (p. 334). Students' opportunities to learn are ultimately mediated by teachers; therefore, what teachers choose to do in the classroom is critical. Hiebert and Grouws (2007), in their literature review of how teaching influences students' learning wrote, “teaching... plays a major role in shaping students' opportunities to learn” (p. 379). They went on to assert that opportunities to learn include more than topic coverage, that *how* a topic is taught influences students' opportunities to learn. Regardless of other factors (textbook, length of school year, standards documents), teachers have control over what is taught, as well as how and when.

Problem and Purpose

What teachers choose to do in the classroom is influenced by their goals for instruction. In other words, teachers' goals are critical to students' opportunities to learn. Teachers choose what is to be learned, how it is to be learned, and when it is to be learned. As a result, the proposed study is intended to characterize secondary mathematics teachers' goals of instruction. Hiebert and Grouws (2007) defined teaching as consisting of "classroom interactions among teachers and students around content directed toward facilitating students' achievement of learning goals" (p. 372). The purpose of this study is to explore teachers' goals within this definition of teaching.

Learning goals are at the core of the educational enterprise and research on teaching toward specific learning goals in intervention settings claims robust results. Hiebert (2003) wrote, "When extra attention is paid to designing classroom instruction with specific learning goals in mind, students usually improve their achievement of these goals (Carpenter, Fennema, Peterson, Chiang, & Loef, 1989; Cobb et al., 1991; Cognition & Technology Group at Vanderbilt [CTGV], 1997; Fawcett, 1938; Good, Grouws, & Ebmeier, 1983; Griffin et al., 1994; Heid, 1988; Hiebert & Wearne, 1993; Markovits & Sowder, 1994; Stein & Lane, 1996; Wearne & Hiebert, 1989; Wood & Sellers, 1996)" (p. 14). Despite results that indicate that teachers can be assigned goals to teach to, and that students tend to display learning relative to those goals, we have extraordinarily little information regarding what teachers' goals are that underpin their instruction and how and where their goals develop. That is, aside from intervention contexts where goals may be assigned, we

do not know much about the goals of the mathematics teachers who teach in the current workforce. Understanding different types of goals, what influences their development, would inform teacher preparation and professional development programs.

Well-defined goals have been identified as crucial to the areas of assessment and formative assessment (Black, Harrison, Lee, Marshall, & Wiliam, 2003; Lesh & Clarke, 2000), discourse (Stein, Engle, Smith, & Hughes, 2008), lesson planning and design (Clark & Peterson, 1986; Hunter & Hunter, 2004; Wiggins & McTighe, 2005), lesson study (Lewis, Perry, & Murata, 2006), meaningful teaching and theories of instruction and pedagogy (Hiebert, et al., 1997; Silver, Mesa, Morris, Star, & Benken, 2009; Simon, 1995, 2006), and learning to teach literature (Hiebert, Morris, Berk, & Jansen, 2007; Hiebert, Morris, & Glass, 2003; Hiebert & Stigler, 2000). For example, Stein, Engle, Smith, and Hughes (2008) argued that many teachers are unclear of what should occur in terms of discourse, and struggle to build toward important mathematical ideas. Stein et al. built upon an argument by Ball (1993) when they argued that:

[The] field need[s] to take responsibility for helping teachers to learn how to continually “size up” whether important mathematical ideas were being developed in... discussions and be ready to step in and redirect the conversation when needed. Unfortunately, guidance for how to do this remains scant. (p. 319)

Stein and her colleagues then identified five practices for promoting productive mathematical discussions. In addition, they argued that success in implementing the five practices depended upon “well-defined instructional goals” (p. 322).

Teachers' goals are an understudied link in the chain from teachers' knowledge, beliefs, and decisions to students' learning and opportunities to learn. Whereas the domains of teacher knowledge, beliefs, and behavior have received much research attention recently, teachers' goals—a critical link between these areas—remain understudied. Teacher knowledge and beliefs have been studied because it is believed that good teaching, thus student achievement, are dependent upon teachers' knowledge, beliefs and practices. Teacher behavior has also been studied extensively, but we have learned that we cannot simply adopt behavior and achieve positive results because individual contexts vary so greatly (Brophy & Good, 1986). Our behavior is regulated toward the achievement of specific goals (DeShon & Gillespie, 2005; Locke & Latham, 1990) and yet we know very little about teachers' goals in the classroom. The purpose of the research proposed herein is to investigate and characterize secondary mathematics teachers' instructional goals as well as the sources that influence the development of those goals.

Theoretical Considerations

Goals are integral to the cognitive aspects of teaching and the pragmatic organization, design, and enactment of mathematics lessons. In this section, I discuss how goals direct teachers' efforts in the classroom.

Goals in a Theory of Teaching

In Schoenfeld's (1998) efforts to develop a theory of teaching that enables one to "explain how and why teachers do what they do *while engaged in the act of teaching*" (p. 6, emphasis in original), he generated a cognitive model of teaching, where knowledge, goals, and beliefs activated in context affect and influence

teachers' decision making and actions. These components are influenced by one's historical knowledge of past experiences with the students, the mathematics they have learned, and the plans and routines that have been previously enacted.

The practical work of the University of California—Berkeley teacher-modeling group with which Schoenfeld is associated is to build a theory of teaching. Their basic goal is to develop a theoretical model that allows “an explanation of precisely why teachers make particular choices at each point of instruction and precisely which beliefs, goals, and knowledge those decisions depend upon” (Schoenfeld, 1998, p. 3). The desired end, though, is more than such an explanation; it is the ability to predict and explain teaching more fully and completely than before. The idea is that at any particular moment in a lesson, a constellation of the teacher's knowledge, goals, and beliefs are at a high activation level—they are being drawn upon—while others lie in the recesses of the mind. Then, as the lesson moves forward, and goals are met or interrupted, new goals, beliefs, and knowledge are activated, decided upon and acted on.

Schoenfeld's (1998) model advances the cognitive research on teaching and brings goals onto equal footing with knowledge and beliefs. Even so I believe that the sequence from the decision making to action is underspecified. In Schoenfeld's model decisions appear to be equally influenced by teachers' knowledge, beliefs, and goals. I accept this, however, I argue that behavior is directed by one's goals (Locke & Latham, 1990). So in building on Schoenfeld's model I believe that given knowledge, beliefs, and goals, and the influence and interaction among these, a decision is made that identifies a more well-defined goal that guides behavior. The

decision-making process functions iteratively in the choosing, pursuing, and monitoring the attainment and progress toward goals that exist at different levels (Carver & Scheier, 1998; DeShon & Gillespie, 2005; Locke & Latham, 1990).

How does this process work in teaching? Consider the basic work of teachers; tomorrow they will have to teach another class or set of classes. The goals at this level are fairly broad and may include having a good lesson, building on today's work, preparing for something that follows, maintaining and building a positive working environment, building students' ability to problem solve, or persist etc. At this point the goal to successfully teach the class is underspecified which prompts the teacher to think further about what to do. Teachers draw on their knowledge of previous instruction, what students have understood or not, the curriculum in terms of content and timeline, societal expectations, and state and local standards. The teacher's beliefs and values play a role in organizing this information by sorting out whether something is worth giving more or less time to, what is important for the students to learn, how they learn it, how they might learn it better, and what strategies might be tweaked in certain ways to improve the lesson. From this milieu, the teacher makes decisions that map out, in increasing specificity and at increasingly concrete and behavioral levels, what is to be done in the class. The teacher's subsequent considerations may continue up to the moment that action is demanded during the class and continue as the teacher monitors progress toward goals. At each level of specificity the teacher's goals are based on and regulated by an increasingly defined knowledge base, beliefs, and other related goals.

Through this process the teacher's goals for the next class have been transformed into highly specified intentions that prompt specific actions. At this point, the goals are still ideas that require action to make them happen. A goal is something to be accomplished, but it is only an idea; it maps out actions to take to decrease the tension between desired end states and the present. The action plan, when enacted, is the effort made toward realizing a goal or goals.

Goals: Definitions and Mechanisms

To discuss important aspects of goals and how they relate to human behavior, I turn to goal-setting theory. Goal-setting theory, largely pioneered by Locke and Latham (Locke, 1996, 2000; Locke & Latham, 1990, 2002, 2006), falls under the umbrella of motivation research in industrial psychology. One of the other significant areas in motivation research is *goal theory*, also known as *achievement goal theory*, which is focused on mastery and performance goals in achievement contexts. Other motivation researchers have developed taxonomies of goals and conducted research on performance or behavioral objectives. What makes goal-setting theory germane to the research proposed herein is that it is open to the specification of goal content and the content of teacher's goals is somewhat different from day to day with the progression through subject matter.

In this section I explain central principles of goal-setting theory that are specifically relevant to the proposed study. The central principles are briefly overviewed and described in greater detail. Goals are derived from two sources: internal and external, and are mediated through one's knowledge and beliefs. Self-efficacy plays a major role in the quality and intensity of one's goals and is highly

interconnected to one's knowledge and beliefs. Goal-setting theory maintains that goals have two main attributes: content and intensity. Additionally, goals exist at various levels from over-arching "big picture" goals down to behavioral and neurological goals. Goals between levels are highly interconnected. Teachers' goals, as enacted in the classroom, affect students' opportunities to learn. Figure 1 contains a conceptual mapping of goals in the teaching context. Note that the bold areas identify the focus of this study.

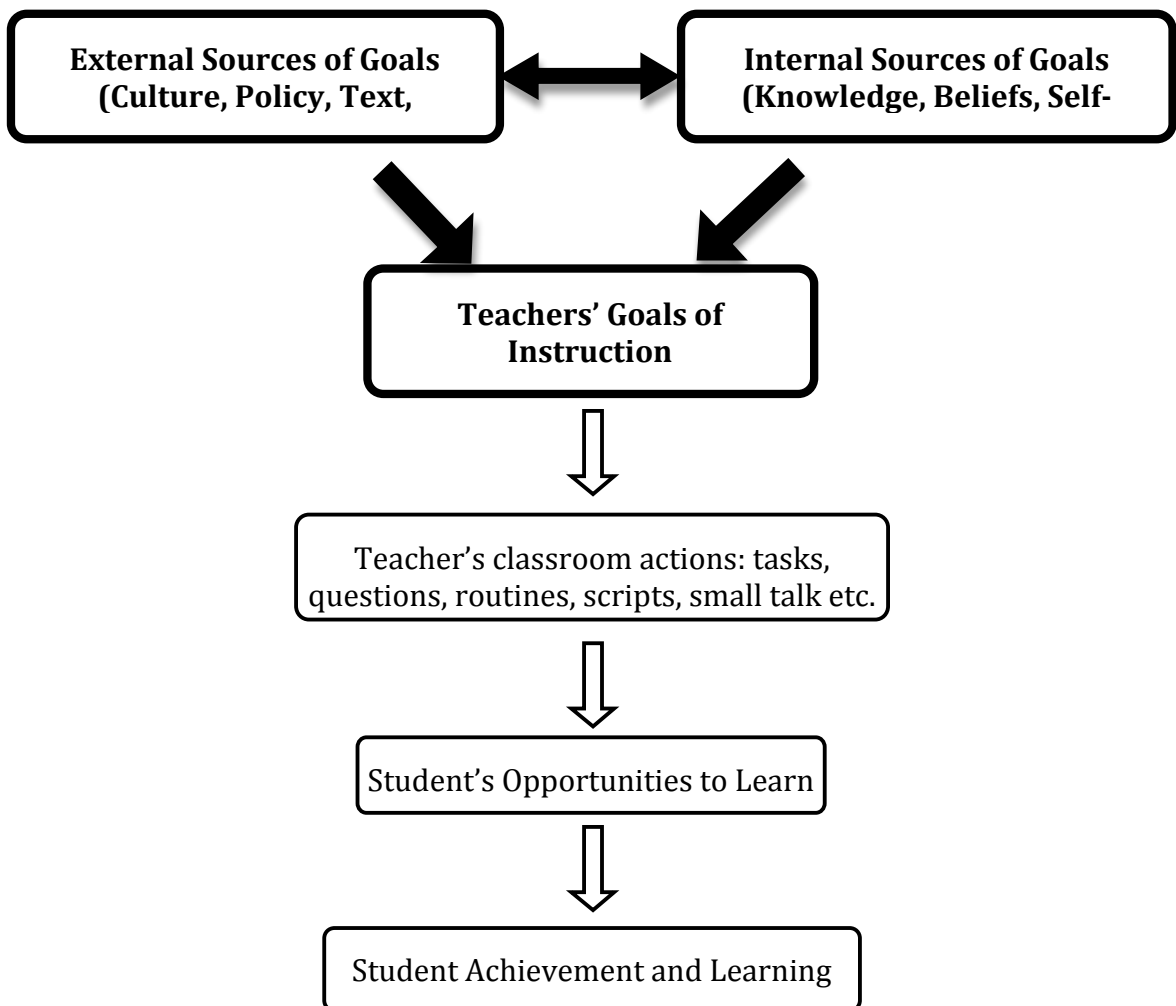


Figure 1. Conceptual location of teachers' goals in the context of teaching and learning.

Locke and Latham (1990) stated, “goal setting theory provides an immediate or first-level explanation of action. Goals and intentions are viewed as immediate precursors and regulators of much, if not most, human action” (p. 8). The theory rests on two central assumptions: that people possess the power to think (cognition) and the power to choose (volition). That our actions are regulated by our thoughts is an assumption that is backed by considerable pragmatic theorizing of cause and effect. Ryan (1970, as cited by Locke & Latham, 1990) observed that “to the layman it seems a simple fact that human behavior is affected by conscious purposes, plans, intentions, tasks and the like (p. 18)” (p. 2).

Goals are defined as “cognitive representations of what individuals are trying to accomplish and their purposes or reasons for doing the task” (Pintrich, 2000, p. 96). Goals direct action toward desired end states and come with recognition that the present does not contain that state. Depending on the context, other words and phrases are synonymous with the word goal, such as objective, purpose, end, cause, aim, task, deadline and intention (Locke & Latham, 1990). These words embody the idea that there is something one wants to achieve, accomplish, or attain. To have a goal is to recognize the difference between an ideal and one’s perception of present reality. This recognized difference creates “a state of tension that [is] maintained until reduced by the performance or completion of the intended activity or a substitute activity” (Locke & Latham, 1990, p. 13). But the tension varies and it depends on the quality and value of the goals. One’s needs and thinking impact the quality and value of goals. At the most basic level, life needs tend to merit the highest value, such as eating, but even being necessary to one’s survival does not

mean that a person takes action to meet that need. At a deeper level, goals are based on values. We make goals around things we value, and we do not tend to make goals around things we do not value.

A person can have many or few goals, and these goals can be focused or vague. The nature of one's goals is dependent on the quality of one's thinking, and one can choose to think carefully or not very carefully. Locke and Latham (1990) described the relationship between the quality of one's goals, actions, and thinking.

The nature of an individual's thinking... will affect whether he or she sets specific or vague goals, long-range or short-range goals, consistent or contradictory goals, personally meaningful or meaningless goals, and realistic and unrealistic goals. It will also affect the degree of commitment to goals and the degree to which rational plans are developed for achieving them. Thinking is also pertinent after goals have been formulated. The individual also has to choose to take action in accordance with each chosen goal by keeping in focal awareness what is to be achieved, the means needed to achieve it, and the reasons for or benefits of such action. (p. 11)

Self-efficacy is a significant factor in the nature and quality of one's goals. Locke and Latham (1990) wrote, "goals, if chosen by people themselves, are based on such factors as their beliefs about what they can achieve, their recollections of past performance, their beliefs about consequences, and their judgments of what is appropriate to the situation" (p. 10). Self-efficacy plays a role both in the choosing of goals and the performance of actions to meet those goals. "Self-efficacy... affects goal choice, goal commitment, and response to feedback, and it also has a direct effect on performance" (Locke & Latham, 1990, p. 24). Self-efficacy combines all the factors that contribute to one's estimation of whether they can, cannot, and how difficult or easy it might be to accomplish a task. These factors include "past performance, ability, adaptability, capacity to coordinate skilled sequences of actions,

resourcefulness, etc. (Bandura, 1986, pp. 231-232)” (p. 68). These elements reflect the intertwining of one’s knowledge and beliefs.

Knowledge plays a special role in attaining goals. When a goal is chosen, related knowledge is activated to the attainment of the goal. For example, if a teacher chooses the goal that students understand equivalent fractions, the teacher’s knowledge of representations and classroom sequences are drawn upon to meet the goal. But if a goal is chosen that one does not have the knowledge to attain, and if one is committed to the goal, the teacher searches for knowledge necessary to meet the goal. This explains Ball’s (1993) efforts to develop meaningful representations of negative numbers for her 3rd grade students, an effort prompted by her dilemmas that arose “directly from [her] explicit goals” (p. 377). Locke and Latham (2002) reported that challenging “goals... [can lead] to the arousal, discovery, and/or use of task-relevant knowledge and strategies (Wood & Locke, 1990)” (p. 707). In other words, the motivation to develop specific knowledge arises through dilemmas related directly to our explicit goals. This concept relates to self-efficacy because self-efficacy is raised when one acquires the knowledge necessary to meet one’s goal (Locke & Latham, 2002).

Goals: Content, Commitment, Level and Source

I describe attributes of goals in this section. These attributes provide important information that help us understand the quality of a goal. Locke and Latham (1990) identified two main attributes of goals: content and intensity. Content refers to the *what* of the goal—what is the nature of the goal, what is it about? In the teaching context, the content of goals might refer to the big

mathematical ideas or processes the teacher intends for the students to learn. Goal content might be further categorized in terms of strands of mathematical proficiency (National Research Council, 2001), or process standards (National Council of Teachers of Mathematics, 2000), or Bloom's taxonomy of learning (Anderson & Krathwohl, 2001; Bloom & Engelhart, 1956). Furthermore, the content of goals might be fragmented, thorough, contradictory, coherent, over-arching, or highly specific. The content of one's goals is different at different levels of abstraction. The content of one's goals becomes more defined, precise, and action-based at levels closer to context and action. At higher abstract levels goals are rooted in needs or may provide rationale for lower goals (DeShon & Gillespie, 2005).

Intensity refers to the "place of the goal in the individual's goal hierarchy, the degree to which the individual is committed to the goal, and the importance of the goal" (Locke & Latham, 1990, p. 26). A more inclusive construct is commitment, which is used in this study. Commitment refers to "one's attachment to or determination to reach a goal" (Locke & Latham, 1990, p. 125). Commitment is demonstrated by repeated and concerted effort to reach a goal and is therefore observable in teacher actions.

In addition to the content and commitment, goal attributes include level and source. Level refers to the degree of specificity and the timeline across which the goal is active. Level has been referenced previously; here I describe this attribute more completely. Abstract or high level goals, such as building problem-solving ability, refer to overarching intentions that may be active across a school year or unit of instruction but do not necessarily specify the activities to be used to meet the

goal. High-level abstract goals might better be identified in the teaching context as unit or course goals. Medium level goals can be thought of as lesson goals. Lower level goals become increasingly specific about the action to be taken and take into account more details about the context. High, medium, and low are not, then, hierarchical indicators of quality, but are rather temporal indicators of specificity.

For example, suppose a teacher intends to teach a lesson in a unit on statistics and probability. Perhaps this unit is part of an Algebra 2 class. Course level goals might be that students understand how various families of functions could model data, and further that students develop skills and abilities to reason through and communicate mathematical ideas. A unit on statistics fits within the course level goals and a teacher might have goals for the unit that students understand the normal curve and how it can be used to explain probabilities and differences associated with statistical data. A lesson level goal could be that students understand standard deviation, what it means and implies, how to calculate it, and how it can be used to describe some aspect of a data set. Within these lesson goals a teacher could further specify activities and the ideas the students are to gain by participating in those activities. At this level the teacher could have goals about what types of questions to ask and/or which students to call on or interact with.

One could ask a teacher about their goals down to a very fine level of detail, but it is possible to take the level of detail too far. Teachers' actions at fine levels of detail may not be meaningful in and of themselves but are meaningful as part of a bundled set of actions, all of which are in service of a single goal. The challenge becomes articulating the level at which goals are to be identified and analyzed in

this research. I intend to investigate teachers' goals at the level of course, unit, lesson and within the lesson as far as they are meaningful.

Teachers' goals at different levels have been referred to in the literature on teaching, mostly at the level of the lesson and activity within the lesson. At the lesson level, Schoenfeld (1998) described *lesson images* which comprise a teacher's related historical knowledge as well as his/her knowledge of routines and scripts in conjunction with goals, and beliefs that serve to steer the lesson. Lesson images are akin to what Leinhardt and Greeno (1986) termed *agendas*. At a finer level within a lesson, Leinhardt and Greeno defined *activity structures* as those components within a lesson agenda such as reviewing homework, presenting materials or posing questions, group and individual practice or problem exploration, etc. Schoenfeld (1998) referred to these activity structures as action plans, and he defined them as they relate to goals: "An action plan is a set of actions intended to be taken in order to work toward the achievement of a constellation of current high priority goals" (p. 27). It is at this level of goals that this research focuses.

A final attribute of goals is that of source. In a teaching context, where the teacher is the ultimate decision maker, some goals are generated through one's own cognitions about what should and can be done, and some are mandated through standards and expectations advocated by other individuals and groups in society. The relationship between assigned goals and personal goals is not straightforward. One can argue that any assigned goal is mediated through one's personal goals, that when an individual is assigned to "do something" they adopt the doing as a personal goal, even if begrudgingly. Nevertheless, it is worthwhile to distinguish the original

source of a goal, particularly in a classroom where the school, district, state, and society mandate particular efforts.

Research Questions

Goals are one of three significant cognitive bases of decision-making and teaching. Goals are ideas to be accomplished. They are tightly bound to one's knowledge and beliefs. Teachers' goals guide their acts in the classroom upon which students' opportunities to learn and their achievement are based. Goals are ultimately pursued at the individual level, but goals can come from initial sources outside of the individual.

In this study I investigate secondary mathematics teachers' goals for instruction in terms of the attributes: content, commitment, level, and source as well as the extent to which teachers believe that they can accomplish their goals. The question that guides this research is: What is the nature of the goals that secondary mathematics teachers employ during instruction? Specific research questions are:

- What are the goals of secondary mathematics teachers' that direct their activities, choices, and organization of their classroom as borne out in their instruction?
- What sources do secondary mathematics teachers identify or otherwise can be inferred as contributing to these teachers' goals?
- What level of commitment do secondary mathematics teachers describe towards their goals?
- To what extent do secondary mathematics teachers claim to meet their goals?

Goals as an object of study appear on the periphery of much research and theorizing on teaching, but few, if any, have taken goals as the focus of research. I recognize that the context in which teachers teach influences their goals. Subsequent research can be directed towards taking into account the relationship between various contexts and teachers' goals in those contexts. For this study, I investigate and characterize mathematics teachers' goals in the context of day-to-day instruction.

Significance of the Proposed Research Study

Goals serve as the lynchpin between teacher knowledge and beliefs, and behavior. While much research has been focused on these three areas, goals have been studied to a much lesser extent. By knowing more about teachers' goals and their sources at various grain sizes, I hope to address this critically important but under-researched area of mathematics teaching. Characterizing teacher's goals will provide teacher educators and teaching theorists with important information to explain, support, and improve mathematics instruction.

The NRC (2001) reported that teachers' plans typically include the activities students will engage with and how those activities are organized, yet the content that students are to learn is rarely elaborated. The authors further indicated that "Researchers have rarely explored what it might mean to prepare for teaching in ways that would elaborate content goals and simultaneously equip the teacher with good maps of the paths they might take to reach the desired destinations" (p. 337). They suggest that in designing lessons one should "combine a significant elaboration of one's content goals with a dedicated and thorough anticipation of and

preparation for a range of likely student responses” (p. 337). Additionally, Silver and colleagues (Silver, et al., 2009) stated, “A careful analysis of the varied, and possible competing, goals that teachers hold for the instructional activities...might shed more light on how to assist teachers to employ innovative pedagogical strategies more effectively” (p. 526). The purpose of this research study is to address this under-researched area, and in so doing, respond to the calls for research that indicates a need to know more about the specification and elaboration of teachers’ goals, their source, and influence in the context of classrooms.

The quality of one’s goals does affect performance (Locke, 1996). In the teaching context, teacher goals are likely to have a significant impact on student achievement. This study will answer significant questions that are necessary precursors to explore this link. This study will provide information on goals that leads to a more complete and integrated understanding of mathematics teaching and the relationship between teaching and achievement. Such an understanding contributes to building a theory of teaching that would allow one to more fully understand different qualities, and different levels of qualities of teaching.

Chapter 2 Literature Review

A challenge of writing a review of literature about the nature and characteristics of teachers' goals is that goals are intrinsic to every purposeful action. In other words, goals are implicitly in many bodies of literature on teaching. However, in the mathematics education literature, goals have been of secondary interest to mathematics education researchers as they examine some other aspect of teaching or teachers. So while goals are tacitly referenced in much of the mathematics education literature, few researchers have taken teachers' goals, in the way I define them in this research, as the object of study. Consequently, mathematics education research has shed little light on the nature and characteristics of teachers' goals. However, teachers' goals have been well researched in the area of goal theory. Thus, in this literature review I first overview teachers' goals in light of goal theory, followed by a discussion of goals as researched in the areas of teacher planning and decision making. Then I review relevant studies on teaching as a system both in mathematics and non-mathematics subjects and mathematics expert-novice teacher research.

Achievement Goal Theory

Goal theory falls under the area of motivation research. At the heart of the theory is a dichotomy between mastery and performance goals. Mastery goals are defined as goals to develop ability. Performance goals are defined by a desire to demonstrate ability as well as or better than a reference peer group. The development of the theory consists of linking and exploring relationships between cognitive structures (knowledge, beliefs, efficacy, interest, success, effort, errors,

etc.). Much research has been conducted to explore the type of goals students have and how this relates to their achievement, and that research has expanded to increasingly take into account the context in which the students are situated that promote one type of goal over another (Deemer, 2004; Urdan & Midgley, 2003). Ames (1992) identified three aspects of classrooms that affect the promotion of the two different types of goals: the task and activities, the evaluation practices, and the distribution of authority of the content.

The theory is more involved than a simple dichotomy between performance and mastery types of goals. In fact, other factors such as interest, beliefs, purpose, and context are evaluated in making assignments to one type of goal or another. In further parsing and evolution of goal theory, Pintrich (2000) proposed three perspectives on goals. The main difference in these levels is the level of specificity of the goals and the extent to which purposes or reasons are included with these goals. The three types are (a) target goals—which are so specific as to only identify evaluation criterion (such as getting an A on a test) but do not specify reasons or purposes for attaining the goal, (b) goal content approach, which includes general/nebulous goals individuals pursue such as happiness or safety and reasons why, and (c) achievement goals, which fall between target goals and the goal content approach. Achievement goals represent “an integrated and organized pattern of beliefs about, not just the general purposes or reasons for achievement, but also the standards or criteria (the “target”) that will be used to judge successful performance (Urdan, 1997)” (p. 94). It is believed that teachers’ goals will vary in specificity as well as the extent to which purposes and reasons are identified.

Although no studies in goal theory appear to reveal information about the content of teachers' goals, they are helpful in understanding the nature of goals and some studies provide information relative to teacher efficacy. For example, Eren (2009) explored the relationship between student teachers' efficacy and their own achievement goals (not achievement goals they had for their students) and their conceptions about teaching and learning. Eren administered a battery of several questionnaires to 374 Turkish student teachers. Eren's main finding was that a "high mastery-approach goal orientation, high self-efficacy beliefs, low performance-avoidance goals, and low traditional conceptions are the main characteristics of student teachers with constructivist conceptions" (p. 79). Although this study does not reveal specific information relative to the content of teachers' goals, it does indicate that high levels of efficacy are correlated with teachers' willingness to diverge from familiar scripts of teaching.

Deemer (2004) conducted a review of several studies and related findings similar to Eren's (2009). She wrote:

Teachers with low levels of efficacy often expend little effort in finding materials and planning lessons that challenge students, show little persistence with students having difficulty and display little variety in their teaching strategies. Conversely, teachers with high levels of efficacy are more likely to seek out resources and develop challenging lessons, persist with students who are struggling and teach in a multitude of ways that promote student understanding (Bandura, 1997; Pajares, 1996; Tschannen-Moran et al., 1998). (p. 74)

Both Eren and Deemer convey that teachers with high self-efficacy are more inclined to push through challenging teaching experiences and seek for and implement alternative strategies to meet their goals.

Goals in Lesson Planning

Clark and Peterson's (1986) well-known literature review on *Teachers' Thought Processes* includes reviews of teacher planning and decision-making. Both of these areas are relevant to this study because teachers' plans include or represent their goals, and teachers' decisions are based on their goals. Clark and Peterson reviewed 10 studies in which the planning process was an object of study. Of those 10 studies, 9 specifically reported teachers identifying and articulating goals or objectives as part of the planning process. The one study that did not report information regarding teachers' natural identification of objectives was conducted to determine teachers' inclination to use a systematic planning model.

One of the 9 studies went further in investigating *when* teachers think about objectives. McLeod (1981) collected data at several points of the planning and teaching cycle with 17 kindergarten teachers and found that 46 percent of instructional objectives were formulated in the formal lesson planning period or after the planning but prior to teaching. She also found that 45.8% of instructional objectives were defined during the act of teaching and 8.2% were identified upon reflection of a lesson. The review by Clark and Peterson (1986) indicates that teachers identify instructional objectives (goals) when they plan their lessons, but it does not reveal information regarding what those goals are.

Borko and Shavelson (1983) and Toomey (1977) found that teachers do not necessarily plan in a linear fashion after the Tyler model (1950) where objectives are stated first followed by selecting and organizing activities and evaluative procedures. Yinger (1977; as cited by Clark and Peterson, 1986) found that teacher

planning is more cyclical than linear and that events in the classroom on Day 1 influence plans for Day 2. He claimed that plans are elaborated progressively in iterative cycles. Borko and Shavelson indicated that teacher planning is iterative finding that teachers move between goals, activities, and students as learners, with all the history they entail, as they elaborate their plans.

Borko and Shavelson (1983), in their literature review of teachers' cognitions, claimed that tasks form the basic structural unit of lesson planning. They further asserted that a task is defined by "its goals, routine procedures and assumed inputs" (p. 212). Then they briefly described goals as falling into cognitive, social, and motivational categories. Finally, they wrote, "One of the major complexities of teachers' planning is reaching a reasonable balance between multiple goals" (p. 212). Borko and Shavelson's literature review provides evidence that teachers' goals are closely connected to instructional tasks, and that their goals fall into three categories.

Toomey (1977) investigated the degree of specificity of four high school social studies teachers' goals. All four teachers had learning goals, but two of the four tended to be more comfortable when they first delineated specific goals and then created or found activities to meet those goals. The other two teachers tended to first identify activities and then consider how these activities could be enacted in order to meet overarching types of goals oriented toward students' productive disposition, such as listening to others ideas and expressing their own ideas. The latter two teachers did not specify learning objectives, but it was clear that they had ideas about what they wanted to happen in the classroom, even if it was not in the

form of subject matter content. Toomey associated the degree of need for specificity of objectives with characteristics of the teacher. He wrote, “the perception the teacher has of the teacher-student relationship, of the appropriateness of content-materials, and of the nature of the instructional process may well help to shape his decision about how to frame his objectives” (p. 126). He went on to classify his participants as being more knowledge-centered or more student-centered, and associated these orientations to their need for specificity in identifying objectives.

Clark and Peterson (1986) also reviewed literature in the area of teachers’ interactive thoughts and decision-making. Marland (1977; as cited by Clark and Peterson) reported that of the teachers in his sample 44% of their decisions were about student behaviors that were: (a) out of accepted levels of behavior (20% of teachers decisions); (b) were taken as an indication that student’s were not understanding (3% of decisions); or (c) were identified as representing incomplete or unsatisfactory work or responses (19 percent of teachers decisions). A teacher who reports making an instructional decision based on student’s behavior as an indicator of a lack of understanding, reveals that the teacher realizes that (s)he is not meeting a learning goal. The point here is that teachers’ interactive thoughts and decisions are in some measure based on their goals.

Mathematics Teaching Studies

Hiebert, Gallimore, et al. (2003) conducted an analysis of teacher goals as part of the 1999 TIMSS video study report *Teaching Mathematics in Seven Countries*. The countries in this study included the United States and six high achieving countries from the 1999 TIMSS study. These researchers argued that, “to better

understand, and ultimately improve, students' learning, one must examine what happens in the classroom" (p. 2). They further identified four reasons for examining teaching in multiple countries: (a) "Reveal one's own practices more clearly" (p. 3); b) "Discover new alternatives" (p. 3); (c) "Stimulate discussion about choices within each country" (p. 4); and, (d) "Deepen educators' understanding of teaching" (p.4). These ideas relate parallel hopes for the value of this dissertation study.

Data collected for the 1999 TIMSS video study (Hiebert, Gallimore, et al., 2003), included video from approximately 100 8th-grade mathematics lessons each by different teachers in each of the seven countries. Teachers of those lessons also completed questionnaires that included four open-ended prompts that had teachers identify lesson, unit, and course goals. Additionally, teachers were asked to explain whether they were satisfied that the video-taped lesson had achieved their intended purpose(s). Teachers' lesson goals were identified as fitting into three categories: (a) content, (b) process, and (c) perspective. Hiebert, Gallimore et al. defined these categories as follows:

Content goals were identified by statements describing specific mathematical concepts or topics. Process goals were defined as descriptions about how teachers wanted their students to use mathematics, such as "solve equations," "solve problems," and "apply mathematics to everyday situations." Perspective goals included those aimed at promoting students' ideas and interest in mathematics and learning, such as "to be sure of their math abilities," "to see that math is fun," and "to learn to be neat and orderly in their work." (p. 20)

Teachers' goals were coded into multiple categories. Of the U.S. teachers' lessons, 81% had identified a content goal, 96% had identified a process goal, and 11% had identified a perspective goal. Only two statistically significant differences occurred in this analysis across the seven countries, and neither of these involved the U.S. In

other words, the category of goal and percentage of those goals in the set of lessons for each country were remarkably similar.

Hiebert, Gallimore, et al. (2003) further categorized the process goals into six categories, but did not report further analysis of the content and perspective goals. I list those categories here with the percentage of U.S. lessons that were identified as having these goals: (a) using routine operations (41%); (b) reasoning mathematically (8%); (c) applying mathematics to real world problems (14%); (d) knowing mathematical content (19%); (e) other process goal (15%); and (f) no process goal identified (4%). No statistical differences were detected across the countries on any of these categories. The researchers additionally analyzed video and found that U.S. teachers either verbally stated or wrote some form of a goal statement in 59% of the lessons. In addition, through analysis of the questionnaire, they found that at least 83% of teachers felt “satisfied” with their lessons. This indicates that the teachers felt they had achieved their lesson goals to some satisfactory level.

The 1999 TIMSS video study represents a substantial effort to identify teachers’ goals, but was based largely on just a few typed responses to open-ended questions. The findings reported appear to be at the lesson level, leaving other levels of goals absent despite having collected data on such. Researchers conducted no interviews with the participating teachers to determine how committed teachers were to various goals or to glean additional goals. In other words, more might be learned by increased focus and data collection around teachers’ goals. In this study I expand on their findings by providing greater depth of analysis on teachers’ goals

both as verbalized through interviews as well as attributed in video analysis and confirmed in interview.

Norton, McRobbie, and Cooper (2002) investigated nine Australian secondary teachers' goals and practices to investigate their response to constructivist-based reform documents. The participants in this study responded to a 31 question Likert-scaled questionnaire assessing their orientation, then were observed teaching two to four lessons and were interviewed relative to these lessons. During the interviews the teachers were asked, "to explain their reasons for conducting classes in the way that they did" (p. 42). This prompted responses that the researchers used to identify the type of goal and pedagogical orientation of the teachers. Goals were identified as conceptual or calculational in reference to able and less-able students. All teachers were identified as having conceptual goals with their able students. For less-able students seven of nine teachers were identified as having calculational goals. These categories can be considered as a basis for coding and analysis for this research study. Additionally the data collection process of this study provides a basis for data collection of this dissertation research.

Andrews, Hatch, and Sayers (2005) asked, "What do teachers of mathematics teach?" (p. 9). Their work consisted of collecting video data on four middle grades teachers from each of four countries: England, Flanders (Flemish Belgium), Hungary, and Spain. These researchers had an interest in examining differences across countries, revealing unexamined traditions, and relating emphases on varying mathematical foci to international achievement data. Teachers were selected by teams local to each country to represent "the better practice in that

country” (p. 10). Each teacher was videotaped teaching four or five lessons in preselected topic areas. Local teams conducted analyses by investigating coherent segments of lessons termed *episodes* in which the “teacher’s didactic or managerial intention remained constant” (p. 10). These episodes were identified with one or more pre-determined mathematical foci: (a) conceptual; (b) derivational; (c) structural; (d) procedural; (e) efficiency; (f) problem solving; and (g) reasoning. According to these researchers, a structural focus was identified when the teacher “emphasizes or encourages the links or connections between different mathematical entities; concepts, properties etc.” (p. 11). An efficiency focus was identified when the teacher “emphasizes or encourages learners’ understanding or acquisition of processes or techniques that develop flexibility, elegance or critical comparison of working” (p. 11).

Overall, teachers across the countries were roughly similar in emphasizing the mathematical foci conceptual development and procedural skill with a derivational focus being the least represented (Andrews, et al., 2005). A derivational focus was identified when a teacher “emphasizes or encourages the process of developing new mathematical entities for existing knowledge” (p. 11). The definition for conceptual development was defined as “conceptual development” so it is difficult to say how this differed from the derivational focus. Perhaps the conceptual focus refers to developing meanings of mathematical objects, but this is not clear. Although the predominant mathematical foci were roughly similar across countries, the less dominant mathematical foci found in lessons across countries were dissimilar. The variability in the less dominant mathematical foci indicate

different national patterns of behavior and traditions. For example, the percentage of structural focus episodes in English teachers' lessons was significantly smaller than the other countries.

The mathematical foci Andrews et al. (2005) inferred in episodes represents an abstract framing of the mathematical content goals in lessons. Their unit of analysis of an episode or segment is the same level at which I have analyzed teachers' goals.

Non-Mathematical Teaching Studies

Researchers outside of mathematics education have examined teachers' goals from general, non-context specific perspective (Lei, 2008), or from a context other than mathematics (Grauerholz & Gibson, 2006; Hmelo-Silver & Barrows, 2006). Lei's work involved a 31-question 4-point Likert survey of teachers at two community colleges in a western state. The purpose of his study was to examine the purposes to which community college teachers teach. He argued that community colleges serve multiple purposes. This study revealed what teachers at the two community colleges were trying to accomplish given the diversity of their student population and the function that the community college offered them. Lei wrote goal survey questions in the categories of knowledge, skill, and affect (roughly parallel to that by Hiebert, Gallimore et al. (2003) codes—content, process, perspective). Among Lei's findings were that teachers rated the integration, application, and knowledge of concepts and principles at the highest level of importance, and recall of facts lowest. Still, the average rating for recall of facts fell between the not very important to somewhat important level of importance. Teachers also rated written

and oral communication at the highest in the skill category, and motivation, positive attitude, and appreciation of the subject at the highest level of importance in the affect category. Lei's study not only revealed trends and values in what teachers intend in the way of knowledge, skill, and affect, but also led to three recommendations, one of which was to organize lessons toward categories in Bloom's taxonomy (Bloom & Engelhart, 1956).

Grauerholz and Gibson (2006) examined university and college sociology teachers' goals and means as revealed in their syllabi. The purpose of this study was to answer questions the discipline had been wrestling with such as: What is important to the field? And, to what degree do teachers' goals align with that of policy documents? Grauerholz and Gibson found that the most frequently occurring goals of teaching sociology were to help students understand the concept of social structures, what these structures implied in social settings, and to develop skill to "think sociologically" (p. 13). Grauerholz and Gibson concluded that their findings represented common values and recommendations as presented in a well known sociology standards and policy document.

Hmelo-Silver and Barrows (2006) reported the goals and strategies of a problem-based learning facilitator in the context of a medical curriculum. The purpose of this research was to explain and understand more completely the work of a problem-based learning facilitator. The data collection included video observation and stimulated recall, and analyses were conducted to identify both goals and strategies to accomplish those methods. The results regarding the teacher's goals were categorized as either learning goals for the students, or

performance goals that explained efforts made by the teacher. Hmelo-Silver and Barrows defined these categories as follows: “Educational goals refer to what the students were expected to learn, whereas the performance goals refer to the behaviors that the facilitator wanted to encourage” (p. 27). The learning goals included the goal that students would understand very specific disease processes and mechanisms, patient’s symptoms, treatment options, and the interactions among these. Additionally, learning goals included the development of student self-monitoring and self-directed learning processes. The teacher’s performance goals included such things as keeping students actively engaged in the learning process, making student’s thoughts and knowledge apparent, and facilitating students’ development of self-awareness and monitoring.

It seems that the performance goals (Hmelo-Silver & Barrows, 2006) reflected how the teacher intended to facilitate the learning, as well as a re-articulation of the educational goals. In addition to educational goals, this study reveals a type of goal that may be less about learning goals, but still directs teachers’ performance and behavior. An example of something like a performance goal for a mathematics teacher might be the goal to build knowledge of how students are making sense of a particular idea given a specific task. In other words, the teacher’s goal may be to examine what students are learning based on a specific task, with the eye to modifying or adjusting instruction to better meet the learning or educational goals.

These studies outside of mathematics have been conducted with various purposes: to determine what the field thinks is important to teach, to explain and

understand the behavior of the teacher, to monitor implementation and alignment with policy, and to examine the goals of teachers who are expected to meet the needs of diverse learners. Each study included knowledge and skill as categories of goals and one study identified the additional category named *affect*. These categories arise often and seem to provide a basis for categories possible in the analysis of the content (what it is about) of mathematics teachers' goals.

Expert-Novice Mathematics Teachers Studies

Another body of literature that provides some information relative to teachers' goals is the literature on teacher cognition. These studies have been conducted to better understand teacher thinking and behavior and often these studies include contrasts between novice and experts. The following paragraphs represent findings in the area of mathematics education novice-expert studies.

Artzt and Armour-Thomas (1999) contended that "knowledge, beliefs, and goals directly influence thinking across three stages of teaching: preactive (planning), interactive (monitoring and regulating), and postactive (evaluating and revising)" (p. 213). The purpose of their study was to develop a framework that allowed for the systematic examination of practice. Their framework included the cognitions (knowledge, goals, and beliefs) of teachers. Artzt and Armour-Thomas interviewed seven experienced and seven beginning secondary school mathematics teachers prior to observed lessons, and twice after observed lessons. The two post-observation interviews involved viewing video of the lesson; in one of these interviews, teachers were allowed to stop the video at any point and talk about decisions they were making, the other interview was a debriefing interview directed

by the researcher. Artzt and Armour-Thomas categorized and reported data in an integrated holistic perspective that combined factors from the teachers' knowledge, goals and beliefs. Consequently the information they shared relative to teachers' goals were embedded in their description of teachers.

Artzt and Armour-Thomas (1999) reported teachers' goals as they related to the degree of effort put toward student understanding, content coverage, or behavior management. One finding is that teachers who directed their efforts toward student understanding were deemed as more accurate in their reporting of having achieved their goals. Those teachers who expressed goals of student understanding, but directed their efforts toward content coverage were less accurate in evaluating the achievement of their goals. These teachers struggled with the tension between content coverage and student understanding, with content coverage seeming to take greater precedence in their teaching.

Leinhardt and Greeno (1986) constructed a conceptual mapping of teachers' activities and cognitions. Their conceptualization consisted of multiple levels of teacher goals, knowledge, and actions that they asserted were aligned and led to relatively automatic decision making for expert or skilled teachers. They explored Sacerdoti's idea (as cited in Leinhardt and Greeno) that "knowledge for skilled performance consists of schemata at different levels of generality" (p. 75) as it applied to teachers. Building on Sacerdoti's work, Leinhardt and Greeno explained that planning involves identifying tasks "by choosing global schemata that satisfy general goals and then by choosing less global schemata that satisfy more specific goals and requirements of the higher level schemata" (p. 75). They defined schemata

as “a complex knowledge structure of interrelated sets of organized actions” (p. 75). For example, they hypothesized decision flow charts for presenting new content that involved decision making concept maps and flow charts around defining terms, presenting algorithms, rehearsing algorithms, and checking for understanding. Each flow chart involved multiple sub-goals, decision points, and actions to take to meet those goals.

Leinhardt and Greeno’s (1986) purpose was to describe and analyze teacher cognitions. They collected data on eight expert elementary level teachers (defined as teachers whose classes were in the top 15 percent of their grade over a five year period) and 4 novice teachers (student teachers considered to among the best in the class). Data collection involved field observation over a period of three and a half months, which included multiple days on which interviews were conducted before and after class—some were stimulated recall interviews. Additionally, teachers were contacted with follow-up questions in subsequent months after the field observations. The data were reported in the categories of homework checking, presentation, and guided practice. Similar to Artzt and Armour-Thomas (1999) Leinhardt and Greeno did not share a focused analysis of teachers’ goals but did find that the skillful teacher has many routines to draw from to enable their effort toward goals. Familiar routines enable the expert teacher to manage the massive amounts of information that must be processed to make responsive decisions in the classroom.

A few years after publication of the 1986 study (Leinhardt & Greeno, 1986), Leinhardt (1989) published an additional manuscript that contained further

analysis of the same data. In this paper, Leinhardt went further in contrasting the competence of novice and expert teachers' math lessons. Among the findings in this report were that expert teachers' "agendas were far richer and more detailed...had goal statements and actions. The experts also had a specific overarching goal that ordered the actions so that the lessons moved from the broad, general procedures to the focused, narrow algorithm" (p. 64). Leinhardt found that expert teachers had a "transparent system of goals. These goals are consistently met by the application of cohesive, well-rehearsed action systems" (p. 73). Novice teachers' lessons were characterized by "an ambiguous system of goals that often appear to be abandoned rather than achieved.... Novices lack the analytic skills to understand where failures occurred or when goals that were implicit in certain actions were not achieved" (p. 73). Leinhardt further claimed that novice teachers are less aware of the goals for different components of lessons. In other words, expert teachers have well developed goals and routines to accomplish their goals and novice teachers do not. Part of learning to teach must include identifying for oneself goals and actions to meet those goals. This study does not contain a rich description of teachers' goals, but does shed light on how goals work in teaching and highlights differences between expert and novice teachers.

Leinhardt (1989) concluded, "We cannot simply provide novices with goals of what we want—namely, lessons that are open, flexible, responsive, problem-based, and intricate" (p. 74). She followed this conclusion with a call to study the process of acquiring expertise. Toward the understanding of learning to acquire expertise, Jansen, et al. (2009) have asserted that a knowledge base for teaching

must be based on well-articulated shared learning goals. In other words, if we only provided novice teachers with learning goals they would also have to build the knowledge base necessary to implement those goals. Of course, each individual must build up his or her own knowledge, but the point here is novices also struggle to define meaningful learning goals for themselves. Perhaps we cannot give novice teachers learning goals, but we should find ways to support their effort to develop and define goals for themselves.

Borko and Livingston (1989) also examined the differences between experts and novices. They identified experts as the mentor teachers with whom student teachers had been placed. They chose student teachers that were deemed strong in their mathematics and mathematics teaching methods classes at a university. As in other studies previously discussed, Borko and Livingston hoped to elaborate differences between novice and experts in terms of planning, decision-making, and teaching. Relevant to this discussion is that expert teachers were found to have well-specified goals that framed and directed much of their work. For example, in their post-lesson reflections, expert teachers “were selective...mentioning only those events that they believed had an impact on the accomplishment of instructional goals” (p. 481). Furthermore, during lessons, expert teachers attended to and processed “information only when they [believed] it [was] relevant to modifying their agendas” (p. 482). Because agendas include goals and actions to meet those goals, we can assume that teachers processed information relative to their goals. It seems clear that novices struggle to cope with the massive demands of teaching.

Expert teachers have goals and actions to accomplish those goals that cut through the extensive information one could attend to in the classroom.

Summary

In this literature review I reviewed studies that reveal information regarding teachers' goals in the areas of goal theory, lesson planning, teacher decision-making, mathematics teaching, non-mathematics teaching, and expert-novice teacher thought process research. Each area has been useful in the conceptualization and development of this dissertation study. The array of purposes, methods, findings, and frameworks regarding teacher's goals inform this study and provide alternatives from which to draw. Overall, it is clear that very few studies have had a primary focus of analyzing and delineating teachers' goals. The 1999 TIMSS video (Hiebert, Gallimore, et al., 2003) provides perhaps the most substantial effort to categorize teachers goals, but their focus is on learning objectives only. In this research the focus is broader to include instructional goals and looks for further depth in drawing these through in-depth teacher interviews based on observed activities in the classroom. The mathematics education researchers whose work I cite in this literature review appeared to collect more extensive qualitative data that potentially could reveal teachers' goals, but they reported goals in narrowly conceived frameworks. The expert-novice literature reported little in the way of teachers' goals, but provided a much more in-depth look at teachers' goals and how these worked in the functioning of their teaching.

This research adds to and extends the literature on teaching by elaborating the nature of teachers' goals. I provide a more thorough characterization of

teachers' goals in the day-to-day work of teaching than has been provided in the research I have cited. Knowing about the contents and other attributes of teachers' goals helps us better understand and explain the work of teaching. In particular, substantiating a framework by which to analyze teachers' goals provides new ways of explaining and making sense of teaching that leads to student understanding. Adding teachers' goals to our framing of teaching can be used to enhance teacher development activities and allow researchers to answer difficult questions of the field, such as how to build a knowledge base for teaching, in increasingly complete ways.

Chapter 3 Method

What teachers choose to do in the classroom is influenced by their goals for instruction. In other words, teachers' goals are critical to students' opportunities to learn. As a result, this study is intended to characterize teachers' goals. The research questions are as follows:

- What are the goals of secondary mathematics teachers' that direct their activities, choices, and organization of their classroom as borne out in their instruction?
- What sources do secondary mathematics teachers identify or otherwise can be inferred as contributing to these teachers' goals?
- What level of commitment do secondary mathematics teachers describe towards their goals?
- To what extent do secondary mathematics teachers claim to meet their goals?

In this chapter I begin by describing the methodology I drew from to answer the research questions. Then I define the qualities of the participants and how they were recruited. Finally, I describe the types of data collected and how the data was analyzed.

Methodology

Case study methodology provided direction in conducting this research. A case study methodology is defined by a research question that calls for the examination of a "particular situation, event, program, or phenomenon" (Merriam, 1988, p. 11). Further defining points of case studies include that the researcher has

little control on the event, treatment, or participants, and the desired end product is descriptive (Merriam, 1988). This study met these descriptors in that the research questions led to an inquiry into the nature of teachers' goals. Furthermore, there was no control on the participants' actions and ideas, and the end product is descriptive in nature. Another prominent feature of case studies is that case studies are investigations of bounded systems, "that is,... an examination of a specific phenomenon such as a program, [or a] process" (Merriam, 1988, p. 9). This research was conducted in a bounded system in that the participants were interviewed relative to their goals for four days they were observed teaching a class to their students.

Stake (1994) described two main types of case studies: intrinsic and instrumental. An intrinsic case study is "undertaken because one wants better understanding of [a] particular case" (p. 237). For example, if you wanted to know the business philosophy of a particular Fortune 500 CEO because he or she is of particular interest, perhaps holding an unusual business philosophy, this would be an intrinsic case study. In other words, the particular case *is* the issue of interest. In an instrumental case study, "a particular case is examined to provide insight into an issue or refinement of theory. The case is of secondary interest; it plays a supportive role, facilitating our understanding of something else" (p. 237). For example, if you wanted to know about the business philosophy of Fortune 500 CEOs, then investigating a sample of them would be appropriate because who is chosen among those 500 is not important, rather, the important consideration is that they are Fortune 500 CEOs. Thus my study is an instrumental case study. The particular

teachers are less important than that they are secondary mathematics teachers. I am more interested in their goals than in the teachers themselves.

Participants

Patton (2002) wrote, “qualitative inquiry typically focuses in depth on relatively small samples... selected *purposefully*.... The logic and power of purposeful sampling lie in selecting *information-rich cases*” (p. 230, emphasis in original). As little research has been done to capture and describe mathematics teachers’ goals, I chose teachers who were likely to be information rich by virtue of their experience and expertise. Although I do not claim that the teachers who participated in this study were experts, I drew upon a set of established characteristics used to identify expert teachers. Identifying expert teachers typically involves one or more criterion including: (a) years of experience, (b) social recognition/nomination, (c) professional/social group membership, and (d) performance criterion (Palmer, Stough, Burdenski, & Gonzales, 2005). For this study two or three of these criterion were observable with each participant, although notably, performance criterion, which is the most credible criterion, was not used in the selection of any participant (for this reason I do not claim that the participants were experts). Each teacher had a master’s degree in education that meets the professional/social group criterion. Secondly, each of the teachers was recognized in social groups including their colleagues and university faculty as possessing expertise. And finally, four of the five teachers had 10 or more years of teaching experience. So while I do not claim these teachers were experts, it is worth noting that they were not novices.

Teachers' goals are likely to be different depending highly on the context of their work. The context of school level (elementary, middle, secondary, post-secondary), level of teaching experience, demographics and achievement levels of students, school building, district, and community culture, as well as subject-matter content potentially influence teachers' goals. This study, however, is not necessarily about those contexts. Because this is an initial study, it is sufficient to shed light on the teacher's goals and leave the context issues for follow-up studies.

Participants were recruited from among experienced secondary mathematics teachers fitting the criterion above in the vicinity of a major research university in a mid-Western state. The teachers were initially identified as high quality teachers by University faculty. After teachers were initially identified I contacted school districts to gain access and approval to conduct this research on site. Once potential teachers were identified I sent them a recruitment email (See recruitment script—Appendix A). Teachers who responded positively to the recruitment email, were contacted and provided a consent form (Appendix B).

Data were collected from 5 secondary mathematics teachers. I introduce each of these teachers here with pseudonyms to protect their identity. All teachers were teaching in the region of a well known state-funded university in the Midwestern United States.

Natalie was in her 11th year as a teacher when I observed her. She spent the first 8 years of her career at a high school in a large school district serving nearly 17,000 students. During her time at this high school she taught Pre-calculus and Algebra 2 for a couple of years and the majority of her time she taught Integrated 2

and 3 using the *Core-Plus* curriculum. During this time she earned her master's degree in curriculum and instruction from the flagship university of the state that was located in the same city. Three years prior to my observation she moved from the city in which she worked and received her education to a rural town roughly 30 minutes away with a population of approximately 10,000. She first taught at the middle grades level there before moving up to the local high school where she principally taught Algebra 1. The year in which the observation was made she was teaching Algebra 1 for her 2nd year. She taught 6 classes a day using the McDougal-Littell Algebra 1, state-specific edition. Natalie was identified from both school leadership and university faculty as being highly qualified.

Adam was in his 17th year of teaching, but in his first year teaching high school students when I observed him. Initially, Adam was certified as an elementary level teacher, he spent the majority of his years (13) teaching mathematics classes to sixth and seventh graders before moving to the high school level. Early in his career he and fellow teachers pieced together units preferring their own developed curriculum over published textbooks. Then the district adopted the Connected Mathematics Project (CMP) curriculum, a National Science Foundation funded problems-based middle grades mathematics curriculum. He used this curriculum for several years. Adam preferred problems-based, student-active curricula.

After serving as a middle grades mathematics teacher the opportunity arose for Adam to work as a math coach in his school district. As a math coach Adam observed and discussed teaching and learning with other teachers. While he was working as a math coach the school district adopted a new curriculum for the

middle grades that Adam did not find appealing. Then, due to budget issues the school district decided to discontinue the mathematics coaches' positions. Not wanting to return to a new middle-grades curriculum that he did not prefer, Adam chose to go to work at the high school where the district offered an integrated curriculum using the Core-plus materials which, like CMP, was developed under National Science Foundation funding and is a problems based curriculum. By this time Adam had a master's degree in curriculum and instruction, had participated in and led leadership and training activities in the district, and was highly regarded by peers and University faculty who had associated with him.

Sarah was in her fourth year teaching high school mathematics in a high school of just under 2000 students. Sarah had earned her master's degree in curriculum and instruction and has since been accepted into a PhD program in mathematics education. Since she began teaching she had been involved in the *Assessment For Learning* initiative in her district and was a leader on this initiative in her high school. Sarah had taught only integrated courses using the Core-Plus curriculum until the year of observation in which she also taught Geometry using a traditional textbook. Sarah was recommended to this research by University faculty not only for her developing expertise, but also because of her tendency to reflect deeply about her teaching and verbalize her thoughts.

Caleb was in his 10th year of teaching and 7th year overall at a well-esteemed private school. For a majority of years at this school Caleb had been teaching the Algebra 2/Trig course to sophomores and juniors. This was an advanced class that went deeply into the trigonometry. Caleb was the technology coordinator at the

school and also coached many sports. At the time of observation, Caleb had obtained a master's degree in public policy and was pursuing an Educational Doctorate degree in educational leadership. Caleb was highly regarded as a teacher by parents, students, faculty, and the administration.

Kathy was in her 26th year of teaching mathematics. She had spent the majority of these years teaching 8th and 9th grade classes at a junior high school. During the year in which I observed Kathy she began teaching 8th grade mathematics using a traditional curriculum whereas the previous years she had used an integrated curriculum, the *Core-Plus* textbook and curriculum materials. She was therefore, teaching an 8th grade level mathematics class to 8th graders for the first time in 20 years by her account. Kathy was national board certified and held a master's degree in curriculum and instruction from the state's largest university. Kathy was respected among the mathematical community and participated in providing professional development to teachers across the state. To assist the reader with identifying the participants I have provided a table of participants (See Table 1).

Table 1

Identifying Characteristics of Participants

Name	Years of Experience	Type of School	Curriculum	Special Characteristics
Natalie	11	Rural public high school	Algebra 1	Had formerly used integrated curriculum
Adam	17	Public high school	Integrated 3	Former middle grades teacher/math coach
Sarah	4	Public high school	Integrated 4 honors	Involved in assessment for learning leadership
Caleb	10	Private high school	Algebra 2 and trigonometry	Pursuing educational doctorate degree
Kathy	26	Public junior high	8 th grade mathematics	National board certified

Data Collection

In keeping with the case study research tradition, this study drew upon “multiple sources of information such as observations, interviews, documents, and

audiovisual materials” (Cresswell, 1998, p. 62). I collected data of the forms Cresswell described, namely, interviews and observation. Each teacher was observed at least four times and interviewed at least twice. Interviews were held after the second and fourth observations.

The interview protocol (Appendix C) took the form of the *general interview guide approach* (Patton, 2002). In this approach a guide is used to “outline a set of issues that are to be explored with each respondent before interviewing begins. The guide serves as a basic checklist during the interview to make sure that all relevant topics are covered” (p. 342). The general interview guide approach provided flexibility in the post-observation interviews where goals relative to different content, activities, and interactions of each teacher were probed.

The post-observation interviews were conducted in the form of *stimulated-recall interviews*, where viewing video of specific instructional moments prompted teachers’ memories. Stimulated-recall interviews are common to research on teacher thinking as well as in research on people’s goals. In the teaching context Calderhead (1981) wrote, “it is assumed that the cues provided by the [video] will enable the participant to ‘relive’ the episode to the extent of being able to provide, in retrospect, an accurate verbalized account of his original thought processes” (p. 212).

Classroom observation and field notes. During the observations I took field notes with an eye to identifying segments of lessons and frequent teacher moves or efforts within activities to follow up with in interviews. Across the days of my

observation routine teacher efforts became more visible as they were repeatedly enacted.

Video recording of observed lessons. Each lesson was captured on video. The video was trained on the teacher who also wore a wireless microphone to pick up and record the teacher's discussions, comments and questions to students. These videos serve as a record by which teachers' goals can be identified as they are represented in their actions. Additionally, these videos served as a resource in the stimulated recall interview to aid the teachers to recall specific moments of classroom teaching around which they were asked about their goals.

Stimulated-recall interviews. Following every other observation I conducted a stimulated-recall interview with the teachers regarding the goals of the class as they were represented in the organization and teaching of the class. These interviews followed the interview guide protocol (Appendix C). The purpose of these interviews was to prompt the teachers to articulate their goals and answer the other questions in this research. In conducting these interviews I took care not to provide teachers ideas or language to aid their articulation of their goals, rather I tried to prompt teachers to identify those things they were trying to accomplish at various moments of the class.

Observations and field notes served as a basis and starting point for the interviews through which the research questions were answered. Although the transcripts served as the primary data source through which all the research questions were answered, field notes and video served as co-primary sources which

were used to support the transcripts in order to gain better understanding of the actions, strategies, and contexts in which the goals were enacted.

Pilot Testing

I pilot tested the data collection process with one teacher. The purpose of this was to check the data collection and analysis process with real human subjects. Pilot testing this research allowed me to refine instruments, data collection and analysis processes. Questions answered by the pilot testing process were: Do the instruments adequately allow me to collect the data that is desired? In what ways might the instruments be modified to better capture the data of interest? Is the analysis process appropriate and will it allow me to answer the research questions? How might the analysis process be modified to better answer the research questions? It was determined that the instruments did adequately allow me to collect the desired data. The instruments were modified to better collect information, but as no complete analysis was made the analysis process remained as originally conceptualized.

Data Analysis

Data analysis of case studies is primarily inductive though guided by an initial theory of the goal dimensions. Merriam (1988) wrote, "Inductive means that, for the most part, case studies rely on inductive reasoning. Generalizations, concepts or hypotheses emerge from an examination of the data – data grounded in the context itself" (p. 13). Initial analysis began during the data collection process. Field notes and observations, video, research memos and reflections were used to initially take stock of findings related to teachers' goals. The main analysis occurred after

each interview was transcribed and was iterative in nature. Huberman and Miles (1994) defined an iterative procedure as “a succession of question-and-answer cycles—that entails examining a given set of cases and then refining or modifying those cases on the basis of subsequent ones” (p. 431) In the following I delineate how these conceptions of research analysis were used.

Initially I attempted to code the transcripts according to various frameworks from the literature on teaching. These included the learning environments from *How People Learn* (Bransford, Brown, & Cocking, 2000), and the strands of mathematical proficiency from *Adding It Up* (National Research Council, 2001). I also coded goal statements as to whether they were avoid or approach statements, and about whom the goals were addressed, students, or the teacher. I found that while noting approach and avoid types of goals was somewhat helpful to analyzing teachers’ goals, using the frameworks mentioned was not helpful because doing so would have removed the identity and complexity of the goals.

Thus I began anew to code the data, with the objective of identifying and describing the central idea of each goal and not trying to pigeonhole statements into frameworks. My central effort in this reading of the transcripts was to note goals in as detailed and concise manner as possible. While doing this I noted sources, efficacy, and commitment statements and similarly detailed these in the coding, attempting to accurately, thoroughly, and concisely describe their nature. I also checked additional data sources, field notes and video data, to corroborate or better understand the nature of the goals being identified. In this way I achieved data triangulation.

Having carefully, methodically, and thoroughly parsed the data, I reread the transcripts searching for connections between codes, that is relationships that formed themes through which multiple codes and sections of the transcripts could be grouped. These emerging themes were noted and then I reread the transcripts again to be certain of the themes, their connectedness and to note all data fitting within them. Some sections of the transcripts required multiple additional readings to identify and tease out the central thread of thought that related goals. Some coded passages and themes at this point were so large as to require splitting the themes, and other coded passages and themes were so small as to either be assigned to appropriate connected goal themes or abandoned entirely.

At this stage I began to write cases for each individual teacher, often returning to the data to fine tune my conceptualization of goal themes. As this writing progressed I noted ideas or assertions that struck me as cutting across the various participants. After the cases were written I shared them with three graduate students and asked them to compare the written cases with the original transcripts to verify my representations of the teachers' goals. This effort is called *auditing* which is

The systematic review of a given study on the part of an external examiner. Its main interest [is] that interested and rigorous peers can determine whether the... analyses leading to the main conclusions and explanations stand up to the most common sources of bias and error. (Huberman & Miles, 1994, pp. 438-439)

I then sent each participant their individual cases and asked them to read these to determine whether I had appropriately represented their goals. This effort is called *member checking*. Stake (1995) described member checking as a process where,

“The actor is asked to review the material for accuracy and palatability. The actor may be encouraged to provide alternative language or interpretation” (p. 115). In both of these efforts it was determined that the individual written cases were trustworthy and fair representations of the teachers’ goals. After the cases were deemed valid I began a cross-case analysis to identify goals or themes of goals that could be identified in a majority of the participants. The cross-case analysis is presented in the next chapter and individual cases can be found in the appendices (Appendix D, E, F, G, H).

Chapter 4 Findings and Assertions

In this chapter I present a cross-case analysis of the goals of the participants in this study. The purpose of this study was to investigate teachers' goals, sources of those goals, commitment and efficacy to those goals as identified through observed instruction. It is my intention in this analysis to describe goals that cut across multiple teachers, whereas those goals that only one teacher held will not be reported here but can be found by examination of the individual cases in the appendices. In the first three sections I detail the variety of teachers' goals from organizational goals to more specific mathematical goals and then professional development and end of year student goals. In this presentation I answer the first research question: What are the goals of secondary mathematics teachers' that direct their activities, choices, and organization of their classroom as borne out in their instruction? Goals are intended outcomes, or cognitive representations of what an individual is trying to accomplish (Pintrich, 2000). As I am also describing some of the teachers' activities I take care to distinguish between and define the goals apart from the strategies and actions used to meet them. Then I present an analysis of the sources of teachers' goals and follow this with a presentation of teachers' efficacy and commitment to their goals. These presentations address the last three research questions: What sources do secondary mathematics teachers identify or otherwise can be inferred as contributing to these teachers' goals? What level of commitment do secondary mathematics teachers describe towards their goals? And, to what extent do secondary mathematics teachers claim to meet their goals?

To begin, I remind the reader that the goals I investigated in this study are of the grain size that provides direction in the teachers' delivery and organization of their day-to-day instruction. I do not claim to have identified all of the participants' goals, nor do I claim to have investigated their goals at a very fine level of detail. Rather I investigated those goals that integrated much of the teachers' activities and efforts identified in specific segments of instruction such as when a teacher engaged students in bell work, or made repeated unique and specific demands of the students during lectures, class discussion or individual or group conferencing. Using inductive analysis, I allowed the goals to arise from the data.

Although similarities in goals were identified across all teachers, variation existed in the teachers' emphases. Furthermore, the source of the teachers' goals, their commitment and efficacy varied slightly according to each individual with the greatest variation in the area of source. Initially, the content of teachers' goals fell into the categories of subject matter goals, goals that supported student learning (which made up a majority of the goals uncovered), and personal development goals related to their career as teachers. Teachers' goals were derived from a variety of sources including their own experiences, perceptions, and philosophies as well as from their exposure to curriculum, professional development, professional learning communities and colleagues, and state and other professional standards. Teachers tended to be highly committed toward their goals, both in word and deed in their classrooms, and they tended to perceive themselves as efficacious in meeting their goals. Individual cases have been written for each teacher and are located in the

appendices. The following sections will detail these findings. To orient the reader, I provide a table of the headings and subheadings in this section.

Table 2

Headings and Subheadings of Findings of Teachers' Goals

Classroom organization and environment goals to maximize student engagement and benefit from the learning process.

To engage all students.

To have or devise a homework and assessment policy that promotes learning and avoids student discouragement.

To prepare students to participate.

To minimize confusion.

Learning goals and goals within mathematical activities to deepen student understanding of the mathematics.

To distribute mathematical authority.

To develop, deepen and refine students' understanding of the mathematics.

To develop, deepen and refine individual students' understanding of the mathematics.

Meta-level goals: monitoring learning, end of year student, and personal improvement goals.

To monitor student learning.

End of year student outcomes and learning goals.

Personal goals for improving as a professional teacher.

*Classroom Organization and Environment Goals to Maximize Student Engagement
and Benefit from the Learning Process*

In this section I present goals teachers held to communicate learning expectations and organize the learning environment to encourage students to learn. In this section teachers' goals related to homework and assessment policies, to social aspects of the classrooms, and to orienting students to the learning goals and activities.

To Engage All Students

Teachers held the goal of keeping students on task—learning. This goal was uncovered by viewing various activities and then interviewing each participant and asking, “What is your goal with this activity?” The various activities I observed included: engaging students in conversations and reflection tasks about learning; instructing students to organize their in-class working schedule to meet subject matter learning goals by set dates; reorganizing seating assignments; and, calling randomly on students or asking the whole class “Do you agree?” These activities were intended to meet the goal to engage students and to *communicate* the expectation that students were to pay attention and stay on task. The first is about goals monitored in terms of student activity: Are the students engaged? And the second is about monitoring one’s own effort: What have I done and what can I do to engage students? In the end, the goal is that students are engaged, but teachers monitored this both in terms of student activity, and personal activity directed to ensuring that students were engaged.

One teacher, Adam, was blunt in his approach to communicating his expectations to students that they be on task. The first lesson I observed was his first lesson following a unit test. Adam began the lesson by engaging students in a reflection activity. The students were asked to write responses to the following questions: “What new learning occurred for you so far this year? How hard did you work on a scale of 1 to 10? How well did you do on the test? Will you change anything [in terms of work or study habits for the new unit?]”? (Adam, Video 1, October 12, 2009). Students worked quietly and were told to keep their responses private. They did not share their responses with anyone.

I asked Adam to explain what he was trying to accomplish through this activity. I have broken his response into three parts to clarify three separate intentions. First he said he was asking the students:

How hard did you work? How well did you do on the test? The equating: I work hard, then my score will show up. I’m not collecting homework points. And so sometimes when I give them something to do they ask, “Is this for points?” And I’ll say the standard reply for me, “It will help you do better on your tests and quizzes. It will help you learn.” So, indirectly, yes, it is for points. I’m trying to equate those two, you work hard and you’re going to do well. I want them to reflect on how could they have worked harder? Was it possible in their workday to put forth any more energy than what they did? In the classroom could they have worked harder? And that’s what that “will you do anything differently?” I’m not so sure how good they are at defining when they’re stuck, and how badly they’re stuck. And if we could improve that at all, I think it turns them into better learners, then they start seeking and advocating and asking questions. (Adam, Interview 1, October 14, 2009)

Adam explained his central goal was to communicate to the students that he expected them to work hard, reflect on their effort, assess what they could do differently to achieve success, and that when they put forth the effort to learn their

grade would follow. Finally he explained how he wanted students to become metacognitive in assessing themselves, their understanding and effort.

He followed these statements with the following, “There was an expectation that you learned something... I’m hoping to set up, “you were expected to have learned something and how big is your list?”” (Adam, Interview 1, October 14, 2009).

One other goal in this theme related to his concern about the apathetic students. He was concerned that some students were there to just get by, to just get their third math credit. He said, “I still get the sense that that some of these kids are blowing it off. Like, if they do a minimal amount of work they can pass. And that’s all that’s going to be necessary for them to do” (Adam, Interview 1, October 14, 2009). Adam communicated that performing a minimal amount of work to pass the class was unacceptable. He spent time ensuring that students whom he felt would otherwise disengage would commit further effort to their learning.

Although Adam was perhaps the most explicit and direct in describing these goals, the other teachers also held these types of goals. Natalie said:

My constant goal [is] keeping kids engaged. (In) my ideal classroom every 25 of my kids would be working on the math when I asked them to do it and participating in class. Something I’ve been thinking about this year is different ways, what can I do to get the kids engaged more? More of them on task and doing the problems. So I’ve tried the clickers, I’ve tried working in partners more. Thursday and Friday the learning specialist is going to let me use her white boards, but she’s also going to be in here and we are going to try to have kids work problems on white boards and then show their answers so we can kind of keep a tally when she’s in here of how many of them are doing them correct or incorrect. And hopefully use that data somehow. So a lot this year I’ve been thinking about what are different ways to present my lesson so that I can get more kids involved. (Natalie, Interview 2, October 6, 2009)

In changing from whiteboards to clickers to groups to pairs, Natalie sought for students to stay engaged. In this effort she did not tell students directly that she was changing these features so that they would stay engaged and on task. But in other ways she was direct in asking students to get to work.

Kathy and Caleb held similar goals in keeping students engaged and communicating to them to stay engaged. To keep students engaged Kathy often asked the whole class: “Do you agree?” This question served many purposes, one of which was to gather attention. Caleb held his students’ attention by calling on random students during his lecture. He said:

It makes the kids a little more interactive and they’re always on their toes because they know that they need to be paying attention because who knows when I might be called up there and they know that a lot of times I won’t even call them, I’ll say alright so and so you just finished, pick another student. It just breaks up the monotony when the kids get up there because usually something funny is done so the kids can laugh a little bit, have fun with it. It works out pretty good.
(Caleb, Interview 1, November 17, 2009)

Keeping students engaged is at the heart of this goal. The remaining teacher in this study, Sarah, who taught Honors Integrated 4, made special effort to keep all students engaged by making sure that the high achieving students were always working. She said, “I don’t want them [the other students] to feel like it’s ok to sit there and not do anything, because they actually need to do an hour and a half work every other day to be as successful as he is” (Sarah, Interview 2, November 4, 2009). So to keep everybody on task, she refused to let her stronger students idle. She believed that if she kept the stronger students on task, the others would have less of a reason to disengage.

To Have or Devise a Homework and Assessment Policy that Promotes Learning and Avoids Student Discouragement

Each teacher in this study held a goal in the area of devising, modifying, and/or having an assessment policy that supported or encouraged students to continue learning and mastering the mathematics after a formal assessment had been completed. They wanted to avoid having an assessment policy wherein students were likely to disengage from learning activities and believe that they were failures or poor mathematics students.

For example, Kathy devised her homework and assessment policies to hold students to rigorous standards while promoting student engagement. I asked Kathy about her grading scheme on a quiz she returned to students. She had not given a traditional letter grade or even points; rather, she used a scheme that communicated student attainment and development related to specific mathematical learning standards. She explained her goals:

I don't want to grade them on their first try because, some of them that's the first time they've ever seen this. I want to see what they know even though I pretested them on those concepts I still wanted to see what they knew on that objective. But I didn't want that to be a final grade. Because I grade pretty tough on these kids and I want them to understand that it's ok to grade tough, that they're not being penalized. Over the years I found out that if I grade as tough as I do and I put a grade on it, as soon as they see the grade, they don't even want to look at the test. But if I don't want to put a grade on it I can grade all kinds of stuff.

I want to avoid them internalizing that as a grade and not internalizing that as a "I didn't get that right." I want them to look at those problems and say, "I didn't get that right," and hopefully look at, "Why I didn't get that right." and take the variable of grade out of it. Because many of these kids, once they see that D, because a lot of them would've gotten a D on this, as soon as they see that D, they "I'm a failure, I'm a D student, I can't do this." (Kathy, Interview 1, January 12, 2009).

The essence of Kathy's goals were to motivate the students to further learning and to avoid their disengagement with the learning process. She wanted to avoid negative student identities formed in response to assessment policies. Because she was sensitive to how students were impacted through summative grades early in the learning process she did not use formal evaluation during introductory activities in the classroom.

Kathy also implemented a unique homework policy to contribute to students learning. She explained:

I tell my kids, "Only work for 15 minutes at home." That's it! I want to know what they can do in 15 minutes. I find that for the most part I get more participation in homework when they know they have 15 minutes.

I don't want them to be, "I've got 2 hours of homework." And the ones that will do it, will kill themselves doing it, and the other ones say, "I can't get all that done, I'm not even going to try." (Kathy, Interview 2, January 14, 2010)

Similar to her goals regarding her grading and quiz policies, her homework policy was devised to encourage learning and engagement and to prevent disengagement because of lengthy homework assignments.

All teachers in this study held similar goals and created policies where mistakes early in the learning process did not affect the students' grades and so encouraged a high level of engagement with the learning process. Sarah, for example, did not give credit for doing homework or doing the class work. Instead, she gave what she called a *check*. A check was administered every couple of days to assess students' learning of mathematics central to those days of work. She explained:

I never wanted to give points just for working the investigation because you should want to do that to learn, not do that for points. So I came up with ways to, you know, the way you're going to get points for doing this, is you're going to learn it, and then I'm going to give you a couple of questions, and if you can do those, it's like giving points for doing the investigation. Really it should be the quiz, you're learning this for the quiz. That's where your points come in. If you do this, you're going to learn it and then you're going to do well on the quiz, and that's how you get points for learning. (Sarah, Interview 1, October 30, 2009).

In essence, she wanted students to engage in class work for the sake of learning, not for points. She continued discussing her thoughts about the check:

I didn't like the fact that if someone wasn't getting it, it [the check] was hurting their grade. Then I thought, "I don't really expect that they have it perfect today, I really don't care if they don't have it perfect until the quiz or the chapter test maybe, or the semester final. It's ok if they're not a hundred percent today." So then I didn't really like grading it harshly, and then a kid getting one out of five points, and being like "oh my gosh I don't understand this." I wanted them to be like keep learning it the next couple weeks, until he could have a five out of five. So, I don't necessarily refer to it as an opportunity for points because sometimes I don't even put them in the computer, and sometimes I do. But every single one that I've actually put in the computer. I've allowed them to either retake, or make corrections, [because] I want them to continue learning it. I don't want it to be like a final like, "Oh you didn't learn it that day, tough!" I wanted them to keep learning it until they learned it. (Sarah, Interview 1, October 30, 2009).

She devised her assessment policy to promote student effort in learning and working until they had learned and understood and to avoid the demotivating aspect of grading before students have been allowed to master the content. In order to accomplish this she continued to modify and experiment with her assessment policies. This excerpt also contributes to our understanding of her subject matter goals. She did not expect mastery of subject matter upon first exposure, she

expected mastery to develop over time and further provided an accommodating grading policy that supported mastery learning over time.

Like Kathy, Adam expressed concern for students' mathematical identities and reflected on how his assessment policy contributed this issue. He sought to avoid certain effects of grading that he believed were harmful. He explained his view on the harmful effects of some grading policies on students' identities:

I think grades unfortunately have placed certain identities on students. And I think students walk in the classroom with their number, "I'm a D student." If you've got a D in my math class, I think they walk in thinking my identity is like a scarlet letter, "I'm a D math student." And I think it can, it's not very motivating to them, especially if you've got an F or a D early on in the learning process. If at the beginning part of a unit you start off with an F or a D, traditionally, you'll never, that F or D will always weigh down, it will weigh everything down, even if you get a 90 percent for the unit test. Why should that F impact what the student knows now? And so that's what I'm trying to communicate to the kids. And boy they just love that... If you want to decide you want to change your habits and work harder, you can, and your grade will immediately show who you are. You can escape your identity of the past very quickly by changing what you're doing in the classroom.

To mediate the harmful effects of grading Adam had experimented with his grading and homework policy and continued to do so. His policy was that students' older quiz and test scores were replaced with new grades representing their current state of learning. In this way, students' grades and identities would not be bound by prior poor performance.

Caleb and Natalie, the remaining two teachers in this study, also gave voice to goals in this area. They also avoided grading early in the learning process because as Natalie explained, "So I want it to be an, "Ok. I can make mistakes." You know I'm not grading on correctness I want you to have the answers I want you to get the

process” (Natalie, Interview 1, October 2, 2009). Contributing to this thought Adam said, “I don’t think homework should be part of the grade. It’s practice, you’re learning... They’re trying to show the teacher, they’re not doing it to learn” (Adam, Interview 1, October 14, 2009). The last part of Adam’s quote refers to students superficially completing assignments to satisfy teacher demands. Each teacher in this study was mindful to devise an assessment and homework policy that they felt minimized harmful effects and superficial learning and promoted the kind of mathematical thinking and understanding they believed was more substantial. Some did not grade homework, but still expected home and class work to be done. Others graded homework, but only in terms of completion and additionally weighted homework low relative to test and quiz grades.

To Prepare Students to Participate

This goal theme encompasses several different but highly related ideas. All teachers in this study held goals and enacted instruction and/or organized the learning space to avoid social contexts intellectually inhibiting to students, and, oppositely worded, to provide encouraging social-intellectual contexts. What I mean by this is couched in the notion of a student feeling inhibited to venture a mathematical thought for fear of being wrong or being ridiculed by others. Teachers wanted to create a social climate where asking questions and being wrong was safe, where students could engage deeply in the mathematics in their social setting. What follows are expressions of this goal and particular strategies or organizations to meet this goal from several of the teachers.

Natalie spent the majority of her career teaching from a curriculum that provided questions that prompted students to think about mathematics. When she moved and began teaching from a new curriculum that did not provide those questions she was challenged to promote student participation in mathematical discussions. She explained:

I still struggle with keeping them involved and willing to share. The kids don't want to go up to the front. They don't want to write on my board. They don't want to answer out in class even when they probably have the right answer. Maybe they're afraid that they have the wrong answer and then they're going to get made fun of. So just kind of overall I just want more of my kids to feel comfortable about sharing in class. (Natalie, Interview 3, October 8, 2009)

Natalie wanted to create a classroom where students felt comfortable participating and discussing mathematics, but found that she needed to enact strategies in which students could become prepared to participate. She used strategies such as pairing, and wait-time, She said:

I don't like to [randomly] call on a kid. I don't like to say ok "Matt would you do this problem?" because if Matt doesn't know how to do it then that's going to make him less likely to answer later. So I don't want to call on a kid who doesn't want to offer. So finding a way so that, if they do check with a partner, check your answer, or somebody and then be able to answer my question, then I should be able to call on anyone. (Natalie, Interview 1, October 2, 2009)

Natalie had the goal to avoid calling on a student who was not prepared to answer because that may make them less likely to participate later, but overall, she wanted students to participate, and in order to get students to feel comfortable participating she held goals to prepare students to participate. Because of this goal she provided opportunities, such as conferring with a partner or working in groups, so that her

students would have the preparation time necessary so that they could be called on to share their thoughts or solutions.

Caleb's central teaching strategy was to lecture, but he was also sensitive to students' anxieties to ask questions or participate. He implemented several strategies to lower the risk and anxiety students felt. One of these strategies was embedded in calling students to the board. He consistently commented to the student at the board that they didn't have to know what to do. They had the privilege of calling on their peers for help. He said:

Well I don't want them to get up there with fear thinking that if they mess up everybody is going to laugh or something. And that's why I made the comment, because I always do, when they look at me with these *I have no idea what I'm doing eyes*. Like "You're the teacher now. You don't have to know what you're doing. You ask the class what to do and they tell you what to do." And that gives them a little more comfort and we're in a good situation here too where the kids really do respect each other and don't have a problem. (Caleb, Interview 1, November 17, 2009).

Caleb also found an unanticipated benefit from calling students to the board that became a compelling reason to continue this practice. He said, "You know the students are even more likely to ask a student that's up there a question than they are when I'm up there a lot of the times" (Caleb, Interview 1, November 2009).

In addition to the strategy above, Caleb encouraged group work, in part to meet his goal of providing a safe learning environment to his students. About group work he said:

I don't mind them working together on homework, any of that stuff, I think peer learning has been very beneficial to a lot of them because they don't want to ask their teachers but they'll ask their friends right next to them. And some of the kids are really good teachers and they're very patient so that's why we also do the group stuff at the end. (Caleb, Interview 1, November 17, 2009)

He voiced similar goals for providing time before school to students. He said:

A lot of those kids just need that one on one time where they can feel a little more comfortable like they're not holding back the other students. I think some of them have this apprehension that they're going to hold everybody back if they ask the question. So coming in in the morning they don't have that apprehension and we can work things through and now instead of worrying about what everyone is going to think when they ask this question they can just get their questions out and we can work them out. So those are the students where I say "You need to come in tomorrow morning so we can talk some things out." And they'll complain about how they have to get up early to get here. But usually I'll have a pretty good group of kids who come in in the morning. (Caleb, Interview 1, November 17, 2009)

The broad goal here for Caleb, was to provide opportunities for students to learn, but part of this involved organizing and providing low-risk learning spaces that helped students feel comfortable asking questions. He sensed that students were more comfortable asking each other questions in group work, asking questions of a peer at the board, and coming in before school to get help.

Sarah's goals in this area were realized through her strategic placement of students in groups. Her goals involved finding placements where shy students were more comfortable participating in group conversations, and where hard working peers encouraged lazy students. Of a shy student she said:

She was really quiet and didn't ever talk at the beginning of the year, and I was concerned with if it was a sex issue because with some of those students with the different religions, they aren't comfortable working with a student of the opposite sex. Especially females so I have to be careful about that. So I was really surprised when she hit it off with Kyle and works really well with him, so I just kept her with him. (Sarah, Interview 2, November 4, 2009)

Once she found a combination where the shy girl felt comfortable enough to participate in group discussions she kept them together. Sarah's goal was to have

productive groups and for that reason she strategically assigned students where she thought they would work well.

But Sarah also organized the group seating assignment to provide an encouraging setting where students could support each other's learning by discussing and challenging each other's ideas. In the following she explained one of her principal goals for seating students in groups:

But sitting in groups, there's a couple of different reasons. Definitely they challenge each other. If someone is saying something or putting down an answer that is wrong, that there's someone there that is catching them and either noticing it's wrong or asking them why, or even if it's right asking them why to make them think better, "How could I explain this to somebody." Or maybe if they explained it they'll realize they did think of something wrong. And it's actually taking a little bit of my job, if they have someone else to say, "Wait, how did you get this answer?" That's not the same thing I got. That they can challenge each other because that forces them all to think a little deeper. (Sarah, Interview 1, October 30, 2009)

Without going too far from the focus of this goal theme the following excerpt from Sarah illustrates how connected these goals are to other goals of the teacher. In organizing the social-intellectual setting by seating students in groups and encouraging them to challenge each other, Sarah also met her goal to be responsive to students real-time learning needs.

The other thing is to help me out honestly. I don't like to stand in front of the room and explain things. I would rather explain it to an individual when they're actually to the point that it's going to make sense to them and they're ready for the explanation or ready for the next question. Then I'm going to give them. So I like to do that as a group, but there is no way I could actually go around and talk with each individual student about all their questions. Not only do they answer each other's questions, so that they need me a little less. But then if I go to talk to a group, I can kind of clear it up for 3 people at once. I don't know if I would be able to teach the class the way I do if they weren't in groups. To help minimize their need for me to be next to them. (Sarah, Interview 1, October 30, 2009)

These goals for Sarah were less about avoiding inhibitive learning contexts and more about organizing and encouraging students to engage with the mathematics and each other which would also allow her to be responsive to their learning needs. Natalie similarly organized her classes in groups but voiced the goal as slightly different. She explained her choice of when to group students as partially aimed toward the need to meet with struggling learners. She said, "I'm hoping that allows me to get to the ones that are at the very low end" (Natalie, Interview 1, October 2, 2009). Where Sarah conceptualized her consistent use of grouping students as partially aiding her in her goal to meet with students when they needed assistance, Natalie only organized groups when she felt that most students could work without her and she could then work specifically with students who consistently struggled.

Adam, a former elementary school teacher, voiced his goal in this area as slightly different from the others. Where the others described more of student-to-student type of goal, Adam spoke from a teacher-to-student perspective. His goal was to build and maintain strong relationships with students. He believed that by doing this students were more cooperative and productive. He began speaking about relationship building in our first interview when we discussed conferencing with students. He said:

I want them to know that I will listen to them, and I will be there to assist them.... I want to keep those relationships pretty strong with the students, speak to them very calmly and let them know that I'm there. (Adam, Interview 1, October 14, 2009)

He further discussed his priority to build relationships with students during the second interview when he discussed one particular student with whom he described his relationship as fragile. He said.

I need to be careful not to blow the relationship with her. The rule was with Jennifer, with all students really, you've got to be careful about their peers and how they look in front of their peers. You can't empower them too much in front of their peers, and you definitely can't take away their power in front of their peers. They'll take advantage of that. (Adam, Interview 2, October 20, 2009)

He then described a confrontation he had with her where he had to assert a rule. She reacted negatively to the confrontation and he went on to describe his relationship building with her in these words: "So I'm trying to nurse her back in to feeling comfortable in the class. Making her feel like she is a part of it, and she has valid ideas and it's ok, that was back in the past" (Adam, Interview 2, October 20, 2009). In this goal theme Adam wanted to make the room comfortable for students and build strong relationships with them. He sought to empower students. Part of his goal included listening and *being there* for students. Adam was highly sensitized to both challenging learners and having relationships with them.

The goals in this theme are about providing and encouraging a setting in which students can safely engage in the mathematics and each other. These teachers held goals to avoid social climates that inhibited students' intellectual work. To meet these goals these teachers organized seating charts and established group work expectations. They called students to the board or provided before school tutoring. They enacted wait-time or think-pair-share strategies and were responsive to students' real-time mathematical questions. They were mindful of the balance between challenging students and maintaining, building and repairing relationships.

To Minimize Confusion

All of the teachers held goals to orient the students to what they were to be learning or to minimize confusion. However, two teachers spoke specifically and extensively about this goal. Some strategies these teachers used to meet this goal were to organize lecture notes to parallel the progression of homework assignments, to use student friendly mathematical language, to overview homework instructions, and to present learning targets and use exit slips.

In the way of previewing or orienting students to what was to be learned all teachers used one or more strategies such as bell work (warm up activity), posting learning targets on the wall, discussing learning targets or reviewing homework instructions. Caleb minimized confusion and oriented his students to what was to be learned by organizing his lecture notes to parallel the developing of mathematics in his homework assignments and also by going through the homework instructions immediately after his lecture and before he gave the students a few minutes to work. He explained:

What I'm really doing is just recapping what we already talked over in class. Because typically my notes are in the same order as the instructions, what they're going to be doing in the homework. A lot of times kids get confused and they start intermixing the instructions. The other thing I like about going through the instructions too, is I tell the kids when they're studying for tests, "Don't study a bunch of problems. Because if you look at the problems that you've already completed, of course you're going to know how to do them, they're right there in front of you. Look at the instructions and then based on the instructions say, "If I get these instructions then I need to do this step, this step, this step." So now they're understanding the concept and what needs to be done, rather than saying, "Oh I know how to do this problem by looking at a problem that's already completed." So I like to reinforce the instructions and keep them consistent from homework, notes, quizzes, and tests. (Caleb, Interview 1, November 17, 2009)

Here Caleb explained his effort to orient his students by making lecture notes parallel homework assignments and by previewing the homework instructions to help students know what they needed to do, in essence his goal was that his students learn the processes that could be applied to a class of problems.

Furthermore, he kept these instructions consistent to avoid confusing the students.

Adam oriented his students by engaging them in a discussion of the learning targets as he began a new unit of instruction. Adam said:

I think it's important that kids see in front of them what direction they're going, what we are expecting them to do. It was a way to tap into some of their prior knowledge. What did they know about quadratics? Some of it started to slip out with the students. It's fun so I just went with it. My intention was just to share where we're going. These are the targets that we're going to be hitting today and in the next couple of days. These are the skills these are the ideas, the concepts that we're going to be doing.... So basically it's almost, it's not really self-reflection, but it's self knowledge or knowledge that you want students to have: Alright, here's where we are today. And this is kind of the pool that we're going to be swimming in today. These are some things we're going to encounter. And it's important for them to kind of feel grounded in a way and know where they're going. That's kind of the idea of giving those targets out. (Adam, Interview 1, October 14, 2009)

One goal was to orient the students to the new content. A secondary goal that he pursued within this activity was to discuss students' prior knowledge. But overall, he wanted to orient his students to what they were to learn, and additionally to connect and frame their new learning in terms of prior learning. Adam maintained this effort to orient the learners through the use of exit slips and shorter discussions in the following days to remind the students what they were to be learning.

Another way Caleb sought to minimize or avoid confusion or orient the learner was by using student friendly mathematical language. He explained,

We just did max's and min's and they talk about how the max is when your graph is increasing, and it hits a turning point, and is decreasing. So we simply call it, that's a hill if that's a max, and it's a valley if it's a min. And then you've got kids who live out in the country and they want to know if you can call it a mound and a ditch. And I'm like, "You can call it whatever you want as long as you remember." We teach them the correct mathematical terms, but then we also put it into terms that they'll understand as well, so that when they're taking the test, they can say, ok this is the mound and ditch or whatever they want to call it. So it's the same thing with a lot of that [topics]. I try to put it in language that's easy for them to recall. (Caleb, Interview 1, November 17, 2009)

Caleb's goal here was to present both correct mathematical language and learner friendly language that they understood and to which they felt connected.

On a variation of the theme of using student learner friendly language, Caleb taught some topics by connecting them to topics students already understood. In particular, when he taught the topic on polynomial long division he began by illustrating long division with whole numbers. He explained his goal within this strategy was:

To ease their minds. Sometimes the kids start getting tensed up when they see things that they're not comfortable with. Well they're pretty comfortable with doing long division with numbers only. And the concepts for doing long division like they did in 5th grade and what we're doing with polynomials a lot of the concepts are the exact same concepts. So I think more of it is to ease them in, get them more comfortable, and then being able to show them "Look here we did this and here we're doing the same thing." So now they can kind of relate it to something that they know. (Caleb, Interview 1, November 17, 2009)

In this excerpt we learn that one of Caleb's goals in teaching is to connect new content to already understood content. He did this to help students make sense of the new subject matter and to ease their minds. Caleb also explained how in the course he was teaching that they used a separate book for trigonometry, but they

“keep the language the same and usually that makes it a little bit easier for them because now they’re hearing the same thing over and over again” (Caleb, Interview 1, November 17, 2009). In these ways Caleb made it his goal to simplify the learning for the students by using consistent language across textbooks so the students would not be confused. Curiously, in this theme where the principal idea is the goal to orient students to what they are to do or learn and minimize confusion, both Caleb and Adam also held the goal to help students connect current learning to prior learning.

The principal goal in this theme has been about orienting students to what is to be learned and to minimize confusion about what to do. All teachers in this study demonstrated some effort or made some comment related to this goal, but Caleb and Adam spoke explicitly and at length about their goals in this area. Teachers made efforts to accomplish these goals by posting learning targets or engaging students in discussions about learning targets, by previewing homework assignment instructions and organizing lecture notes to parallel homework assignments. They also sought to orient their students or minimize confusion by using student friendly language or by connecting new learning to prior knowledge.

Learning Goals and Goals Within Mathematical Activities to Deepen Students

Understanding of the Mathematics

In this section I present goals teachers pursued within mathematical learning tasks as well as the subject matter learning goals of the activities. Goals pursued within mathematical learning tasks could also be conceptualized as fitting in the previous section that focused on organizational and learning environment goals, but

I put them in this section because these goals were more specific to helping students develop mathematical understanding.

To Distribute Mathematical Authority

To varying degrees each of the teachers in this study described a goal in the spirit of avoiding answering questions or telling and getting students to make sense of the mathematics for themselves. Teachers varied in their particular approach to this goal as well as the degree to which it was a significant part of their set of overall goals. For three of the teachers, Adam, Kathy, and Sarah, this goal was firm and quite possibly their highest-level goal when organizing instruction and teaching individual students.

Adam's goals were that students develop mathematical power and realize that they could reason and make sense of mathematics for themselves. Additionally he worked to encourage students to take academic risks. With these goals in mind he consistently organized instruction to allow students to struggle with important mathematical ideas. The following interview excerpt illustrates his goal in this area:

I'm trying to establish in there and it's taking a while, but it will get there I believe. Like I said, the last day of school I'll be doing that. It's trying to establish the culture of "I'm not the only authority in here." You have peers sitting around you that if you probably put your heads together can do some good thinking together and you can share and I'm going to expect you to turn and talk and communicate about math. And I'm not the only one who knows the answer. And that's part of the reason why I do that, not only does it, I feel like it engages more kids, but it also sets the expectation again. Here's another chance, or here's another thing he's asking us to do, he's asking us to talk to our partner and communicate about math. He's going to do that everyday. So that becomes: He values this. He values us communicating and talking with one another. (Adam, Interview 1, October 14, 2009)

A few moments later in the interview Adam expressed the following:

It's important that I'm not after the right answer all the time. Because that will shut students down I think. If the end all, be all, what I am only concerned about is whether they get the answer right or wrong. Well we're going to make mistakes, and the whole idea of practice and learning is we're trying things we're not going to get it right, but that's when you ask questions about it. So I try to treat errors as opportunities to learn. (Adam, Interview 1, October 14, 2009)

The two goals related here are to distribute mathematical authority and to encourage academic risk taking. He did not want students to look to him as the only source of mathematical correctness, he wanted them to have the ability to discern for themselves the strength and validity of their own and other's mathematical reasoning. In working to meet this goal I observed him refrain from restating or revoicing a mathematical idea that a student had contributed in a discussion. He said it was because it did not need restating, that he wanted to send the message that he was not the only mathematical authority. Furthermore he worked to establish an environment wherein students could be wrong, and not be penalized, thus fostering a propensity to take risks and try things as they engaged in mathematics. He believed that working towards these goals engaged students at a higher level and communicated his working expectations, thus linking this with his other goals.

Kathy wanted students to realize mathematical ideas for themselves, she wanted to involve them as much as possible to be doing the work or articulating the mathematical ideas, and she wanted to avoid being viewed as the "giver of information." She frequently used the question, "Do you agree?" in her whole class discussions. She explained her purposes for using this phrase:

I'm trying to get them to listen to other people, I know that's one of my worst aspects is I don't get the kids to listen to each other enough.

So that's one thing. I ask them "Do you agree?" because I want the kids to be able to feel comfortable that they can give a wrong answer. And I also want the kids to be comfortable that they can say, "No I don't agree." I want them to stand up for themselves if they don't agree for something. Don't just take something. So I really want them to really challenge when people say things.

And then I try to make it where the kid that even is wrong doesn't feel that they can't make mistakes; where it's not destructive, but it's constructive.

I want to train them that I'm not the giver of information; they are the giver of information. They can teach each other things by just looking at patterns in mathematics, and looking at what's happening. And to take a chance, I don't want them to look at me every time somebody says something "Is she right?" I want them to be able to siphon out some of this stuff and say, "Ok, is it really right? Does it mesh with what I'm thinking?" (Kathy, Interview 1, January 12, 2010)

Her goals with this device were to promote listening, to develop a discourse community where disagreement was safe, and to encourage students to be thoughtfully responsible for their understanding. Kathy explained in the interview that she began the year with an activity where she introduced this idea. She had students tell truths and lies and the rest of the class had to determine whether they agreed.

Sarah explained her goal in this area as avoiding having students memorizing and realizing that they had the mathematical power to problem solve. She said:

I don't expect my students to maybe have all of this stuff down, but they're able to reconstruct it really quick and pull up things when they need them. They understand how things work so they can figure it out. (Sarah, Interview 2, November 4, 2009)

To be able to reconstruct and figure things out was a goal Sarah consistently voiced.

Natalie and Adam expressed the challenge of withholding themselves from telling too much with an eye toward developing students' mathematical power to solve problems. Natalie voiced her goal in relation to the fact that students do get

frustrated at times. Here I include Natalie's goal exhibiting her sensitivity to student frustration. She said:

I think it was hard for me at first to not jump in right away and just give an answer and developing that skill of knowing... ok this kid needs an answer right now or he's going to be so frustrated he can't go on versus I need to let this kid struggle a little bit more because I think they can make it. I guess it is kind of a sense I guess you have to get from the kids once you know them. (Natalie, Interview 1, October 2, 2009)

Adam voiced similar thoughts about being careful to challenge his students, but being watchful for a sense of frustration when he felt it would develop into unproductive anger. He said, "maybe I don't push a kid hard enough... if I push them any further they're going to be mad" (Adam, Interview 2, October 20, 2009). Implicit in both Natalie's and Adam's thoughts was the idea that pushing a student at a certain point of frustration was counterproductive in that students might disengage from the learning process.

All five of the teachers in this study expressed some variation of this goal theme. They wanted to teach students to think and reason mathematically and to get students to believe that they could reason mathematically for themselves. The typical strategy to achieve this was to engage the students in problems and avoid telling them how to do it either in whole class or small group discussion. Part of their goals involved letting students make mistakes and avoiding correcting too soon so as to allow other students to listen and evaluate. Kathy engaged students in a beginning of the year activity to teach and launch the idea that they could and should listen to their peers and evaluate whether they agreed. Sarah explained how she would not tell students how to solve problems, but would consistently work

with students to redevelop the ideas and relationships through the whole school year so that they would learn that she expected them to do this kind of reasoning.

Subject Matter Goals

Because of the way the teachers of this study were selected—teaching different courses to different levels of students at different times of the school year—no two teachers held the same subject matter learning goals for their students. Because of this the teachers’ mathematical goals cannot be grouped into meaningful theme by mathematical topics.

Various frameworks could be used to analyze teachers’ subject matter goals, but as my sample is low, and as work of this nature has been done (Hiebert, Gallimore, et al., 2003) little value would be added. Nevertheless, I give a short overview of the subject matter goals of these teachers. Each of the teachers was able to vocalize their subject matter goals in the interviews extemporaneously, which I take to indicate that not only did they have subject matter learning goals, but also that they knew them well. Two of the teachers additionally had written their subject matter goals for the students. The subject matter goals of these teachers spanned across categories in various frameworks, the strands of mathematical proficiency from the book *Adding It Up* (National Research Council, 2001), for example. For descriptive purposes I use the strands of mathematical proficiency from the book *Adding It Up*, as well as to illustrate the different nature of the teachers’ subject matter goals. Combined, the teachers in this study held subject matter learning goals in each of the five strands of mathematical proficiency. Individual teachers’ emphases varied in these strands.

Briefly, the strands of mathematical proficiency are: (a) conceptual understanding; (b) procedural fluency; (c) strategic competence; (d) adaptive reasoning; and, (e) productive disposition. These are briefly defined in Table 1.

Table 3

Strands of Mathematical Proficiency

Conceptual Understanding	Comprehension of mathematical concepts, operations and relations.
Procedural Fluency	Skill in carrying out procedures flexibly, accurately, efficiently, and appropriately.
Strategic Competence	Ability to formulate, represent, and solve mathematical problems.
Adaptive Reasoning	Capacity for logical thought, reflection, explanation, and justification.
Productive Disposition	Habitual inclination to see mathematics as sensible, useful, and worthwhile, coupled with a belief in diligence and one’s own efficacy.

Note. Taken from page 116 in “Adding It Up: Helping Children Learn Mathematics.” J. Kilpatrick, J. Swafford, and B. Findell (Eds.). Mathematics Learning Study Committee, Center for Education, Division of Behavioral and Social Sciences and Education. Washington, DC: National Academy Press.

Natalie emphasized procedural fluency, but also held the goal that students represent contextual problems and learn to represent solutions using algebra notation—strategic reasoning. She also insisted that students justify their steps in the process, a part of the strategic competence strand. When asked about her subject matter goals she said:

Probably my first [goal] would be the symbolic manipulation. Just being able to solve and we’re getting into the proportions today and percent problems later. It’s basically solving equations, the algebraic manipulation the skills of being able to do that. And then also, being

able to write equations for situations so that they can solve them.
(Natalie, Interview 3, October 9, 2009)

In this excerpt Natalie voiced goals related to both procedural fluency and strategic competence. Later she expressed goals related to adaptive reasoning. In class I observed her asking students to provide multiple reasons or justifications for typical algebraic manipulations. When asked why she asked these types of questions she said:

Just to make them think about, because there are the ones that can just do these problems because that's the way we've done them forever. They just probably never have been asked: "Why are we doing that?" It's just Ok we're supposed to add 7 so let's add 7. "That's just how we were taught." So what's the math behind it. (Natalie, Interview 1, October 2, 2009).

In another excerpt she voiced goals related to developing a productive disposition.

She said:

I guess it's not relying on me so much. I joked with one kid today. I said, "I'm not the expert." You know not relying on me to give them the answer, tell them they're correct. I want them to be able to check their work. A lot of the kids were, "Is this right? Is this right?" Well how can we do that? Check to see if your answer makes sense and is reasonable. But I also think that if they find their mistakes. Then maybe, they won't make that same mistake again. "Ok I keep forgetting to distribute the negative." So if they can see that for themselves maybe they won't do it again and again and again.
(Natalie, Interview 1, October 2, 2009)

Where Natalie's first goal was to help students develop symbolic manipulation skills her secondary goals were that students learn to justify mathematical steps and develop the ability to reason for oneself the correctness of an answer and thereby develop greater mathematical efficacy. In other words, she had goals in the areas of procedural fluency, adaptive reasoning, strategic competence, and productive disposition, four of the five strands of mathematical proficiency. It is arguable that

she also held goals in the last strand, conceptual understanding, as she worked to help students understand the meaning of algebraic symbols and justify various symbolic manipulations.

Adam displayed learning goals to his students. These written goals emphasized developing skills and understanding. The goals he displayed to his class were: (a) "I know and can apply the effects of a , b , and c of a quadratic equation in standard form $y = ax^2 + bx + c$;" (b) "I can use the quadratic formula to solve quadratic equations;" (c) "I can write inequalities to express questions about functions of one or two variables;" (d) "Given a graph of one or more functions, I can solve inequalities related to the functions;" (e) "I can describe the solution set of an inequality in one variable symbolically, as a graph on a number line, and using interval notation" (Adam, Video Day 1, October 12, 2009). These targets are somewhat balanced across the strands of mathematical proficiency with the exception of productive disposition being noticeably absent. In a personal communication he voiced a goal related to productive disposition that students "appreciate math more" (Adam, personal communication, March 23, 2010).

So at various points Adam expressed a variety of different learning goals that span the strands of mathematical proficiency. When asked about his goals in the interview, Adam emphasized conceptual understanding. He said:

I rattled it off with the last group. I had to stop and say let's just take a moment. Can they find a line of symmetry and know exactly what that means? What does that line of symmetry tell you? Then we calculated the minimum or maximum using that line of symmetry as my x value, but I don't think they know that that is their x ...What I might do is... just give them a solution. Then ask them, "So what does [it] $(-2, 1)$ tell you? What does this mean in this problem? Where is that on the graph? Where do you find that in the work that is shown?" I might

have them do something like that, have them just analyze, take a step back and birds' eye view almost of what is all this for? What is it showing me? (Adam, Interview 2, October 20, 2009)

The language Adam used in this excerpt indicated an emphasis on both skills and concepts associated with finding and understanding the meaning of quadratic maximum and minimum points. It is also clear that he felt students were struggling with both. It is interesting to note how his learning targets speak more to skills than his interview excerpt, perhaps indicating a bias, or even just a temporary problem area to be addressed at that point in the unit of instruction.

In addition to subject matter goals in the area of procedural fluency and conceptual understanding, Caleb and Kathy held goals in the area of productive disposition. Caleb held a goal to insert more applications into his Algebra 2/Trigonometry class. He said:

My biggest goal this year is bringing in some practical examples of mathematics... I'm trying to bring more practical knowledge in. So trying to plan these things where [professionals] can come and talk about "this is why math is important, this is what it can do for you. This is how I use it in my career." (Caleb, Interview 2, November 19, 2009)

Similarly Kathy also held goals of this nature. She said:

I keep, putting this up here (hands on both sides of her face mirrored) so they can see that (line symmetry). Trying to tie it to their real life. And when you say goals, if I had to write my whole obituary and say what is it I want to accomplish in my life, it's to have the kids understand that math is out there, that math is not something you use in a classroom that you'll never see again that you hate. I want them to have fun. I want them to enjoy and to apply it. I want them to be able to say, "Yeah it does happen." That's my goal. (Kathy, Interview 1, January 12, 2010)

To meet this goal Kathy not only explained how line symmetry applied to the human body, but how transformations were used to make wrapping paper and also in

making digitally animated films. She explained that at the end of the year she hoped students would: “Like math and understand it’s out there, and they can do it. They can take the tools and apply them” (Kathy, Interview 2, January 14, 2010).

Each teacher held goals across the different categories of mathematical proficiency. Each teacher had their own special emphasis on what was important and what they spent instructional time in working to meet. No teacher struggled to identify his or her subject matter goals, and as the interview and observations progressed additional subject matter goals were uncovered such as that held by Kathy that students learn that “math is out there.” Kathy, Interview 1, January 12, 2010).

To Develop, Deepen and Refine Students’ Understanding of the Mathematics

Teachers in this study held goals to develop, deepen, and refine students’ knowledge of the subject matter in systematic ways. These goals were uncovered as I asked teachers about the questions they frequently asked the whole class or the organizational decisions they made. Natalie, for example, consistently and systematically challenged students to justify their steps or find alternative solution paths. Kathy challenged students to clarify their thinking in whole class discussion. Caleb chose the most challenging problems he could for homework assignments to challenge the students and eliminate surprises on quizzes and tests. In these and other ways, these teachers provided instruction and support directed to deepen students’ understanding of the mathematics. A few specific examples follow.

I identified several instances when Kathy deepened student understanding of an idea in whole class interactions. I noticed her use of patty paper while reviewing

a quiz problem. A majority of the students misidentified a shape as having rotational symmetry. She passed out patty paper and asked the students to trace the shape and then rotate it on the original to examine the symmetry. She explained:

I wanted to make sure, that patty paper, you know they can trace that out really easy and then fold it. And then most of them when they did that said, "I can't get it to work." And so they figured out it didn't work even though I was saying it, it's still their ah-ha moment. Oh yeah that didn't work. Those spokes [parts of the image] aren't going the right direction or whatever. (Kathy, Interview 1, January 12, 2009)

In other words, Kathy used this activity to help students more clearly see the idea involved in the rotational symmetry for themselves on which they had been confused.

In another interaction in whole class discussion Kathy pushed a student to more accurately articulate an idea. They were reviewing line reflections. Kathy asked a student to explain a line reflection in her own words. The student responded with a definition too vague for Kathy. So she asked the student to further clarify and added, "I'm picky Kelie" (Kathy, Video 1, January 11, 2010). In the interview Kathy explained her goal:

A lot of kids, especially in the transformations in geometry in the whole thing, they use the same words to describe 20 different things when they say it cuts it into two equal parts, it doesn't matter if it's a reflective part, it doesn't matter if it's a rotated part. It's two equal parts and they don't understand that we really need to know that it's not just cut into two equal parts, but it's also mirror images of each other. That's the whole thing about reflection symmetry. So I wanted her to make sure that she didn't stop at two equal parts. (Kathy, Interview 1, January 12, 2010)

In this excerpt we learn that Kathy wanted the students to verbalize and articulate the ideas, but she also insisted that they be as mathematically accurate as possible. She wanted them to know the critical points of the idea. She was avoiding letting a

student articulate an idea incompletely. She was pushing the students more deeply into the mathematics. Her choice to do this in whole class discussion was indicative of her desire that more than just the one student deepened their knowledge at this moment.

Caleb consistently chose the most difficult problems for homework assignments, quizzes, and tests. He said:

So what I do for the homework is I make sure the homework is just as tough as any quiz or test problem I'm going to give. I say this a lot. I say, "I can't make a problem any more difficult than this. So I give them all different scenarios punched into one problem and once they've got that down they're comfort and confidence is a lot higher because they know they're not going to be surprised by anything at the end. I try to pick problems in the book that are going to be more like what I would choose. Because I make my own tests and quizzes, I don't like book tests and quizzes, I think they're, I don't think they're challenging enough. So I try to pick the most challenging problems in the book so they will complement what they're going to see, when we get to test and quiz time. (Caleb, Interview 1, November 17, 2009)

The goal to challenge students mathematically was expressed in Caleb's choice of lecture problems, homework problems, and quiz and test problems. He wanted to avoid surprises for the students, and at the same time, he wanted to build confidence for the students: that by doing challenging problems his students would gain confidence for his tests and quizzes.

Caleb complemented his challenging assignments with many resources to help students work through the problems. He maintained and updated daily a class website with lectures from each day as well as worked solutions to each homework problem. He also consistently arrived to school an hour early to help students in need. He explained that these resources were helpful to meet different students' learning needs. For example, by providing the worked out solutions, sometimes in

multiple ways he helped students overcome frustration with figuring out what to do.

He said:

I don't want them to get so bogged down with getting frustrated not knowing where to go that they quit. What I've found in the past is kids will start working on homework and if they don't get past the 4th problem and they're like, "I don't understand any of this." They'll just stop and quit. And I'm trying to encourage them, "don't quit. You can look and see what the next step is and you can say, Oh ok I'm just forgetting this step"" And then they'll continue on. (Caleb, Interview 1, November 17, 2009)

In other ways similar to this, Caleb provided support so that while students knew that his assignments, quizzes, and tests, would be challenging, they had resources to support their learning.

To Develop, Deepen and Refine Individual Students' Understanding of the Mathematics

Teachers in this study held goals to develop, deepen, and refine students' knowledge of the subject matter in individual contexts. These goals were uncovered as I asked teachers about the interactions they had with small groups and individual students. Natalie, for example, organized group work specifically to meet with chronically struggling students. Sarah and Adam met with and helped individuals and groups of students understand mathematical ideas. In these ways, these teachers provided instruction and support directed to deepen students' understanding of the mathematics. A few specific examples follow.

Adam, Natalie, and Sarah organized their classes so that much of the learning was carried out as students worked individually and/or in groups on learning tasks and problems. In fact, Sarah's class was organized so that practically all of the time was spent this way. She made a special effort to eliminate or reduce the number of whole class discussions as she found that these discussions were less necessary or

helpful to her students. Consequently, many instances of her working with individuals or groups of students were observed where she consistently worked to help students develop and refine mathematical ideas. Sarah's work in these interactions involved helping students consider mathematical choices, recall pertinent information, generalize ideas through examples, provide examples or counterexamples to help students realize the correct mathematical ideas, and otherwise think about problems to develop mathematical knowledge.

While Sarah held the goal to deepen students' mathematical ideas and regulated her behavior in terms of helping the students think and generalize, she also held the goal to avoid telling them rules and procedures. These goals were put into practice by her skillful questioning and bringing important information to the attention of the students to help them reason. In the following excerpt Sarah related an interaction with a group who was struggling with the task to identify families of functions that could be used to generate a given graph. Specifically, a girl in one group was wondering whether a function from the inverse power function family $f(x) = k/x^n$ could produce a particular curve. She explained:

I started to ask her "What are some things we knew about inverse functions?" Because I wanted her to see, we talked about that they had: an asymptote on the x-axis and the y-axis. So I wanted her to think about that. That's what I asked for next. Next I asked her to think about where the inverse functions never existed. And she said on the x and y-axis. So I wanted her to kind of decide if that was going to help her say that this would be a possible type of function for this graph, or if it wouldn't. So I wanted her to think about if that would help defend it. Or say "No it's not." Just making her think about the actual qualities of each type of function. (Sarah, Interview 1, October 30, 2009)

Her central goals in this exchange were to prompt the student to recall and consider particular characteristics of the inverse power function family and use that to make a decision about whether this function family could produce a given graph.

In another interaction Sarah worked to help students develop the mathematical relationship between the period of a trigonometric function and the coefficient b of a generalized trigonometric function such as $f(x) = a \sin(b \cdot x) + c$. Students in this interaction were struggling to change the period of a cosine function from 2π to 2 . They had previously worked through a trigonometry unit and had learned to change the period but had forgotten the relationship. In this unit they were learning about stretching and shrinking in both horizontal and vertical directions, but had forgotten the relationship they had made for the trigonometric functions. In doing this she did not write the rule on the board, rather she asked the students questions about changing the period from 2π to π , and to 8π , to prompt them to remember the relationship between the period and the b -value in a standard trigonometric function. She explained “I was hoping I would just kind of draw them back to how we came up with a little rule. That if you take 2π divided by b gave us the period” (Sarah, Interview 2, November 4, 2009). She further said:

More importantly, if any of these kids are going to take the ACT six months from now, and they have to do something like that I want them to be able to, if they can't remember; they could reconstruct it really quick. So that's why I'm trying to get them to write some stuff down, like “What happens when I do to this function? Oh yeah I remember this is what happens.” I'm hoping if we try it with a couple simple examples, and the hard thing for them is trying to change the period to something that doesn't have a pi in it. So it's a lot easier for them if you say I want the period to change from 2π to 4π . And then they're like Ok got that. Hopefully I can get them to think of those couple of easy examples each time or remember how

it's done if they can't just remember how they did it. (Sarah, Interview 2, November 4, 2009).

In this example Sarah tried to help the students redevelop the relationship between the b value of the function and the period of the function so that they could change the period from 2π to 2 by helping them think through easier period changes.

Meta-Level Goals: Monitoring Learning, End of Year Student, and Personal Improvement Goals

In this section I present goals teachers held at the meta-level. These goals fit into the bigger picture of their teaching efforts. They held goals to monitor learning. Indeed, this was largely implicit in all of their goals. Here I make this goal explicit. I also present goals teachers held related to overarching learning goals they hoped students would take away from their classes by the end of the year. Finally, I present goals teachers held for their personal improvement.

To Monitor Student Learning

All teachers monitored activities and student learning, but much of this was implicit in the interviews. It is evident from the transcripts and the goals already presented that the teachers were continuously monitoring not just the learning of the students, but the classroom environment and learning activities according to their goals for these areas. This monitoring activity fed information back to the teachers that helped them regulate their activity and the activities of the class. In other words, teachers' goals often existed in parallel in two places. For example, if they held the goal that students listen to each other, they monitored whether students were listening to each other and they monitored their personal activity that contributed to or influenced students to listen to each other. In this way a tight

feedback loop was used that cycled between monitoring student activity according to a goal, and monitoring their efforts to attain the goal.

Natalie, Adam, and Caleb each spoke briefly and explicitly about goals to monitor student activity and learning. Natalie consistently used bell work at the start of each day to both review and preview subject matter, but she also used this time and the time spent checking homework which immediately followed to explicitly monitor student learning and attainment of learning goals. About bell work she said:

It [is] a good way to review the previous day's lesson. I could walk around and see which kids had done it, which kids hadn't. So I can kind of get in my mind a feel for "oh this one's just being lazy, or this kid doesn't know where to start." (Natalie, Interview 1, October 2, 2009)

In addition to reviewing or previewing subject matter, Natalie stated that she monitored and assessed the students to gather information about them, their abilities, their efforts, and their needs through the bell work activity. Natalie further assessed students in these areas during the homework check. Natalie explained the purpose of the homework check, and this activity influenced her later instructional choices. She said:

As I'm going around I'm looking to see are they missing one or two, or are they missing 10 or 12. There was some that missed a lot because they didn't try them. There are some that are very confused. There are the ones that have got this down and they don't need the extra practice. So just kind of getting a feel for that. Then hopefully that helped me know who to focus on in the groups. (Natalie, Interview 1, October 2, 2009)

Natalie's goal with the homework check was to get a sense of the needs of the students. She used this information to focus on select individuals and groups of

individuals in later instructional activities. Natalie continued to monitor student learning and activity throughout her classes as she engaged students in a guided practice format class. She used a wireless overhead technology that allowed her to roam the room, which afforded her the opportunity to monitor.

Caleb monitored student learning by taking note of their work as they were called up to the board to work a problem. He explained, "I'm constantly using legal pads to write down what works, what doesn't work, what do I need to tweak, what do I need to try sort of thing. I don't use lesson plans. I use legal pads and computer" (Caleb, Interview 2, November 19, 2009). He further explained:

Maybe somebody will get up there and say something a little bit differently than I say something, and that might stick and then I write it down on my legal pad and I might steal that from the kid for next year. Or it might be something that somebody would say "oh I see when he did this, and it works out really well so." I like doing it and then a lot of times too when we do things that have multiple ways of solving I like to have the kids go up there too because I like to see what the norm is what do kids like to do more so than this. Kids don't like to write things in vertex form. They like to use the equation for the axis of symmetry and then plug it in to find the y. That's how they like to find the vertex. So it gives me an idea of ok, what are kids choosing more so than others so I can do more examples and that type of a thing. (Caleb, Interview 1, November 17, 2009)

In addition to illustrating how Caleb made an effort to monitor student thinking, this also illustrates how his strategy to call students to the board was multi-purposed. It was not used only to keep students' attention, or make a safe space for students to ask questions, it also served as a monitoring device.

Adam also briefly described monitoring student learning. Recall that large portions of each of his classes were conducted as students worked together in groups on investigations or problems. During these times Adam held several goals.

First among them was to “get around and talk to every student and hear what they’re thinking mathematically” (Adam, Interview 1, October 14, 2009), and secondly (b) to “try and figure out a way to get them to the learning without showing them or telling them” (Adam, Interview 1, October 14, 2009). His goals were to listen in at each table and hear the students’ mathematical thinking and to help them learn without telling them.

Although very few interview conversations were focused explicitly on monitoring student activity and learning, it is obvious from most of the teacher goals that monitoring was integral to their activity. How else could Kathy know precisely which quiz problems to review, or how else could Caleb know that students were anxious to direct questions to him during his lectures. Sarah reorganized her classes to almost eliminate whole group conversations because she sensed that holding those discussions was unnecessary and stalled the learning experience. And how else would Adam know to provide additional attention to certain mathematical topics?

End Of Year Student Outcomes and Learning Goals

The teachers of this study held a variety of goals related to what they wanted students to learn or get out of their classes by the end of the year. Many of their thoughts in this area were unique to them as individuals, and some of these will be reported here. However, one area did hold across individuals. These teachers wanted to prepare their students for the following year of school, and some additionally wanted their students to stand out in future courses as having come from them.

In an email communication, Adam expressed these goals:

My goals by the end: I want to influence students to appreciate math more. (I want them to like math class.) Related to this... I also want their confidence in and flexibility with their math abilities to skyrocket. Of course, my goals have always been to have my kids kick the tar out of other kids on their math tests, and outperform them in math classes in their future years. I could embellish all of those, but that's pretty much it. Gain an appreciation, gain in confidence and flexibility as a mathematician, and then succeed (kick butt) in their future schooling. (Adam, Personal Communication, March 23, 2010)

Although not all teachers wanted their students to outperform other teachers' students, they all said things in the manner of preparing students well for future years. To achieve this goal of having their students well prepared Sarah and Caleb both described talking with the teachers who would have their students the next year and asking them what their students needed more preparation in.

Two of the teachers expressed concern about students' and parents' perceptions of their classes in regard to how well their classes prepared students to succeed at the next level. Adam, for example, explained that part of his work in meeting with groups of students was to provide learning support. He explained:

The best PR for any math program is the kids go home feeling like they were supported in the classroom, and challenged. And I'm still working on that. But I want to be that support for them so that when they go home and they talk to their parents they can communicate, "yeah my teacher is supportive and my teacher helps me." (Adam, Interview 1, October 14, 2009)

Sarah said:

I really don't want any of them to leave here with the impression that integrated math didn't serve them well. That's a reality of what's being said in our community. I really don't want that. I don't want any of them to walk out of here at the end of the year and feel that they didn't learn the math that they needed to learn. I really don't want that to happen. I want them to feel like I enjoyed doing this curriculum, I learned so much from it. I am a good math thinker now.

So that's not an issue with them. I really want to avoid that issue.
(Sarah, Interview 2, November 4, 2009)

For Sarah, these goals were strongly linked. She wanted students to be well prepared, and this would, in part, help her meet the goal that students have a positive view and experience with the curriculum. In addition to being well prepared and having a positive experience, she wanted her students to become good math thinkers. Adam and Sarah were confident they would be able to meet these goals with most of their students.

Caleb and Kathy held different goals. They wanted to bring in practical applications so that, as Kathy put it, the students would know that "math is out there" (Kathy, Interview 1, January 12, 2010). She further said:

I hope they walk away saying, "It is useful, and it is something that is going to advance me in life." I just hope they like math and they understand it's out there, and they can do it. They can take the tools and apply them. (Kathy, Interview 2, January 14, 2010)

This was expressed in a previous theme, but was for these teachers a yearlong goal.

Each of the teachers expressed in different ways the goal that students become problem solvers or like math. Caleb said:

So I think that's kind of the main goal is let's get them excited about the math, let's get them excited about learning and problem solving so when they get out, it doesn't matter if they remember all the stuff they've learned they've learned how to be a problem solver and how to figure things out. (Caleb, Interview 2, November 19, 2009)

The instruction teachers used to realize these goals varied.

Natalie's end of year goals were that students have:

The ability to represent and solve problems in multiple ways. I'm thinking equations, graphs, tables. I'm hoping to tie in this solving equations and how many solutions to a graph and to a table and how

to look for solutions that way. So that's kind of a big idea of representing and solving equations. That's a big one.

It always seems like the linear chapters are a big thing for me. I really try to hit that more. Because I want them to have the concept of slope and have the concept of graphing equations before they go on to their next courses. Maybe because I know it's a topic that will continue all the way through. (Natalie, Interview 3, October 8, 2009)

In a personal communication, she related that she wanted to help students develop "their problem solving skills, so that when they encounter math problems in real-life they have the skills necessary to solve the problem" (Natalie, May 13, 2010).

Teachers in this study wanted students to be well prepared mathematically for future years. A major part of their goals in this area was to help students develop problem-solving skills that could be applied outside of the classroom. For some teachers, developing problem-solving skills led to their effort to make explicit connections between in-school mathematics, and how that mathematics would connect to applications in real world settings. Some teachers focused their efforts on helping students develop skills and learn processes to meet their overarching goal that students become stronger problem-solvers. Other teachers focused much of their effort on distributing mathematical authority to achieve their yearlong student learning goals. Kathy, for example, spoke about her constant effort to:

Train them that I'm not the giver of information. They are the giver of information. They can teach each other things by just looking at patterns in mathematics, and looking at what's happening. I don't want them to look at me every time somebody says something and ask me, "Is she right?" I want them to be able to question, and if they don't agree, I want them to be able to say, "I don't agree" (Kathy, Interview 1, January 12, 2010)

In these ways, these teachers' yearlong goals were worked toward by their daily efforts to deepen students' understanding and skills in mathematical processes and to distribute mathematical authority.

Personal Goals for Improving as a Professional Teacher

When asked, the teachers were able to describe goals they had for their personal improvement as teachers. Their goals varied according to the contexts they were in.

Natalie spent the majority of her career using integrated curriculum, but for this study was in her 2nd year teaching algebra. Her main goal was, "To engage ALL students in class—that is, they should be working on math during the entire class period and should attempt all problems to the best of their ability" (Natalie, personal communication, May 13, 2010). This goal for her could be the result of teaching in an entirely different style with a new curriculum. She said, "I still struggle with the whole classroom management and keeping them on task and keeping them involved" (Natalie, Interview 2, October 6, 2009).

Adam was in his first year teaching at the high school level. He had the requisite mathematics background, but still found a need to get to know the curriculum better. He explained:

Personally I've got to get to know the curriculum at a level much deeper and wider than what I'm teaching. So each day I work at going through the problems and trying to get into the heads of the authors and making notes about high school, how it's a little bit different. (Adam, Interview 2, October 20, 2009)

I'm still feeling a little iffy about the content, it's a new curriculum for me. I feel like in some way I'm over my head a little bit, in that I'm not prepared, I don't know what questions they're going to ask me, I've never taught this before. (Adam, Interview 2, October 20, 2009)

The goal and concern here have to do with knowing the curriculum well and knowing it well enough to organize learning activities and respond to student questions and challenges.

Adam further related goals and concerns as they related to his standing with other teachers. He said:

Although I started off this year telling them I'm going to come and ask questions, and I feel like everyone would answer my questions, which is good, but, you've got to be careful, "Well let's not give Adam this class, because he can't handle the math. Or let's give Adam the easy classes." I end up with a herd of kids that are way behind in school and it's because they think my math is not up to par. So I've got to protect that a little bit, but I have to be true to the kids at the same time. I can't be someone who doesn't know the content. (Adam, Interview 2, October 20, 2009)

Here we learn about the tension Adam felt between protecting his image among fellow teachers and his need to be true to the students, to be one who knows the content well enough to teach it.

Kathy, in her 26th year of teaching, was teaching from curriculum materials newly adopted in her district. She said:

I feel like I'm not as organized, especially this year I'm feeling really out there, because a new book that I hate, that I don't think has a lot of good material in it. I'm recreating the wheel, and I'm organizing. When I say recreating the wheel, not necessarily, I'm stealing from things I've done over the years, but just putting it all into a condensed format where next year I can build on it more, and I try to take good notes on what worked, what didn't work, what took too much time, what could I have done in shorter amount of time if I had done this differently? So just taking more notes and figuring out how I can make it better next time. (Kathy, Interview 2, January 14, 2010)

By taking note of her activities and collecting activities around central ideas Kathy intended to improve her course for the next year, hoping to make it more coherent and effective for future students.

Sarah held three goals within her classroom towards improving her teaching. The first of these probably led to the others. Sarah did not want to be complacent with her teaching. She said:

I don't want them to ever think that I'm content with what I'm doing. I don't want to be known as the teacher who I've heard people talk about, that does it the same way all the time and it's not working and they keep doing it and they're not going to change the way they're doing it. I never want to be anyone to say anything even close to that. (Sarah, Interview 2, November 4, 2009)

Sarah's goal was to consistently modify her teaching to avoid practices and policies that were not working.

The other two goals she held for her improvement in this year were to develop greater working knowledge with a new technology, the TI NSpire, and to improve her ability as a facilitator. She said:

One of my major things is trying to get them a little more comfortable with using the NSpire. That's one of my goals of teaching, is how can I incorporate it a little better into some of the things we're doing and get comfortable enough with it myself that I can help them when they use it?
Being a better facilitator, that's my job that's my role in this type of class that I have. Just getting them to keep thinking, getting them to keep moving, not to stop, and question them and make sure they can really understand and verbalize and explain what they're doing. I want to be this facilitator that allows students to progress at the rate they're comfortable and for them I struggle with quiz dates and does everyone take them at the same time. I want to be better at doing all that but then, some kid gets to a point sooner than another kid and I don't know what then I do with them sometimes, so it's hard. (Sarah, Interview 2, November 4, 2009)

These two goals to better incorporate the TI NSpire and to improve her ability to facilitate learning were significant part of Sarah's thinking as I met with her.

"I don't want to be complacent and so every year I try to say I'm doing something new this year, and not necessarily new for new sake" (Caleb, Interview 2, November 19, 2009). In this year Caleb explained he was trying to bring in more practical applications of the mathematics and to develop better communication with parents. By observation it was clear that he also intended to improve his teaching year after year. He explained, "I'm constantly using legal pads to write down what works, what doesn't work, what do I need to tweak, what do I need to try sort of thing. I don't use lesson plans I use legal pads and computer" (Caleb, Interview 2, November 19, 2009).

The teachers in this study were conscious of areas in their teaching that they felt needed improvement. They wanted to know the curriculum better, or organize the learning better, or engage students at a higher level. They wanted to include practical applications and were mindful of how students were learning and looked for ways to innovate and improve. They did not want to be complacent; they wanted to be better teachers.

Sources of Goals

In this section I illustrate the sources of teachers' goals. I begin with two vignettes of Sarah's teaching goals that illustrate the reasoning she engaged in that led to two of her goals. These examples broadly illustrate the sources of the other teacher's goals in this study. This first vignette is about her effort to organize the

format of the learning activities to minimize or eliminate unnecessary pauses and maximize the time available to students to engage in learning activities.

Sarah taught Honors Integrated 4 and organized the class to minimize unnecessary pauses involved in whole class discussions. The reader should be alert to notice Sarah's concern for student learning and how her teaching philosophy and preference influenced her choices, her goals, her policies, and her activities. The reader should also notice how she began teaching this class with a strategy she had used previously—holding whole class discussions frequently to clear up misconceptions. But when she held these discussions she observed and perceived that the students already understood the mathematics. Therefore she was led to ponder how to reduce these unnecessary stops, and at the same time ensure learning. These excerpts are condensed from the original transcripts. She said:

I was used to, they work on the investigation for a while then we stop to kind of clear up some misconceptions some groups are having. It was very sectioned off.

I realize there were times that I *thought* we needed to stop and talk as a class, and everyone would just kind of stare at me like we already know that.

They worked so hard together, and they worked so well together, that if there's anyone that had it off, the rest of the group helped them figure it out, and they had it corrected.

I realized that I was standing in their way by saying ok I want you to stop after this problem.

I need to get out of their way. We don't need to stop at certain points.
(Sarah, Interview 1, October 30, 2009, emphasis added)

The reader should notice how her efforts evolved. That is, she *thought* that she needed to stop but when she did, she observed student expressions that indicated they already knew the mathematics she was intending to discuss. She perceived

these discussions as unnecessary. Her goal was to get out of the way, to do away with unnecessary discussions so students could learn.

So Sarah developed a plan where the students were given dates for quizzes and tests and were instructed to develop group plans to learn the mathematics for those tests and quizzes. This was the second year she implemented this idea. She continued:

So I just started it with them this week. However, I'm really struggling with the way they're grouped. They're not working at the same pace in their group. So we're going to have a quiz next week, and I'm sure that I will put the kids who are working faster together, and the kids who work a little slower together, because I think they'll work more together.

I don't want everyone to take the same amount of time of time on every problem. That's not the way they learn or have to think through problems. There has to be that point where they thought about it before I'm going to give them an answer. (Sarah, Interview 1, October 30, 2009)

She initiated this plan the week I began observing. Notice that she observed students working at different paces within groups and how this led to her thinking about grouping students in pace-alike groups. In fact, she had assigned a new seating chart the first day I observed her, then, on further observation and reflection, reassigned seating the last day I observed her.

She continued discussing her goals for having students work in self-scheduled groups. She said the benefit from having them organize their own schedule was:

They're never sitting in class, feeling like they're waiting. And I hated that, so I want them to feel like they can keep on learning. Keep on doing problems, they don't have to wait for me to say, "Ok yes now you can move forward."

The other thing is, I hope that they start to learn this idea of, "This quiz is covering this content, and it's kind of up to you, the way you

want to work through it.” So I’m hoping they start to decide those things for themselves, rather than the teacher always saying you have to do this. (Sarah, Interview 1, October 30, 2009)

Her efforts toward instructing students to develop their own schedule were enacted to meet her goals that students’ learning be uninterrupted by unnecessary whole class discussions and so students begin to develop greater responsibility for preparing themselves for quizzes and tests. In this way these efforts were in the service of her goals to create an effective learning environment.

This vignette illustrates the sources of one of Sarah’s goals. Her goal to have students self-pace their learning was rooted in her observation that these students did not need to have frequent stops to clear misconceptions. She wanted to maximize learning, so she developed a strategy to have students self-pace. This new organization fit with her conception of the learning process, that students would develop understanding at different paces. And this organization fit with her conception of teaching, that the teacher should engage with students once they had opportunities to think about the mathematics. These conceptions, then, served as a groundwork of sources that were further developed through her observations and perceptions of what was occurring in the classroom relative to these goals.

The previous example illustrated the sources of one of Sarah’s goals related to classroom organizational matters. In the following, I illustrate the sources of one of Sarah’s goals related to developing students’ mathematical understanding. In this example Sarah described her goal to help students make sense of a vertical stretch of a function and the correlated coordinate rule notation. The students were given the task to write the coordinate rule that transformed the function $f(x) = \cos(x)$ to fit

a graph of the same function under the vertical stretch of a factor of five. Specifically they were to fill in the blanks of the following $(x, y) \rightarrow (?, ?)$ with appropriate values that transformed $f(x) = \cos(x)$ to the vertical stretch by a factor of five. Notice how the sources of her goals in this area were rooted in the mathematical concepts and in what she understood of the student's difficulty. Sarah described what she saw on one student's paper and what she did to help her make sense of and learn from this problem. Of the student's work, Sarah said:

She wrote $(x, y + 4)$. I think she just looked and saw it worked that 1 became 5, and so she wrote plus 4. But then she recognized that it wasn't a good enough rule, because then she said, this actually got 4 less because she said negative 1 became negative 5. So that's why I said, let's look at those two points and I added in that zero stayed zero. So hopefully she wasn't seeing that it was adding or subtracting something, because that could be a misconception of you're just looking at like 1 to 5. That's why I wanted to throw in there the 1 went to 5, the zero stayed zero, and the negative 1 became negative 5. Hopefully she would see that it was multiplication. With a lot of them I had to look to see what they had on their paper. But I had to help them realize that it was multiplication, and then I had to help them realize where the multiplication was, was it to the x values or to the y values? And then what that looked like when they actually wrote the function $y = 5 * \cos(x)$. So it kind of depended on what they had on their paper, where I jumped in with them because some of them already realized that it was multiplying by 5, they just put it in the wrong spot in the coordinate rule or the actual function. Some of them didn't realize it was multiplication, so she started out with addition, so that's why we had to pick some values for her to even realize that it was multiplication to start with. (Sarah, Interview 2, November 4, 2009)

In this example, to help students make sense of vertical stretches, Sarah's specific goals with individual students were rooted in what she saw of their work, what they understood, and their responses to her prompts. This goal was also rooted in her approach to teaching to get students to do the sense-making, and in her subject matter learning goals.

In the examples shared, the reader should notice that Sarah's goals for instruction and rationale for those goals were rooted in her observation, perception, and hypothesizing about how to better organize learning structures, policies and instructional decisions to make the learning environment effective. In other words the source of Sarah's goals were her teaching philosophy combined in a deeply integrated way with the mathematics and her observation and perception of students responses to her instructional choices. Her efforts to enhance her teaching were based largely on observations and perceptions of student learning in her system of teaching. Her goals were additionally influenced by virtue of being in a school district with an assessment for learning initiative and her collaborative work in her school. While the textbook in some degree dictated her subject matter learning goals ("the curriculum set the goals for me" (Sarah, Interview 1, October 30, 2009)), her goals related to organization, policy, and student mathematical activity and teaching interactions were based on this milieu of teaching philosophy, observation, perception, and learning enhancement effort.

The sources of Sarah's goals as illustrated in these examples represent the source of goals for the other teachers in this study. They had teaching philosophies that led to consistent patterns of instructions. They enhanced these patterns of instruction as they observed, perceived, and hypothesized and enacted enhancements.

Other sources of goals include curriculum, district initiatives, and images of teaching to avoid. Additionally some teachers' goals were developed in unplanned

ways as the teacher enacted routine instruction and noticed unanticipated positive outcomes. In the following I illustrate these sources.

A strong source of goals for several of the teachers was their exposure to reform curriculum. Kathy, for example, had been a strict lecture style teacher, but slowly evolved to pushing students to make sense of the mathematics for themselves. She said,

I fought reform curriculum for years. I mean I was a traditional teacher I got up there “Ok let’s open our books to page 1. We’re doing page 1 today, we’re doing page 2 tomorrow, we’re doing page 3” and we just go cycle cycle cycle. When I was traditional I was the mathematical authority. Whatever I said, this is you do it, and this is how you will do it. But as I’ve gone through the reform curriculum, [district leadership] pushing me, having us do the [professional development] stuff. Even though I gripe about having to go on Saturday’s, you know. But I will tell you that one bonus of that is it does help you think about letting the kids have more freedom. (Kathy, Interview 1, January 12, 2010)

She identified the sources for her change as the mathematics curriculum, professional development and district leaders.

Adam said, “I learned through teaching reform and letting go of my authority in the classroom and giving it to the students, which really the learning belongs to them. It’s not me giving them the learning” (Adam, Interview 1, October 14, 2009).

Natalie explained that a source for her goal to have students make sense of mathematics without her telling them was partially due to her experience teaching from an integrated curriculum. The goals related to this source mainly involved challenging students to do the sense-making instead of telling. I do not have information to indicate how much this shift was realized in these teachers’ teaching, but this still indicates a significant shift in teaching style.

Several teachers identified a district initiative toward assessment for learning as the source of their goals to identify and communicate learning targets with students. This was discussed in the cross-case analysis theme regarding orienting students to what is to be learned.

An interesting source of teachers' goals was their exposure to non-ideal images. Teachers held goals to avoid these non-ideal images by enacting instruction to ensure they did not occur in their classes. Adam and Kathy both described goals of this nature from this unique source. Adam was determined to avoid what he had seen in other classes when he was a mathematics coach. He wanted to avoid having classes where students were not allowed to think. He explained what he saw as a coach:

Some of the teachers would be so structured [that] students were not allowed to write an answer down unless the teacher had written that answer up on the board. So those kids got in such a mode where they were afraid to try anything without the teacher showing them how to do it first. (Adam, Interview 1, October 14, 2009)

Adam also cited his personal experience as a student where in math class there was "no thinking about math, and then when I got home to do homework there was still no thinking. I was just following the process" (Adam, Interview 1, October 14, 2009). This led him to earnestly pursue teaching strategies that promoted thinking and avoid homework policies that did not support student thinking.

Kathy explained that her strategy to repeatedly expose students to the same mathematical ideas came from her goal to avoid the experience she had as a student. She explained:

I think one of the things that I feel as a math student that hindered my learning of mathematics is that my teacher only showed us one thing,

and we could only look at that one thing and then, as soon as we looked at it, we took a test on it and then we moved on to the next little thing. (Kathy, Interview 2, January 14, 2010)

That this perception and image stuck with her over the course of her 26-year career is impressive. It illustrates the power of a non-ideal image. In the preparation of mathematics teachers we often cite Lortie (1975) for bringing to the fore the conception of apprenticeship of observation. The idea being that teachers have a great deal of exposure to images and organizations of classrooms that leads them to teach in the way they have observed, often despite formal training to the contrary. These participants also illustrate a kind of apprenticeship of observation teacher training, but one where they chose to avoid particular strategies or routines they had been exposed to, or on the other hand, to implement strategies and routines to avoid learning experiences they had.

A curious source of goals appeared to be the accidental stumbling upon unanticipated but valued positive outcomes; much like so many accidental scientific discoveries. Caleb offered numerous examples of goals that seemed to have initially been unexpected outcomes of certain strategies. As he noticed these positive outcomes it gave him even more incentive to continue enacting strategies to achieve them and in this way they became additional goals that he pursued. For example, when asked about calling students to the board, his primary goal was to keep students on their toes, but he came to notice that students were more likely to ask their peer at the board than they were to ask him. This derivative outcome (other students' willingness to ask questions of their peers) became both a reason (source) for calling on students (I do this because this happened in the past, and I liked it),

and at the same time, an outcome (goal) which he sought. Although it is unclear from the interview data, it is possible that this observation and new goal then spawned greater sensitivity and additional effort toward creating a safe learning environment for students because he identified several other ways in which he worked toward this goal.

The mathematical learning goals could be said to have come through the milieu of the teachers' conception of the mathematics, state and local standards, and the textbook in use. The teachers' general goals to provide an effective learning environment came through their teaching philosophy and combined with their observation, perception and reasoning about what would make learning happen better. But some goals were clearly related to the teachers' own special pet topics and beliefs about the best way to learn, about what was best to learn and these had a significant influence on day-to-day and moment-to-moment instructional choices.

In conducting this research, asking about goals alone often prompted the teachers to explain how they came to their goals. Teachers' often shared reasoning and history of their efforts and what they noticed of the effects of their efforts to meet their goals. This reasoning and noticing was critical to the development of these teachers' goals. In this section it has been my intention to illustrate the reasoning that teachers engaged in as they managed, revised, and maintained their goals. These teachers' initial conceptions of teaching were likely developed through sources already well known to the research body such as Lortie's (1975) apprenticeship of observation or through formal training. However these teachers did not often cite these sources, rather they cited their own preferences and

philosophies and experiences in the classroom that were involved in the evolution of their goals and efforts. In other words, their goals were not so much taken from training or observation as evolved from training and observation and developed in their own classroom contexts and experiences.

Efficacy and Commitment

In this section I look across teachers' claims to efficacy and commitment within the goal themes already shared. Recall that Bandura (1997) defined efficacy as "beliefs in one's capabilities to organize and execute the courses of action required to produce given attainments" (p. 3). And Locke and Latham (1990) defined goal commitment as "one's attachment to or determination to reach a goal, regardless of where the goal came from" (p. 125).

The short answers to the research questions about secondary mathematics teachers' efficacy and commitment are that their perceived level of efficacy was relatively high and their commitment was strong. I say their level of efficacy was relatively high because when asked, all participants gave answers not unlike Natalie who said regarding her ability to get students to learn symbolic manipulation and equation solving:

I don't know. I don't know the percent of my class that would be proficient at that skill. As I look at their assessments. I would hope that around three-fourths of the class would make A's, B's, C's, on that. So there's still some things with solving equations and like we said with the all reals and no solution, and do they really understand that? But maybe I'll clear that up when I talk about the graphs more. I'm hoping to go back to that. So I feel like some of them are better at the symbolic manipulation. It was a goal of this chapter. As long as they're the basic ones, don't throw in the fractions or too many negatives they do ok. They still make some silly mistakes, but $2*3$ they write 5 instead of 6. Well that's easy to fix. They're getting there.

And it's something I want them to be very efficient at before they go on to geometry and algebra 2. (Natalie, Interview 3, October 8, 2009)

In other words, Natalie believed that she would be efficacious in getting most students to a proficient level of understanding, but not all. Connected to this was her sense of commitment. Notice how she spoke about getting back to topics and wanting students to be very efficient before they graduated to the next class. Kathy echoed similar sentiments when asked if she was going to reach her subject matter learning goals. She said, "Exposure? Yes. Building the ordered pairs and the knowledge of looking at those ordered pairs? Yes. Have they mastered it? No, not by far" (Kathy, Interview 2, January 14, 2010).

The long answer to questions about efficacy and commitment are that these teachers' saw themselves as being efficacious over time, and so committed effort to their goals over time. Regarding the subject matter learning goals for one day of observation Sarah said, "I don't really expect that they have it perfect today, I really don't care if they don't have it perfect until the quiz or the chapter test maybe, or the semester final" (Sarah, Interview 1, October 30, 2009). And Adam referred to both his efficacy and commitment in these words "they're going to get it... they'll get it before the test because I will keep hitting them with it, and hitting them with it. Just a little at a time" (Adam, Interview 2, October 20, 2009). Representing her commitment broadly to help students learn to reason mathematically, Sarah said,

If I have to help five groups recreate it 3 times this year, by golly by the end of the year hopefully they'll see they can do that by themselves. Hopefully by me continually doing that the next time they'll be like, "she's going to make us go through that whole process again, let me see if I can figure it out again really quick." So they'll start to just do that naturally. (Sarah, Interview 2, November 4, 2009)

The commitment level of these teachers was high and their perceived level of efficacy was high—in time.

Teachers' sense of efficacy and commitment to goals in areas other than subject matter were similarly stated. Adam perceived his success as more contingent on his relationships with students than teaching strategies. He said,

I know that I'll be successful, the teaching. I've had conversations with my wife, I do not have the best teaching techniques... I have the relationships I build with the kids and the kids work because they know I care. And they want to achieve because the relationships...I think the relationships with the kids is really going to take you a lot further than any little tiny strategy that you did to keep them engaged. Although I try to put those in there obviously. (Adam, Interview 1, October 14, 2009).

The other teachers expressed similar commitment and efficacy in meeting their goals to help students learn in the strategies they developed.

The teachers in this study believed that they would be mostly efficacious in meeting their goals, because they intended to keep working at them throughout the school year. They continually sought to improve their classrooms because they did not believe they were ideal. They committed consistent effort to seeing that their goals were met, but they knew this would take time.

Assertions

In this concluding section of the chapter I make three assertions related to the findings. The first is about the nature of these teacher's goals. The second is about the impact of teachers' top-level goals. The third is about teacher's professional growth through the vehicle of their goals.

The Nature of Experienced Secondary Mathematics Teachers' Goals

Experienced secondary mathematics teachers' goals are interconnected, hierarchical, and layered in a mutually supportive and coherent way. While analyzing the data in this study I found it difficult to extricate a goal as a stand-alone goal. The teachers' goals were connected in such a way so that often one goal was in place to enable the reaching of the next goal. Natalie's goal to have more students participate worked this way. In order to have more students participate she developed goals to *prepare* students to participate.

Teachers' goals were linked not only to activity but also to sources and to other goals. This seems rather obvious at the outset, but what I mean is that one goal highly connected to another where one serves as the source for the next and so on until activity is decided upon in the classroom. One way to conceptualize this linking is in the following sentence explaining how teachers' organized their classrooms through their goals. In order to teach x, I need to provide y and avoid z. Providing y and avoiding z, then, were goals teachers held that supported achieving the goal x. But goal x could itself be in service to achieve goal w. And on the other end. In order to provide y and avoid z, perhaps I need to achieve a and avoid b. This type of reasoning then links both upward and downward from conceptions of teachings to enacted activity with many goals in between.

Because teachers' goals were interconnected, teachers could be perceived to be working toward most of their goals at the same time while they worked with individuals and groups of students. In this way, their goals were not just linked together, but layered so that many goals were in play at the same time. For example,

Adam held goals to engage all learners, distribute mathematical authority, help students reach mastery with content they had previously been exposed, build and maintain relationships with students, support students in the classroom to develop positive public relations, and deepen student understanding of mathematics. So when he helped one student reason through a proof (a topic from a past unit) he was in some way putting forth activity towards all of these goals.

Another way of thinking about the linking and layering of teachers' goals is that many of the teachers' activities could be described as multi-purposed. A central feature of Caleb's instructional repertoire was calling students to the board. Doing this helped him meet goals to keep students alert, provide a safe space for others to ask questions, monitor student learning and preference, and take notes about things the student at the board said that seemed to make sense to the other students.

Experienced mathematics teachers' goals funnel students to mathematical learning and development. Experienced mathematics teachers' goals are organized to funnel towards mathematical learning. Not all goals held by these teachers were about mathematics, but their non-mathematical goals contributed to organizing and developing classroom norms that contributed to students learning mathematics.

Furthermore, the teachers in this study knew their learning goals. They had clear in their minds what mathematics and other learning they wanted to occur and could automatically execute scripts and activities to meet them (Gaea Leinhardt & Greeno, 1986). Learning goals were at the heart of their activities, but their goals were directed to getting the students there. In this way teachers in this study

developed a learning environment in their classrooms that effectively and efficiently brought students into the most desired activity, engaging in mathematics.

The teachers' in this study were not content with their practice. They held goals to improve themselves in various way which belie the reality that they both reflected on their practice, and wanted to improve it. For example, reflecting on and improving practice was in Adam's nature. He said:

I'll try something new everyday maybe between hour to hour just to see if it will increase their engagement. And I'll reflect on whether it didn't or did. But I know there's ways I could get better. So I'm not going to continue to do what I've always done, well I guess what I've always done can't be defined because I've always tried new things. I mean I want to continue to make improvements, and I will all the way until June. I'll still be making improvements and trying new things and thinking that I need to engage the students better and challenge them at a higher level. I think all kids can be motivated. You'll see them shooting free throws until 9 o'clock at night, but they won't do the math. So how do you reach that level of motivation and commitment with the kid? So I'm still going to be looking for that magic bullet. (Adam, Interview 2, October 20, 2009)

Similarly, the other teachers explained their self-improvement efforts and their desire to avoid complacency.

Experienced teachers know they must follow up with each expectation or request they make in class or they risk becoming irrelevant in the classroom. They know the extent that they do not follow up and hold each student accountable the students will recognize the pattern and learn that some requests are merely lip service. Consequently they are careful to have a well-defined set of expectations that they continually address and follow up on. Adam, for example said,

I think teachers set up their expectations in very subtle ways, by what they expect in the classroom. It can be seen in what they say, and the actions that they do. And I think that the kids will pick those things up. The kids will learn what it is that you value the most, by what you pay

attention to, or what you say, what you do, the messages that you give them. And you give those messages in many different ways. You can't just say at the beginning of the year and expect it's going to latch on. I think you have to live it and your actions need to be congruent with what you're saying as well. (Adam, Interview 1, October 14, 2009)

Experienced teachers know that kids will pick up what you are really after in the classroom because you will follow up with it and maintain it. Teachers in this study did not just have goals; they had strategies to implement them and were committed to making efforts towards them in their teaching. In these ways, the teachers followed through on their goals so that students knew what was expected.

Experienced teachers realize accomplishing their goals requires a continual effort, that little is accomplished in a day. Teachers know that no single activity or effort will result in powerful learning for all students and they know that they have to return to the same ideas multiple times to see that some level of understanding is developed. Sarah, for example, said,

The day's goals weren't to understand vertical stretching and compression or understand horizontal stretching and compression. It was to look at one function and see if we could come up with what happened to go from this graph to this graph. It was really to look at one specific function and see what happens and I was completely ok with them not even feeling confident.

I think once we do a couple more they'll definitely be able to come up with it. I think the book starts to do enough that they can start to make a connection after they apply it to several things, but if not then I will just have them graph a bunch of things in their calculators. I'll give them a list and help them so they can generalize. (Sarah, Interview 2, November 4, 2009)

Natalie voiced similar sentiments about her goal to get students to find their own mistakes in algebra problems. She said,

Eventually down the road in the 2nd quarter they're going to know what I expect and what I want. There's a couple of kids now that I have had in 8th grade, 9th grade and now again in 10th grade. So "oh

yeah Mrs. Natalie makes us do this.” Oh maybe I got through to that kid. (Natalie, Interview 1, October 2, 2009).

In essence, it appears that experienced teachers do not believe that any activity or strategy is completely effective, nor do they believe that they will ever be completely done teaching something. Whether it is subject matter, or norms of discourse, or developing students’ learning dispositions, experienced teachers realize that there is no such thing as done or perfect or complete. They are always performing maintenance on their goals, realizing that each new day requires revisiting their goals.

Experienced teachers hold goals that are difficult to assess. Connected to the last assertion that experienced teachers realize continual effort must be put forth to meet goals and that no single effort or activity is completely efficacious experienced teachers hold goals that are difficult to assess. Teachers in this study struggled to claim 100 percent effectiveness and often answered with responses like, “I don’t know. I don’t know the percent of my class that would be proficient at that skill” (Natalie, Interview 3, October 8, 2009). The nature of the goals contributed to this difficulty in perceiving success. For example, how do you measure how well you distributed mathematical authority, or prepared students to participate? These are not easily measured. When I asked teachers about their efficacy to meet a goal they often answered by explaining that they were uncertain, but further related efforts they would make to see their goals realized. In other words, instead of speaking about efficacy, they answered in terms of commitment.

The nature of experienced teachers’ goals is that they are linked and layered so that their broadest goals align with narrow goals in ways that enable the

achievement of goals closer to getting students to learn the mathematics. They hold mathematical learning goals at the heart of all of their efforts. They hold goals to continue improving their teaching practice. They know that no one activity will be completely efficacious. They hold goals difficult to assess and so they commit effort across multiple days to achieve their goals.

Teachers' Highest-Level Goals Heavily Influenced Instructional Choices and Students' Opportunities to Learn

Experienced teachers take advantage of classroom opportunities to push particular learning goals. These are their highest-level goals and they play a significant part of the day-to-day instruction and student opportunities to learn. Natalie held a small set of high-level goals. Two goals she consistently spoke about were to develop students' ability to justify symbolic manipulations and to get students to participate in whole class discussions. These were goals more deeply rooted in her value system of what mathematics should be learned and how students should learn it. So when she noticed students struggling to know how to start solving an equation she pushed justification. When a student volunteered a comment, she took up the opportunity to let the student speak, even though he was largely in error.

Caleb, systematically pushed students to develop steps and processes. He had several features in his teaching that continuously provided repetition of and understanding of what steps to take and when. Adam and Sarah had goals to avoid telling and get students to explain and reason. These goals colored nearly all of their teaching moves in the classroom and provided the basis for students' opportunities

to learn. Where in Caleb's class students were more greatly exposed to learning mathematical skills, students in Adam's and Sarah's classes were more greatly exposed to learning mathematical reasoning. Respective emphases could be highly related to the textbooks in use, but more than the presentation of mathematics in the textbook, these teachers were personally highly committed to these different goals of instruction. In the end, teachers' goals dictate student opportunities to learn and these can be very different from one teacher to another.

Teachers' Goals Guided their Professional Growth

The teachers in this study developed knowledge bundled around their goals of instruction. In this section I describe how the reasoning teachers engaged in around their goals prompted a search for effective strategies and ideas for teaching and that this resulted in teacher knowledge being bundled around their goals. This reasoning was described in a previous section about the source of teachers' goals. In this section I assert that this reasoning led to teacher learning and teacher professional growth.

Although the learning I describe can be assumed in each of the teachers' goals, an area where this learning was easily evident was in their personal goals for growth as teachers. Natalie, for example, wanted to improve the level of engagement of her students. This led to her experimentation with different classroom features (electronic clickers, white boards, groups, pairs). She said,

My constant goal [is] keeping kids engaged. (In) my ideal classroom every 25 of my kids would be working on the math when I asked them to do it and participating in class. Something I've been thinking about this year is different ways, what can I do to get the kids engaged more? More of them on task and doing the problems. So I've tried the clickers, I've tried working in partners more. Thursday and Friday the

learning specialist is going to let me use her white boards, but she's also going to be in here and we are going to try to have kids work problems on white boards and then show their answers so we can kind of keep a tally when she's in here of how many of them are doing them correct or incorrect. And hopefully use that data somehow. So a lot this year I've been thinking about what are different ways to present my lesson so that I can get more kids involved. (Natalie, Interview 2, October 6, 2009, emphasis added)

Her effort to better engage students naturally led to her own professional growth.

Because of her goal she experimented in the classroom and developed new insight and strategies to meet her goal.

Other teachers' explanations of the sources of their goals similarly demonstrated their past learning. Kathy, for example, sought to distribute mathematical authority and deepen students' understanding of the mathematics. With this goal in mind she developed knowledge of students' typical responses and a strategy for pushing further. She said:

Kids, especially in the transformations in geometry, use the same words to describe 20 different things when they say it cuts it into two equal parts, it doesn't matter if it's a reflective part, it doesn't matter if it's a rotated part. It's two equal parts and they don't understand that we really need to know that it's not just cut into two equal parts, but it's also mirror images of each other. That's the whole thing about reflection symmetry. So I wanted her to make sure that she didn't stop at 2 equal parts. (Kathy, Interview 1, January 14, 2010)

This explanation was produced when I asked her why she followed a student's inadequate response with "I'm picky Kelie." And further requested the student explain the mathematical idea. Kathy had learned that students typically do not completely explain the mathematics. And she further developed a strategy to push students to state more completely their mathematical ideas.

In these examples and throughout this research the goals the teachers held led them to engage in a learning process about the students, the mathematics, and strategies and examples to enhance learning. This learning process was not formal in the spirit of writing out hypotheses and engaging in formalized scientific processes. It was implicit, but nevertheless led to experimenting and learning from experiences in the classroom that would help them achieve their goals for instruction such as engaging students, and their learning goals for students such as helping them understand horizontal translations.

Chapter 5 Discussion and Conclusion

Frameworks for Teacher Goals

In the following I present two frameworks for teacher goals. The first is a tentative framework proposed for the organization of the content of teacher goals; the second is a revision of the framework presented at the beginning of this paper (see Figure 1) and situates teacher goals in the broader context of teaching. The interview protocols that I used were developed to investigate teacher goals in the following areas: subject matter goals, year-long student learning goals, personal professional goals, and goals in areas that were uncovered as they came through observable or identifiable teaching segments and features. Having done this analysis I propose the following framework (see Figure 2) for further conceptualizing and organizing the content of teacher goals.

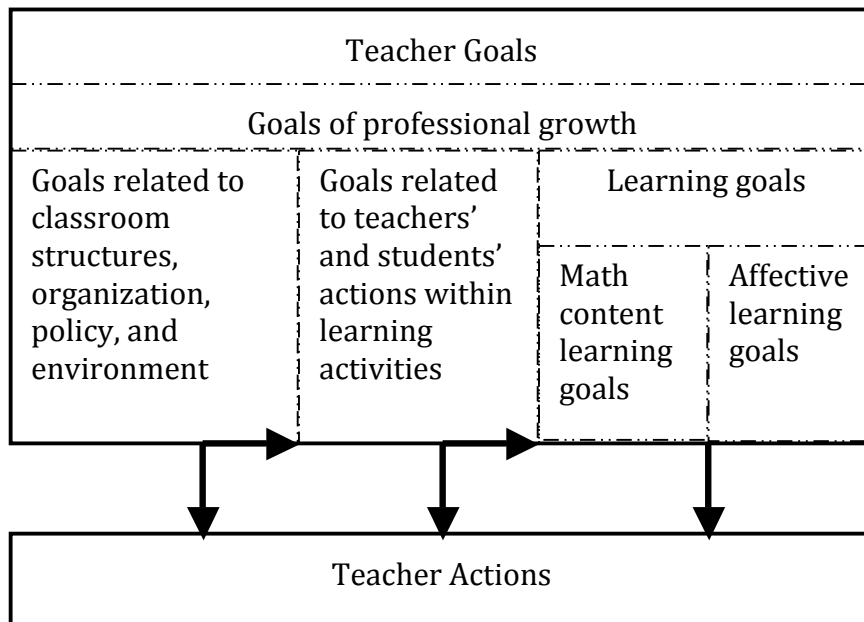


Figure 2. A framework for secondary mathematics teachers' goals.

I define the area with the text “professional growth” to be the area of teacher goals related to improving themselves. I define the “classroom structures, organization, policy, and environment” category of teachers’ goals to be those goals that are conceived to apply broadly to the whole class. Goals in this area orient students to what is to be learned, to what is expected. Goals in this area relate to providing a safe learning environment for all students to enable the learning process with the whole class etc. The area with the text “goals related to teachers and students actions within learning activities” to be about those goals a teacher has and works toward within learning activities that directly contribute to their facilitation of . These may be goals to help an individual or group of students make sense of an idea as it comes to the attention of the teacher. In other words, goals in this area are of a shorter duration, and are often developed responsively to student activity, and involve pressing (challenging and supporting) students to realize an idea. Learning goals, both mathematical and affective, are the goals defined to be the facts, definition, ideas, conceptions, relations, intended to be taught by the teacher and learned by the students as well as other goals such as developing positive student mathematical identities or confidence.

Teachers in this study held goals for improving themselves as professional teachers in the three areas just below this section in the framework. For example, several wanted to improve their ability to organize or establish a positive learning environment. Others held goals to improve their ability to facilitate learning in class activities. Others held goals to develop additional learning goals such as implementing more practical applications and real-life connections to mathematics.

In other words, the goals teachers held towards their professional growth were situated within and contributed directly to the teachers' ability to meet goals of instruction in the three areas just below in Figure 2.

To explain the arrows in Figure 2 I posit that teachers' goals of instruction are hierarchical, that goals related to organization and policies contribute to successful attainment of goals within learning activities and meeting learning goals. Furthermore, goals within learning activities make learning goals attainable. Finally, each of these three areas contributes to teacher actions. In this way teachers' goals are linked together and flow from regulating their own behavior to providing a learning environment and learning activities that supported their students in meeting learning goals.

In Figure 2 I have used dashed lines to indicate how goals in these areas are not just adjacent to but contribute to revision and development of goals in each of the other areas. For example, the goal to distribute mathematical authority was a goal that existed in all the areas and contributed to teacher actions and reflections in each of the other goal areas. In this way, teachers' goals, at least in this study, are conceptualized as coming from a milieu of reasoning wherein any single goal has implications for goals in the areas of personal growth, classroom organization, learning activities, and learning goals.

With the exception of year long and personal professional goals for teaching the order of the goals in the findings were semi-ordered to show an increasingly tighter relation to mathematics and responsiveness to learner need. Those goals illustrating this sequence are listed here:

- To engage all students.
- To have or devise a homework and assessment policy that promotes learning and avoids student discouragement.
- To prepare students to participate.
- To minimize confusion.
- To distribute mathematical authority.
- To develop, deepen and refine students' understanding of the mathematics.
- To develop, deepen and refine individual students' understanding of the mathematics.

The goals towards the bottom of this list are increasingly mathematical in nature and realized in one-on-one interactions within learning activities. Goals at the top of this list are more organizational and structural in nature, but contribute to goals towards the bottom.

In the broader context of teaching, teacher goals sit within a cyclical structure that involves monitoring activities, reasoning about how to better deliver instruction and adjustment of goals and development of strategies to provide instruction. This cycle is illustrated in Figure 3.

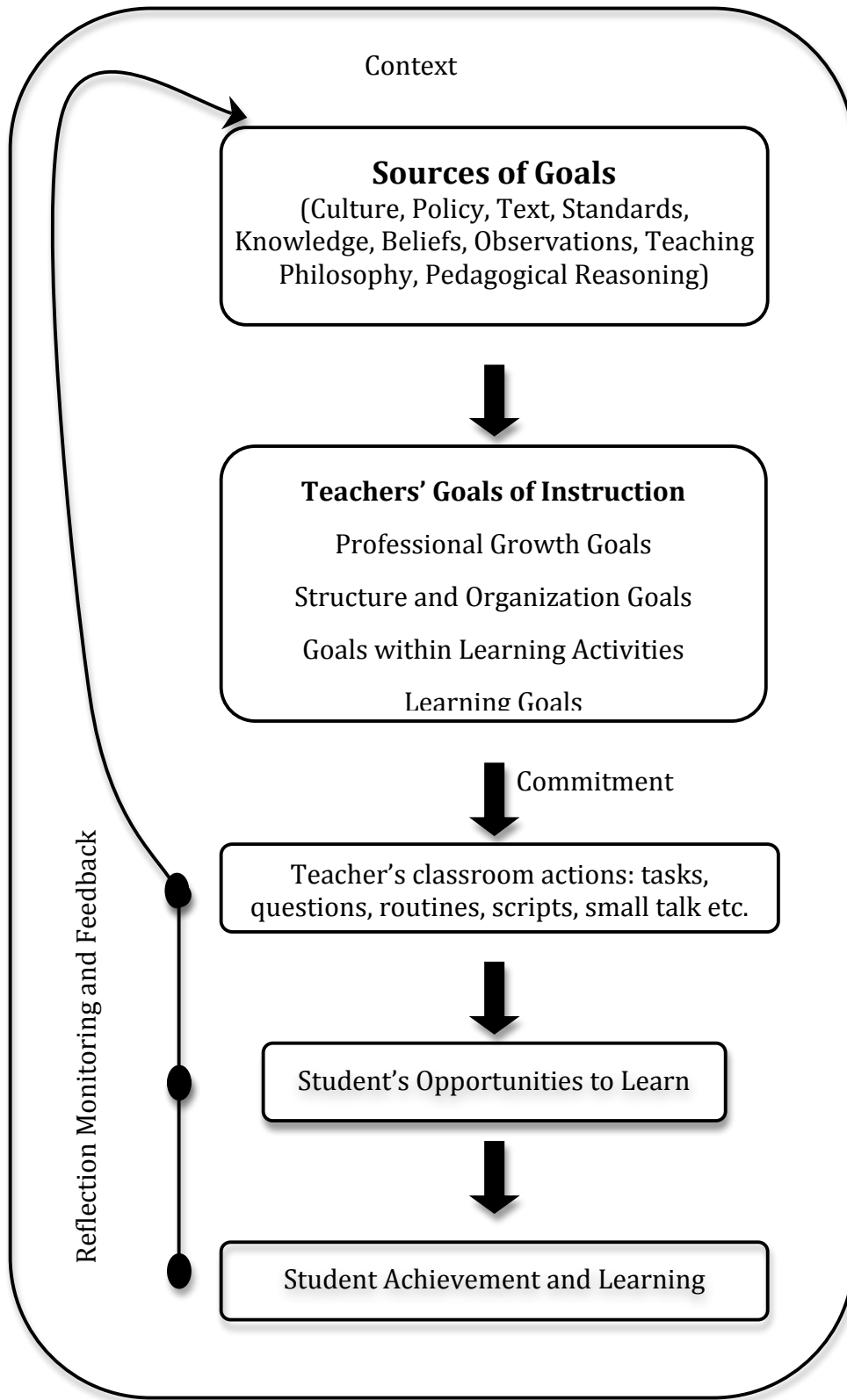


Figure 3. Teachers goals situated in the context of teaching.

The importance of Figure 3 is not just that teachers' goals are situated in the context of teaching with all its history, but the reality that teachers' goals are influenced and developed through teachers' tacit monitoring of events in the classroom. This is indicated in the arrow labeled "reflection monitoring and feedback" to the left of the figure. This monitoring feeds into teachers' cognitive processing that combines elements found in sources of teacher goals. Through this process teachers adopt new goals or maintain or modify existing goals with an eye toward improving student achievement or the learning environment that contributes to student achievement.

The relation between Figure 2 and 3 is that Figure 2 is conceptualized as fitting inside the "Teachers' Goals of Instruction" area of Figure 3. Figure 3 is a revision of Figure 1 presented at the beginning of this paper. The modifications are that I have delineated the content of teacher's goals into four sections, the data for which is the cross-case analysis presented in chapter 4. I have also collapsed the source categories into one, not that there is no distinction between external and internal sources of goals, but based on the assertion that what teachers know, believe, observe, and perceive and eventually reason these sources all run together to contribute to the milieu of thought from which teachers goals are derived.

Significance

In this section I discuss the meaning of the findings in this study in connection with issues in teacher development and mathematics education. First I discuss the findings related to teacher goals from this study in connection to research that includes or pertains to teachers' goals as well as suggestions and

implications about best practices in the field of education and mathematics education. The difficulty with research in the area of goals is that nearly all areas of teaching and teacher research are relevant. This point indicates that research on teachers' goals serves as an umbrella under which all these different areas can be gathered. Therefore, my purpose is illustrative rather than exhaustive in highlighting a few of the more salient connections. Then I discuss the meaning of teacher's highest-level goals. Finally, I discuss teachers' professional growth through goals.

Linking Goals to Previous Research and Best Practice Suggestions in the Literature

Much research has been done in the way of exploring, explaining, and modeling teaching and teacher thinking (Alexandersson, 1994; Borko & Livingston, 1989; Borko, Roberts, & Richard, 2008; Clark & Peterson, 1986; Leinhardt & Greeno, 1986; Schoenfeld, 1998; Schon, 1983). However, inasmuch as goals have been addressed, tacitly or directly, this study provides more in-depth characterization of secondary mathematics teachers' goals than the research currently available. Therefore, this research provides extensive data on which to further articulate the role of goals in teacher cognition and models of teacher thinking. In this way, this research extends the current literature and contributes empirically to the literature on teachers' goals and therefore can be used to further theorize about how goals are situated in the cognitive models of teaching presented by Schoenfeld (1998) and how teacher goals relate to knowledge and beliefs (Aguirre & Speer, 1999). After all, any theoretical view must be examined against new and more robust data sets.

In another vein of research goals in the classroom have been examined in terms of whether students perceive or develop mastery or performance goal orientations (Ames, 1992). These studies typically analyze how these orientations contribute to the nature and intensity of student motivation. Teachers' goals tend to be conceptualized as part of the context of classroom environment—or, similarly dichotomized as mastery or performance type. Teachers in this study held some performance goals, these are goals about demonstrating high ability relative to others. And teachers held some mastery goals, goals that focus on “learning and self-improvement” (Harackiewicz, Barron, Pintrich, Elliot, & Thrash, 2002). However, the majority of teachers' goals were neither of these, so while much research has been done on the environment that contributes to students taking on mastery and/or performance goals, researchers have not addressed the matter that most teacher goals are service oriented, how these are also part of teachers' motivation, and how these influence the nature of the classroom environment.

However, while mastery or performance goals were not aligned with the purposes and findings of this study, another common distinction of goals, as approach or avoid type, do. Although it was not my intention to strictly categorize teachers' goals this way, it nevertheless was useful to realize that teachers goals are of both the approach and avoid type and that often teachers used the “I want” and, “I do not want” phrases to define parameters of acceptable conditions relative to their goals. This was particularly evident in teachers' assessment related goals. They revised their policies to encourage students, and did not want students to be discouraged. Both the positive and negative phrasing here acted as parameters on

the conceptualizing of what was acceptable. Less formally, this is known as the *Goldilock's principle*.

In the mathematics education literature teachers' goals have received little attention. Typically studies have been focused on classroom mathematical learning objectives of the whole class grain size (Andrews, et al., 2005; Hiebert, Gallimore, et al., 2003; Norton, et al., 2002). This study contributes to these by providing additional detail and information on the goals teachers hold in which mathematical learning objectives are situated. These supportive and surrounding goals must be given more consideration in the overall scheme of what students learn and what teachers do. More of this will be discussed in the following section.

In expert-novice research, Leinhardt (1989) found that expert teachers have a specific overarching goal that orders their teaching actions so that lessons move from the broad, general procedures to the focused, narrow algorithms. Borko and Livingston (1989) similarly found that expert teachers' had well-specified goals that framed and directed much of their work. Although this research does not extend these claims, it does corroborate with them.

Borko and Shavelson (1983) asserted that teachers' goals fell into cognitive, social, and motivational categories. Findings in this research support this assertion even though I framed teachers' goals differently (see Figure 2). Social and motivational categories are components of teachers' goals related to classroom organization as well as goals related to teacher and student actions. Cognitive goals are part of the learning goals in my framework. This research provides a specific

framing of teachers' goals, as well as explicit examples of teachers' goals on which theory can rest.

In best practices literature Jere Brophy authored a booklet on teaching published in 1999 by the International Bureau of Education. This booklet was commissioned to gather, summarize, and present information on generic best practices of teaching. Twelve major categories were produced and are: (a) a supportive classroom climate; (b) opportunity to learn; (c) curricular alignment; (d) establishing learning orientations; (e) coherent content; (f) thoughtful discourse; (g) practice and application activities; (h) scaffolding students' task engagement (i) strategy teaching; (j) co-operative learning; (k) goal-oriented assessment; and, (l) achievement expectations. The suggestions Brophy made in this booklet resonate with many of the goals of the teachers in this study, but only in generic form. The particular goals teachers held were to develop and deepen students' mathematical understanding and other goals.

In other, more specific literature, goals of teachers in this study related to effective learning environments and learning principles suggested in the book *How People Learn* (Bransford, et al., 2000); to the mathematical teaching triad which consists of (a) management of learning; (b) sensitivity to students; and (c) mathematical challenge proposed by Jaworski (Jaworski, 2002; Potari & Jaworski, 2002); to the notion of caring discussed by Noddings (1988, 1995); to effective manager behaviors and characteristics suggested by Locke and Latham (1990); to suggestions about enabling classroom task and environment structures suggested by Ames (1992); to suggestions related to developing positive student mathematical

identities by Cobb, Gresalfi, and Hodge (2009); and to assessment for learning principles and suggestions as found in Wiliam (2007) and Black and colleagues (Black, et al., 2003; Black, Harrison, Lee, Marshall, & Wiliam, 2004; Black & Wiliam, 1998, 2004). Teachers' goals related to many other areas as well, but these few illustrate the breadth of variance.

More connections could be made, but it is significant that by researching teachers' goals we have access to investigate teachers' thoughts in all these matters. This makes investigating goals a significant avenue to investigating teaching and in contributing to helping novice teachers learn from others' practice as well as to more fully understand teaching through the eyes of the teachers that Schoenfeld (1998) and Leinhardt (1998) assert as an important undertaking. It is significant that by investigating teacher goals one can gain access to these efforts deemed important by practitioners as well as teaching researchers and theoreticians. It speaks to the reality that teachers are powerful researchers and theoreticians of their own right and an as yet largely untapped resource that could contribute to the development of fellow teachers in ways beyond anything we currently have in place.

Teachers' Highest-Level Goals

Teachers' overarching goals cannot be ignored in their influence on students' opportunities to learn. Hiebert et al. (1997) in describing the nature of classroom tasks described *residue* as the "learning that students take with them" (p. 22) from experiences. In the different examples I have shared students were exposed to different emphases of mathematical learning and will certainly have differences in what they take from those experiences. Because of this, some students will develop

high ability in skills and processes, other students may be more likely to take with them mathematical habits of mind (Cuoco, Paul Goldenberg, & Mark, 1996).

Differences in students' opportunities to learn are directly related to teachers' highest-level goals, and these differences in emphases vary greatly from teacher to teacher. This indicates a lack of consensus on the most important goals in mathematics education. Although great pressure is applied by heavy loads of standardized testing that would seem to coerce teachers to hold the same high-level goals, the reality is that teachers' highest-level goals vary greatly and contribute greatly to what students will take from their classes. This finding is not new. Boaler (1998) studied two different systems of instruction where different aspects of mathematics were emphasized and found that the students in these systems developed different conceptions that afforded them different strengths related to mathematical activity. I contend that teachers' goals are pivotal to what they do and what students experience.

A question that follows in this area relates to mathematical standards documents. In a recent commentary in *Education Week*, Douglas Reeves (2010) argued that the current initiative for common standards was problematic in that the language describing how to teach these standards was too loose. This loose language allows teachers to work towards the learning goals in ways that vary so greatly as to completely change the nature of what students experience and gain from classes. So while common standards may resolve some problems, other issues may remain and speak to the difficulty for the field and for the community at large to devise standards that promote a balanced and researched approach to what

students should experience in mathematics classes. In this way, research on teachers consistent daily goals that frame the majority of their work and their end of year student learning goals provide a measure of the balance or emphases of students' opportunities to learn and the effectiveness of standards of initiatives.

Learning to Teach and Professional Growth

Hiebert and colleagues (Hiebert, et al., 2007; Hiebert, Morris, et al., 2003) have delineated the process of learning to teach as a pattern matching the process of monitoring and revision illustrated in Figure 3. In their 2007 paper they identified four skills for teachers to hold and a process to engage in for learning to teach. Those skills are: "Skill 1: Specify the learning goal(s) for the instructional episode (What are students supposed to learn?)" (p. 51). "Skill 2: Conduct empirical observations of teaching and learning (What did students learn?)" (p. 51). "Skill 3: Construct hypotheses about the effects of teaching on students' learning (How did teaching help [or not] students learn?)" (p. 54). "Skill 4: Use analysis to propose improvements in teaching (How could teaching more effectively help students learn?)" (p. 55). Findings in this research indicate that teachers naturally and implicitly engaged in this process based on the goals they held in the classroom. But this does not imply that teachers engage in this process so well that they become experts at everything. That teachers naturally engage in this process and develop professionally around their goals is not unfounded, but they are likely limited in their growth by their own sense of what is worth improving and what is good enough. I take up these two points respectively.

In this study, teachers' goals led to observations, evaluations, and reasoning that in turn led to their development of enhanced instruction. In many ways it is clear that they developed pedagogical content knowledge as they learned "ways of representing and formulating subject matter that make it comprehensible to others" and "the conceptions and preconceptions that students... bring with them to the learning of... topics and lessons" (Shulman, 1986, p. 9). However, my interest here is not that teachers developed pedagogical content knowledge; rather it is how this knowledge developed by reasoning about how to achieve their goals. This process is called pedagogical reasoning, "the *process* of transforming content knowledge into forms that are pedagogically powerful and adaptive to particular groups of students" (Brown & Borko, 1992, p. 221). However, I define it more broadly to include the reasoning teachers engage into to enhance all areas of their instruction, including those parts organizational in nature that promote high levels of student engagement. Elsewhere Cooney (1994) used the words adaptation and pedagogical power to describe this effort to transform "what we are able to do to what we want to do" (p. 9).

Teachers' own interests, contexts and teaching philosophies sensitize them to enhancing instruction in unique and idiosyncratic ways. Shulman and Shulman (2004) discussed this issue in their development of a framework for teacher learning. In essence, they asserted that the teachers' vision of teaching, their goals, served as a sort of gatekeeper for teacher development and learning. They said, "A highly developed and articulated vision serves as a goal toward which teacher development is directed, as well as a standard against which one's own and others'

thoughts and actions are evaluated” (p. 261). Having this vision, they argued, prepares teachers to learn things necessary to enact it, but I suggest this simultaneously constrains teachers’ growth.

Learning because of goals is not a new idea. Locke and Latham (2002) stated, “goals affect action indirectly by leading to the arousal, discovery, and/or use of task relevant knowledge and strategies (Wood & Locke, 1990)” (p. 707). But having a goal is not the whole of the process. Goals sensitize and prompt teachers to observe, to think about, to hypothesize, and to experiment in order to meet them. Consequently, teachers’ goals and interests lead them to monitor and reflect on aspects of the classroom related to these goals. And recall that goals come from teachers’ own unique experiences, interests, and philosophies about teaching and learning. In the end this means that what teachers notice and reflect on varies. Although teachers with similar goals will likely notice very similar things (Jacobs, Lamb, Philipp, & Schappelle, 2009). Noticing and reflecting, then, follow from having goals and this process contributes to teachers learning from practice.

In this section I have made the assertion that teacher growth and development is built around their goals. This is embedded in “I want students to understand the notation of horizontal translations of functions, therefore I seek and am sensitized to finding clever ways of making it clear.” I am not the first to make claims of this type. Pintrich (2000) stated that “goals are assumed to be internal cognitive representations or knowledge structures” (p. 96). And Locke (2000) made the strong assertion about the links between knowledge and goals in these words:

Once the individual decides to act to achieve a goal, spurred on or not by emotion, both conscious and subconscious knowledge come into

play. Consciously one has to ask: how will I go about reaching this goal? How does it tie into my other goals: How long will it take: How much effort will be required: Can I do it: What resources will I need: Some of these questions will pull relevant subconscious knowledge into awareness and some will require more thinking and information search. (p. 412)

Still, teachers' goals have not received the attention they should in our quest to understand teacher thinking.

Implications

Teachers' goals lie at the heart of educational activities. Goals operate as principles through which teacher activities are tethered. Learning to teach is not a process of learning strategies, or activities, or content alone, but purposes that link these objects together. Of late, discussion in the field of mathematics education has included talk about developing a knowledge base for teaching that links student mathematical learning with teacher activity, and linking teacher learning with teacher development activities (Silver, 2008). Including information about teacher goals would be helpful in conceptualizing this database and how it might be organized or accessed (Jansen, et al., 2009).

Investigating teachers' goals uncovers the rationality of teacher activity and sheds light on the realities of the work of teaching. Knowing the underlying thoughts and intentions of teachers can serve researchers to better organize models of teacher cognition. How will describing goals help build theory of teaching? Because a theory of teaching must be able to accommodate varying teacher goals. If a theoretical conception cannot take into account a goal that a teacher has, then the theory is insufficiently conceptualized. This is where Leinhardt (1998) took exception to Schoenfeld's theorizing and model building work. She argued that his

choices (one class period, and teacher's in easier contexts) limited the conclusions he could make in developing a theory and model of teaching. This research contributes to theorizing and model building by providing a robust set of teacher goals for which to account.

In terms of teacher knowledge, goals become a highly accessible avenue to explore teachers' knowledge, as teachers are highly able to explain their reasoning as it relates to specific goals that they hold. In the area of teacher learning or learning to teach, goals form a basis for all that follows. Further research in both of these areas will be enhanced by increased attention to the role and meaning of teacher goals. Additionally, research on beginning teachers' goals and the sources they cite for their goals would shed additional light on the trajectory and challenges beginning teachers face as they develop their own expertise.

Additionally, teachers in the field would be benefitted by awareness and discussion about goals, as these discussions tend to connect deeply to individual contexts and draw out what is important to attend to. Identifying and discussing goals in teacher development programs may help beginning teachers link activities and observations with the purposes of these activities in more coherent ways. Pre-service teachers may benefit from asking field and mentor teachers about their goals as a way to strip away the veneer of simplicity. Mentor teachers could better support the learning of new teachers through the robust information that talk about goals linked to activities and observations provides.

Teacher development programs and professional development programs can be strengthened and more powerfully serve teachers by targeting instruction and

support to help teachers develop on the basis of their own goals of instruction. To the extent that teachers' goals are ignored, the learning process will be limited. Interested parties may voice concern that basing teacher development programs on teachers' goals may unnecessarily limit the potential value added by programs constrained in this way. But if teachers are likely to develop competencies according to their own goals then organizing this way can actually accelerate the pace at which teachers come to realize the limits of their typical practice. Caleb, for example, a lecture-based teacher came to enhance his lecture by calling on students. Originally he felt that calling on students would detrimentally slow down the pace of the course, but in time he realized that calling on students actually enhanced the learning process. Sarah wanted to deepen students' understanding of mathematics and originally held frequent pauses for whole class discussions, but realized that this actually hindered their learning. By building on teachers' deeply held teaching goals and helping them think about and achieve them, professional development schools could quicken the rate of teacher development in positive ways. This effort could help teachers more quickly develop strategies to meet their goals, or help teachers more quickly see the limitations of their strategies and conceptions of teaching. Research should explore these possibilities.

While much of teacher learning is contingent upon the philosophies teachers hold, context matters. Of the 5 teachers, 4 had taught with integrated curriculum in a district that had done much to support students' investigative learning of mathematics. Two of these teachers then later found themselves teaching in contexts with traditional texts, but brought with them goals not typically expected in

such classes. Natalie demanded student justification and alternative processes. Kathy continually pushed students to explain and do and otherwise realize mathematics for themselves. Their practices went beyond typical efforts to help students develop fluency with processes. Their experience with curriculum influenced their goals, they both claimed as much. Further research should be conducted to investigate links between teachers' goals and the context in which they teach, particularly, the curriculum they use.

Limitations

Several limitations apply to this research. First although this research was an examination of secondary mathematics teachers' goals it was not possible to recruit teachers in stasis as recommended by Palmer et al. (2005). Unfortunately, that is not always practical or easy. The teachers in this study were not all in a steady state. Sarah was a 4th year teacher, her second year teaching Integrated 4 Honors. Kathy was in her first year with a new curriculum. Adam was in his first year at the high school level. Natalie was in her 2nd year teaching Algebra after so many years teaching upper level integrated courses. Only Caleb was teaching the same course to the same quality and age of students for his 7th year. Yet in studying the goals of these teachers, the adjustment to relatively new contexts could be viewed as an advantage for research in that their highest-level goals could be more relevant or close to the surface of their thinking. Although it is just as possible that their emphases or highest-level goals moved to areas of the highest level of concern such as learning a new curriculum or getting students to engage and did not represent their typical areas of greatest emphasis.

Another limitation of this research was that my focus was both broad in investigating teachers' goals, whatever they may be as observed in practice, and narrow in that I took little account of goals teachers' held that were less visible in their practice. Another limitation was the bias in my selection of activities to ask teachers about. In narrowly looking at teachers' lesson segments and activities, little information was gathered regarding teachers' goals related to organization and policy. Further research should be conceptualized to take into account specific features of this type explicitly. Another narrowing limitation was that my observations were made at a particular time of the school year. Further research is likely to uncover different goals by targeting times of year conceived as likely to be unique. Research of this type could help uncover the wisdom of practice about teaching at different times of the school year.

Further limitations existed in the nature of interview questions. My questions were often phrased, "What were you trying to accomplish with that?" and teachers often interpreted this question as "What were *you* trying to accomplish with that?" The difference I suggest is that often teachers' responded in broader terms about rationalizing their behavior, which was not unwanted, but then sometimes this rationale was more teacher-centered than learning centered. A different question to prompt teachers' learning goals would be "What did you want *students to learn* from that?" Intentions of teacher action and learning goals are not always the same, but both are embedded in activity and so care must be taken to address both if the more full range of goals are to be uncovered in research of this nature. Still, this speaks to the broad nature of this research and the difficulty in

researching goals, that is our efforts are multi-purposed and so extensive interview is required to uncover the full range of teachers' goals.

Another limitation occurred in the observation format. This research was conducted where teachers were observed teaching four consecutive lessons of one class. They were interviewed after the 2nd and 4th classroom observation. Because teachers often responded by identifying multiple goals, it became difficult to follow up on questions about source, commitment, and efficacy, not to mention the multiple goals that were occasionally shared. Further research would be enhanced by focusing on goal and source initially, and later following up on questions about commitment and efficacy. Organizing data collection so that multiple interviews could occur over a period of time to allow the researcher opportunity to follow up on emerging details would supplement this effort. Additionally, combining open-ended explanations about teachers' sense of efficacy and commitment with Likert scaled surveys could enhance further research to reveal differences across goals.

Further research could also be enhanced by investigating teachers' highest-level goals. As this was not a major focus of this research, the claims I make are hypothetical in nature. But the researcher is advised also to watch for and ask about moments when the teacher can make claims about taking special advantage of teachable moments. Keeping this in mind is likely to uncover the teachers' highest-level goals. However, even with these limitations important information was gained on the realities of teaching.

It is possible that teachers report goals they do not have or are highly ineffective at reaching; research has shown this pattern (Artzt & Armour-Thomas,

1999; Cooney, 1985; Nathan). This is a matter of self-report bias. In the end these matters are left to the observer's judgments. In this study I perceived that teachers did in fact hold the goals they claimed to hold as I viewed their enactment in teaching. However, I did find one case where the teacher used the word concepts when it seemed that processes was what was being discussed. On this matter I made a special effort to avoid this teacher's use of the word or otherwise connect this word to his or her connected language about processes.

The context in which these teachers taught was not a major part of this research. Further research could examine the nature of teachers' goals in relation to the unique contexts and histories in which they work. An area that would further uncover teacher knowledge would be investigating teachers' goals in different sections of the same course. This would help to account for the subtle differences related to classroom and student dynamics and indicate the relative sensitivity and responsiveness of teachers to these different contexts. Another would be to relate the goals of teachers in different curriculum or population context. This would address the variance in student opportunity to learn relative to teacher choices, curriculum, and population contexts as well as address a long-standing argument that teachers cannot or should not adopt standards of another locale because they do not transfer. One could then make claims about the reality of this variance in real opportunities to learn.

Conclusion

This research has been exploratory and was conducted with the purpose of characterizing secondary mathematics teachers' goals. Connected to these goals I

explored the sources of the teachers' goals, and the teachers perceived level of efficacy and commitment towards their goals. I have presented a framework for organizing teachers' goals of instruction and described how experienced teachers' goals of instruction flow from personal improvement to student learning. I have asserted that experienced teachers' goals are hierarchically organized and are ultimately aligned or developed to provide increasing levels of detail and direction toward student learning. This was argued on the basis that teachers' rationale for their goals provided linkages in this way. In the way of further research several questions are worth pursuing. One regards the nature of pre-service or beginning teachers' goals. Are they linked in this way or another way? Another area is the development in expertise in conjunction with goals? How are goals part of this development? What trajectory or trajectories might teachers take in terms of goals as they develop their own practice?

I have also claimed that discussions about goals uncover the wisdom of teachers' practice and the realities of the challenges of teaching. Teachers and pre-service teachers would be benefitted by greater opportunity to learn from and discuss both learning goals of instruction and goals that direct teacher behavior. Furthermore, teachers' highest-level of goals influence to a great extent students' opportunities to learn as the teachers choose what is most important. Further research in this area will be necessary to investigate correlations between teachers' highest-level goals and student learning. Finally, I have asserted that goals support the investigation of teacher learning and knowledge. If much of learning to teach and teacher's knowledge is bundled and built around teachers' goals then research

in these areas must do better to take this critical area into account. Doing so will enhance these research areas. Afterall, goals are the vehicle and path of teacher growth and the basis of students' formal learning opportunities.

VITA

Matt Webb grew up in Baker City Oregon, the fifth of seven children, on a small ranch out of town. His parents, who remain sealed to each other to this day were hard working and loving and provided him with all the opportunities they could afford. They bestowed on him, as all their children, their faith in God, a belief in effort, and a belief in the value of education.

Matt attended Ricks College (now known as Brigham Young University-Idaho) and initially majored in engineering, but after serving a mission for his church, The Church of Jesus Christ of Latter-Day Saints, he decided to change his major to mathematics education. He graduated from Brigham Young University in Provo, Utah and worked for three years as a mathematics teacher at Washington High School in Fremont, California. While there he married Holly, whom he had first met his first Sunday at church at Ricks College. With a new baby girl, Mariah, in their arms, they moved back to Provo, Utah where Matt spent three years completing a master's degree at BYU. With another new baby girl in their arms, Ruth, they moved to Columbia, Missouri to obtain a Ph.D. in mathematics education at the University of Missouri. When they finished their time in Missouri, now with another girl, Lindsay, and one more girl on the way, they moved to Cedar Falls, Iowa where Matt would work as a professor at the University of Northern Iowa. Matt likes movies, music, reading, family, faith, service, trap shooting, politics, and root beer (not in that order).

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Appendix A: Recruiting Email

I am conducting a dissertation research study entitled, “**Teachers’ Goals and Their Sources in Secondary Mathematics Education.**” My dissertation committee members at the University of Missouri have approved the proposal for this study and your school district administrators have given me permission to contact you as a potential research participant.

In order for me to investigate teachers’ goals and their sources in secondary mathematics education, I will videotape mathematics lessons and interview participants.

I invite you to take part in this research study. I believe that the research findings will help other teachers in thinking about the various and challenging goals they work to accomplish. I also believe that you will benefit from participation in the study as you reflect on goals you work toward each day. Ultimately, this reflection will provide you with new insights into teaching and the various goals we try to make into reality. By learning more about your goals, I can share the findings with teacher educators and professional development designers in order to improve support for secondary teachers in every context.

[Send a copy of the Consent Forms.]

The attached consent form explains the details of the research study and outlines the commitment of the work if you were to agree to participate.

Please respond to this email (mmw4hf@mizzou.edu) or phone Matt Webb (573-882-1495) if you have any questions about the study or if you are willing to participate in the study.

Appendix B: Teacher Informed Consent

A Study of Teacher Goals in the Classroom

The purpose of this research study is to investigate the nature of your goals at various levels in your classroom. The two or three day data collection process will be conducted between the months of October 2009 and conclude in January 2010.

INFORMATION

You must be at least 18 years of age to be eligible to participate in the study. Your participation in this study is voluntary; you may choose not to participate and there will be no penalty. If you decide to participate, you may withdraw from the study at any time without penalty.

PARTICIPATION

1. Allow the researcher to conduct interviews and observe two consecutive days of lessons in one of your mathematics classes. This will be scheduled at your convenience between the months of October 2009 and January 2010.
2. Respond to lesson planning prompts and participate in an initial pre-observation interview and two post-observation interviews following two consecutive days of instruction. You will be asked questions about your goals across the two days of lessons. I anticipate that the interviews will last approximately 1 hour.
3. Allow the researcher to observe and video record 2 consecutive days of lessons in one of your mathematics classes.
4. Allow the researcher to display clips at professional research conferences and other professional meetings. (Your image may appear in these clips.)

BENEFITS

Your participation in this research study will provide insight into the many things mathematics teachers are trying to accomplish in the classroom. Your teaching will be enriched as you reflect on your goals in the classroom. The research findings will support understanding of teachers' thought processes. The information gained in this study may be useful to designers of teacher education programs and professional development programs in mathematics education. The information gained in this study may be published and may also be useful to mathematics teacher educators at other universities and colleges.

CONFIDENTIALITY

Your identity will be kept strictly confidential. The data collected during the study will be stored in a secure area in Townsend Hall. In reporting the findings of this study, your name will be replaced with a pseudonym. You may view the videotapes on the University of Missouri campus and request that certain video segments not be used. You may choose to end your participation at any time during the study, and your data will be destroyed. Data will be stored for three (30) years beyond the completion of the study and at that time it will be destroyed.

RISKS

This project does not involve any risks greater than those encountered in everyday life.

This project has been reviewed and approved by the University of Missouri Human Subject Review Board. The Board believes the research procedures adequately safeguard your privacy, welfare, civil liberties, and rights. For additional information regarding human subject participation in this research, please contact the University of Missouri IRB officer at (573) 882-9585.

CONSENT

Please read the consent statement below and place an “x” next to the statement that describes your desire to participate in this study at this time. Sign and date the form.

I have read the information presented above and have had an opportunity to ask questions and receive answers pertaining to this project.

_____ I hereby agree to participate in this research study. I am aware that my participation is voluntary and that I am free to withdraw participation at any time without any penalties to myself. I agree to allow my classroom instruction to be videotaped as part of my participation in this study.

_____ I do **not** agree to participate in this research study.

Signed: _____ Date: _____

Printed Name: _____

Thank you. If you have questions at any time, please call Matt Webb at the University of Missouri at (573) 882-1495.

Appendix C: Observation Interview Protocol

Work through the lesson sequence, asking about the goals, the source, intensity level, content, and efficacy (constraints/affordances)(challenges/promote/support/enable) as appropriate. Many questions will be specific to unique activities of the teacher in the classroom, but generally they will take some form of the following:

There were a few moments where I wanted to ask about. Present the context. Show clip or verbally prompt teacher about a moment in class and ask:

- What was your goal at *that* moment, or in *that* interaction, etc?
 - How certain are you that you are able to meet this goal? Why?
 - What did you do to achieve this goal?
 - Where did this goal come from? (Probe for sources.)
- What do you hope students got out of this lesson?
 - What are your goals for this course (unit/lesson/lesson segment)?
 - What do you hope students take away from this course (unit/lesson/lesson segment)?
 - What is the big idea in the mathematics for this course (unit/lesson/lesson segment)?
 - How did you determine the goal for this unit/lesson/lesson segment?
 - To what extent do you think you accomplished this or these goals?
 - How do you know?
- What things did you hope to avoid in this moment/class/unit/course?
- Among these goals _____, what do you feel effective about?
- What teaching activities make you feel effective/ineffective?

If an activity is identified as a goal ask:

- What is it that you were trying to accomplish with this activity?
- What is the mathematical idea that you are hoping to get across to students in this activity?

If the teacher is speaking more abstractly and not relating goals to activities of the class ask

- What did you do in the classroom to accomplish this goal?
- What should I see as evidence that you worked toward this goal?

Within the different levels ask

- Among your goals for the lesson (course, unit, lesson segment) which of the goals is most important to you and which are least and why?
- What is your single most important goal for this course? Unit? Lesson? And specific lesson segment?
 - Tell me about which goals you felt you met and which ones you didn't?
 - How do you know?

Efficacy

- Among your goals for the lesson (course, unit, lesson segment) which of the goals do you think were most or least accomplished and why?

Individual student goals

- What goals do you have for individual students.

Personal goals

- Within in your teaching what personal goals do you have?
 - Source, rationale, efficacy, intensity, level.
- Why did you organize your instruction in this particular way?
- What do you try to promote in the classroom?

Appendix D: The Case of Natalie

Natalie was in her 11th year as a teacher when I observed her. She spent the first 8 years of her career at a high school in a large school district serving nearly 17,000 students. During her time at this high school she taught Pre-calculus and Algebra 2 for a couple of years and the majority of her time she taught Integrated 2 and 3 using the *Core-Plus* curriculum. During this time she earned her master's degree in curriculum and instruction from the flagship university of the state that was located in the same city. Three years prior to my observation she moved from the city in which she worked and received her education to a rural town roughly 30 minutes away with a population of approximately 10,000. She first taught at the middle grades level there before moving up to the local high school where she principally taught Algebra 1. The year in which the observation was made she was teaching Algebra 1 for her 2nd year. She taught 6 classes a day using the McDougal-Littell Algebra 1, state-specific edition. Natalie was identified from both school leadership and university faculty as having expertise.

Teaching Structure

I observed Natalie's last class of the day six times. Each class was 50 minutes in length. She identified the class I observed as one of her more challenging classes in terms of both behavior management and academic achievement. She had to lecture the students a little bit each day to stay on task. But she was persistent and for the most part had their cooperation. The unit I observed her teaching was about solving first-degree equations with one unknown. Her approach to teaching Algebra 1 and with the textbook she had typically consisted of a guided practice format for instruction. She gave students a problem or two and a few minutes to work on these, sometimes in partners and other times individually, then either worked the problem herself or invited students to work and explain the problems. Regardless of who presented the solution she consistently asked questions about other methods one could use, or common mistakes one might make, or asked the students to justify their operations. She iterated this cycle, posing a problem or two, allowing time to work, then working through the problem, using the remainder of the class time. She began the class with a warm-up and then checked homework. She then spent the balance of the class in the guided practice mode until just before class was over when she often assigned homework and/or outlined the activities of the upcoming days.

Overview of Natalie's Goals

A special orientation to promote error checking, justifying, and knowing alternative steps to solving equations existed within Natalie's subject matter goals. Her teaching goals primarily centered around engaging students, meeting the needs of struggling learners, preparing students to participate, and holding students accountable. Much of her work in the area of teaching goals involve motivating students. In the following sections I present the case of Natalie's goals in terms of subject matter goals, teaching goals, and personal and professional goals.

Subject Matter Goals

Developing Symbolic Manipulation Skills

Across the six days that Natalie was observed she was engaged in teaching a unit about solving first-degree equations with one unknown. Her goals in terms of subject matter were that students would learn symbolic manipulation so as to be able to solve symbolically presented equations and proportions. She said:

Probably my first [goal] would be the symbolic manipulation. Just being able to solve and we're getting into the proportions today and percent problems later. It's basically solving equations, the algebraic manipulation the skills of being able to do that. And then also, being able to write equations for situations so that they can solve them.
(Natalie, Interview 3, October 9, 2009)

Her central subject matter goal was to help students to solve equations.

A number of more specific goals in terms of mathematical skills were determined in course of the interviews that directly related to her goal to teach students the symbolic manipulation necessary to solve equations. Natalie's efforts to address these skills appeared throughout her instruction. These skills include: using the distributive property, correctly operating with positive and negative integers, combining like terms, using inverse operations, and thinking of fractions in terms of inverses as opposed to as fractions. This last item needs more clarification. Natalie's goal involved helping students know when or when not to distribute a fraction or when or when not to convert it to a decimal. She preferred that students eliminate fractions by multiplying by their inverse. She said:

They struggled with fractions and so, when I want them to use the inverse instead of dividing by fractions and then they don't do it right in their calculator. There were the problems with fractions and using the inverse and trying to get them to see that there might be an easier way to deal with the fractions. (Natalie, Interview 1, October 2, 2009)

Later in the interviews I asked Natalie about an interaction with a student. The student was confused about what to do with the fraction in this problem: $4x - 5 = \frac{1}{5}(5x + 20)$. She stated that she viewed distributing the one-fifth, or converting it to a decimal as acceptable methods. But she went on:

The prior day we had emphasized using the inverse or the reciprocal to cancel out the fraction. But there was only a numerical value on the other side of the equation. So today she's saying ok I'm going to use the inverse but I don't know what to do on [the left] side.

They can distribute or they change it to decimals and then they work the problem ok. Which that's a fine method for me, but I don't want them to always revert to changing to decimals because, then if they have something like $\frac{1}{3}$ then they're going to round it and their answer is not going to be correct. So knowing there's going to be problems like that in their homework I didn't want them to always do decimals or distribute so I wanted to clear up her question here about using the inverse and she didn't know what to do on this side.

They see $\frac{1}{5}$ as a fraction. They're not really seeing it as everything divided by 5. It's just fractions. Them and fractions and not getting fractions. Finding ways for them to get around the fractions is kind of a goal because I know that kids just, the number sense and fractions

and adding, subtracting, multiplying, dividing, it's just not great. At this level I'm not so much worried about teaching them all, it's how can I get around it so they can continue to solve the problem. Another way to get them past that so they can start somewhere. (Natalie, Interview 2, October 6, 2009)

Natalie's goal here involved more than using the inverse, but also helping students deal with fractions effectively, and knowing how to get started when a fraction is in the problem. Natalie's central goal was for students to learn to solve algebra equations. As part of this, she held goals that students learn the skills associated with solving equations.

Source, efficacy, and commitment to developing symbolic manipulation skills.

I asked Natalie where her goals came from. It was evident already through observation and interviews that she made some instructional decisions because students were struggling with a skill and needed more exposure to it. But she identified these subject matter goals as first coming from official documents. She said:

Well, mainly they come from the grade level expectations, you know, so. I'm, whatever grade level expectation that is that matches up. I'm pretty sure there is a symbolic manipulation or using multiple methods to solve problems. Or being able to represent a problem situations with tables, graphs, equations. (Natalie, Interview 3, October 8, 2009)

I then asked her "to what extent are you going to accomplish these goals?" She answered:

I don't know. I don't know the percent of my class that would be proficient at that skill. As I look at their assessments. I would hope that around three-fourths of the class would make A's, B's, C's, on that. So there's still some things with solving equations and like we said with the all reals and no solution, and do they really understand that? But maybe I'll clear that up when I talk about the graphs more. I'm hoping to go back to that. So I feel like some of them are better at the symbolic manipulation. It was a goal of this chapter. As long as they're the basic ones, don't throw in the fractions or too many negatives they do ok. They still make some silly mistakes, but 2×3 they write 5 instead of 6. Well that's easy to fix. They're getting there.

And it's something I want them to be very efficient at before they go on to geometry and algebra 2. (Natalie, Interview 3, October 8, 2009)

Natalie's answer of having three-fourths of the students proficient is an indicator of her efficacy. She perceived that she would get many students proficient in this content area. Within her response is also an indication of her commitment; that she intends to address specific skills in the coming days. Similarly her commitment was illustrated in her choice of problems each day throughout my observation. She chose problems often because students struggled with them.

Representing Algebra Problems and their Solutions

An additional significant subject matter goal Natalie held was that students learn to "write equations for situations so that they can solve them" (Natalie,

Interview 3, October 8, 2009). She also wanted students to be able to represent their solutions on paper. During one of the observations she noticed a student who solved a proportion problem in his head. She engaged him in trying to get him to record his thought process for the solution on paper. She explained that she did not want to discourage the mental math, but:

I want to have him have a method for writing down what he was doing in his head. And why we can just multiply by 3. One of the girls earlier just started multiplying and dividing numbers because when you do cross products you multiply and divide. So she just started doing it but she didn't know why. "Oh is that going to work? You got the right answer." She had no way of showing it. (Natalie, Interview 3, October 8, 2009)

Natalie's goal was that students would be able to write the algebraic notation for problem situations and use written algebraic notation to represent problem solutions.

Her goals in this area applied directly to word problems. Most of the problems in the text she was using and in her instruction were non-contextual algebraic problems. But she held the goal that students would be able to write algebraic equations representing contexts in a few selected word problems. In the following interview excerpt, Natalie described her goals as she found that students had struggled with a homework word problem:

They don't attempt the word problems. They don't read them and try to make an equation or do anything with it. They just skip those on their homework all the time. So I'm trying to get them to break the problem down into littler pieces. What steps will I need to know, what do I not need to know? Because sometimes they throw in extra information. (Natalie, Interview 2, October 6, 2009)

Part of Natalie's goal here is to help students interpret and use information, but additionally she wants students to understand the expressions they write. For example, in one particular problem the class discussed two painters had already painted 45 square feet and had to paint a wall with total area of 1000 square feet. The first painter painted at the rate of 4 square feet per minute and the second painter painted at the rate of 3 square feet per minute. Natalie asked students to interpret and use each piece of information and prompted them to help her write the expression. A student suggested: $1000 = 4x + 3x + 45$, which was correct. Natalie then asked the class to interpret the meaning of the "4x." She explained in the interview the purpose of her question:

I think a lot of times the students will just say, 4 times x, or 4 divided by x, or divide those. And they'll just blurt that out, but they don't really know why should we multiply, or why am I putting four times x, why isn't it four divided by x? They may not be asking that question, but in my head I'm thinking, "Do they really know why it's 4x?" Why are we multiplying here? I think that's what I was trying to get at. I'm not sure that I was doing the best job at getting them to see that, but anyway that was my goal there. Because they'll be given two numbers

and they'll just multiply or they'll divide and they don't really know why. (Natalie, Interview 2, October 6, 2009)

In summary, Natalie's goal is that students will learn to represent algebraic expressions and equations from a context and to understand the meaning or interpretation of those expressions, and to represent solutions with algebraic notation.

Source, efficacy, and commitment to teaching students to represent contextual algebra problems and solve problems in written algebraic notation.

As with the last goal theme to help students learn to solve algebra equations, this goal, in part, stems from Natalie's understanding of state standards documents. Additionally, her emphasis on interpreting and writing algebraic expressions was generated by her observation that students were struggling to do so. She reported how she became cognizant of the challenge:

One way is just because of seeing their homework. Where they have done all the naked math problems and they get down to the word problems and they haven't even written anything down. I mean nothing, nothing they are just completely blank, they "I don't want to do this." The other thing is whenever they ask questions over homework, they ask questions on the word problems. So by 7th hour I've seen every class seems to have issues with the word problems. And it's been a theme almost the whole year, especially in this chapter. I've noticed that they don't do the word problems because they are just freaked out by them. (Natalie, Interview 2, October 6, 2009)

Natalie came to pay special attention to this area because she noticed students had been struggling with it in the homework. Her commitment and efficacy to these goals are bundled with her commitment and efficacy with the first goal theme. She did not articulate different levels for this area. She felt that roughly 75 percent would become proficient and stated her commitment to keep addressing these goals in her instruction. By virtue of her efforts in class in organizing instruction and spending time addressing this goal theme I perceived her commitment to be high.

Natalie's subject matter goals centered around helping her students to develop skills to do symbolic manipulation of algebra problems, and the ability to represent and understand contextual algebra problems. Within these themes additional goals involved more specific skills such as representing solution processes in algebraic notation, using the distributive property, and combining like terms. Other goals existed for Natalie, which may have been included in the area of subject matter. These goals involve knowing common mistakes, finding one's own errors, justifying steps, and knowing how to get started.

Goals that Support Learning

In this section I detail a number of goal themes that Natalie held that supported students learning. Among these was her frequent request of students to justify their steps, to identify common mistakes, and to know multiple pathways to solving problems. Additionally, Natalie held goals to engage all learners, to support struggling students, to help them all participate, and to keep them all accountable to the work expectations.

Justifying Steps, Getting Started, Catching Mistakes, Having Multiple Pathways

In this theme I identify a number of goals Natalie held that supported students learning the subject matter. Specifically these goals involve understanding and solving equations. During my observations one of the first identifiable goals in Natalie's teaching was for students to justify their steps. On the first day Natalie began the class with two warm-up problems. One of the problems was " $-(2/5)x - 7 = 11$." After students had a few minutes to work both problems she asked the students: "I need three reasons, why did I add sevens to both sides?" (Natalie, Video Observation 1, October 1, 2009). In the interview I asked Natalie why she asked this question. She said:

First of all to the students that look at that problem and see a fraction and then they don't know where to go from there. They don't know where to start. And kind of an order of operations thing. Do I add seven first or do I multiply first, or do I distribute first? You know, what's my first step and why is that my first step. So to kind of give them somewhere to go, because I heard it today I think. "I don't even know where to start" "I don't know what to do." For other ones just to make them think about, because there are the ones that can just do these problems because that's the way we've done them forever. They just probably never have been asked: "Why are we doing that?" It's just Ok we're supposed to add 7 so let's add 7. "That's just how we were taught." So what's the math behind it. (Natalie, Interview 1, October 2, 2009).

Asking students to justify their steps was the result of two goals, one being to help students know how to start, and another purpose was to prompt students to think about why operations were justified. On this last front, she claimed that many students did some algebraic manipulation without thinking or knowing why it was justified. These efforts, to help students get started, and to help them learn why steps were justified, were embedded throughout my observations of her teaching.

Two other goals are discussed in this theme. The first is helping students know that an equation can be solved by completing a different sequence of steps. When asked about this goal Natalie explained that several students questioned the validity of their effort when they had begun a problem a different way. She further explained in the interview, "My goal is to get them to see, "Well maybe you didn't do the same first or second step, but eventually you are getting to the same answer." So that there are different approaches to solving it" (Natalie, Interview 2, October 6, 2009).

The last goal I discuss in this theme was helping students learn to identify and learn from their mistakes. This effort was easily identifiable because she frequently asked students what mistakes one might make in the various problems and she further urged students to check with one another to find their mistakes and correct them. She explained several purposes for this effort.

I guess it's not relying on me so much. I joked with one kid today. I said I'm not the expert, you know not relying on me to give them the answer, tell them they're correct. I want them one to be able to check their work. A lot of the kids were, "is this right, is this right?" Well how

can we do that? Check to see if your answer makes sense and is reasonable. But I also think that if they find their mistakes. Then maybe, they won't make that same mistake again. "Ok I keep forgetting to distribute the negative." So if they can see that for themselves maybe they won't do it again and again and again. (Natalie, Interview 1, October 2, 2009)

Several purposes come from this excerpt that also address the other goals in this theme. One of these is that she wants students to realize that they can determine whether a solution is a correct. Associated with this thought is the idea that she is not the only expert in the room. Furthermore, she wants students to learn from their mistakes, she believes if the students find their errors they will learn faster than if she is the sole source of error correction.

Natalie's goals were to help students get started solving problems and part of how she approached this was to prompt them to justify the various steps taken. On a regular basis Natalie asked why certain operations were acceptable. The answers she often looked for were things like combining like terms, distributing, or using inverse operations. Additionally, Natalie wanted the students to understand that they could perform the operations in a different order and achieve the same answer. Natalie also wanted students to identify their own errors so that they could more quickly self-correct. These goals relate to her view of what students need to know and do when doing algebra.

Source, commitment, and efficacy to justifying steps, catching mistakes, having multiple pathways, and getting started.

Natalie's perception of student difficulties and needs were a central source of the goals in this theme. Additional sources of these goals, justifying steps in particular, are voiced in the following interview excerpt. I asked her where these goals had come from. She said:

Just to support their math, because it used to be on the [state] test they had to do a lot of explaining and a lot of variety. But a lot of the end of course test now is multiple choice. So I'm having to kind of rethink how I ask questions sometimes and giving them some multiple choice answers, so the why really is more for those explaining ones. Explain your steps or justify your reasoning. And I guess I saw that a lot in core-plus. And also leading up to proofs in geometry. I used to teach stuff with proofs, not the two-column format proof, but more of a paragraph of this is the first thing I noticed and giving reasons why. (Natalie, Interview 1, October 2, 2009)

Some the sources Natalie pointed out were the end of year state mandated test and the curriculum she had used in the first part of her career. Both of these required students to do some explaining or justifying and these influenced her emphases within this unit of instruction. A third source for the goal to require justification was her knowledge that in Geometry students would have to justify steps in a proof and she saw her effort here as leading up to and supporting that demand.

As for the goal that students learn to find their own mistakes Natalie again pointed to previous use of curriculum for which finding mistakes had been emphasized. But she also had noticed that the students continued to make the same

mistakes, which brought about the following thought, “They’re still making the same mistakes. Well then I guess I can’t just tell them, I guess they gotta do it for themselves if they want to fix it” (Natalie, Interview 1, October 2, 2009). In other words one source of the finding their own mistakes goal was a belief that telling them was ineffective and prompting them to find them for themselves would be more effective.

Natalie’s sense of efficacy within this goal theme was moderate. Specifically regarding her goal that students justify their actions she said, “They’re getting better at answering, “What were the three things again?” They remembered them. I’m not going to stop asking them” (Natalie, Interview 1, October 2, 2009). Furthermore, her commitment to asking the question was high. She intended to keep asking them. Regarding her goal to get students to catch their own mistakes she said:

There’s some students that do. There was a group today that I know that they were finding their mistakes because they were comparing. I still think I get a lot of kids that they’ve missed this one on their homework, they didn’t care. There’s a couple kids that say “Hey I missed this one can you help me?” And there’s other kids that just marked them wrong and didn’t really care that they missed it, they don’t want to go back and do it that assignments done, let’s go on to the next day. So I don’t know if I’m getting through to more than half or not.

Eventually down the road in the 2nd quarter they’re going to know what I expect and what I want. There’s a couple of kids now that I have had in 8th grade, 9th grade and now again in 10th grade. So “oh yeah Mrs. Natalie makes us do this.” Oh maybe I got through to that kid. (Natalie, Interview 1, October 2, 2009).

In this goal theme Natalie’s sense of efficacy was moderate. She recognized that many students still struggled to justify their steps, to get started, to catch their own mistake, or to realize that multiple methods were acceptable. Nevertheless, she was committed to keep asking students to do and know these things. She indicated that her efforts endured through the years on these fronts.

Reviewing, Introducing, and Assessing

Natalie’s routine for each class began with bell work and a homework check. I asked her about her goals and purposes for these activities. She answered:

It [is] a good way to review the previous day’s lesson. I could walk around and see which kids had done it, which kids hadn’t. So I can kind of get in my mind a feel for “oh this one’s just being lazy, or this kid doesn’t know where to start.”

So reviewing the previous day’s lesson, may be leading them to something that’s going to be coming up. And this day, “well now we did this so let’s try this and see how they can do on it.” Or review for a test that day, “these are questions I know they’re going to struggle on on the quiz, so something similar to what they’re going to see. So that’s what I’ve kind of used it for. (Natalie, Interview 1, October 2, 2009)

The three central purposes she claimed for the bellwork activity were to review the previous day's material, to introduce new material, and to give students additional opportunity to learn an idea or skill she expects to be challenging. Within these purposes Natalie stated that she monitors and assesses the students to gather information about them, their abilities, their efforts, and their needs. Natalie further assessed students in these areas during the homework check. In a later theme, I discuss how Natalie organized her teaching during lessons to monitor and assess her students.

Following bell work, Natalie conducted homework checks. She explained her goal for this activity:

As I'm going around I'm looking to see are they missing one or two, or are they missing 10 or 12. There was some that missed a lot because they didn't try them. There are some that are very confused. There are the ones that have got this down and they don't need the extra practice. So just kind of getting a feel for that. Then hopefully that helped me know who to focus on in the groups. (Natalie, Interview 1, October 2, 2009)

And another thing on this homework check. You may not see me go over homework like this on Monday. This homework check today, that was again, like the first time that lesson was presented. So I want it to be an ok I can make mistakes. You know I'm not grading on correctness I want you to have the answers I want you to get the process. Then today they did the extra practice the extra worksheet I'll probably just collect that, because I was able to go around and help them some. Maybe they will have a question or two, but it's like the 2nd go around of the same material. So I'm hoping that some of their misunderstandings we got out by helping in the groups. So I'm not going to do a homework check. (Natalie, Interview 1, October 2, 2009)

Natalie's primary goal was to get a sense of the needs of the students. She used this information to focus in on select individuals and groups of individuals. Additionally, Natalie had the systemic goal to provide an assessment scheme that allows students to make mistakes in the learning process without those mistakes being recorded in the students grades. These goals were also evident in other parts of Natalie's instruction which I will describe in greater detail in a later section.

Source, efficacy, and commitment to reviewing, introducing, and assessing.

Natalie explained that she was first required to do bell work when she taught at the middle school, just prior to moving up to the high school in her new town. Because she was required to take attendance at the beginning of class, and because the bell work helped her achieve the goals already described she continued to begin her classes with bellwork and a homework check when she moved up to the high school. These features of her instruction were firmly embedded in her routines so I ascribe her commitment as high. Her purposes to review, introduce, and assess appeared to be met in part by virtue of the activities and her actions within them. However, direct interview information regarding her commitment and efficacy were not obtained.

Encouraging and Preparing Students to Participate in Class Discussions

Natalie had spent the majority of her career teaching from a curriculum that provided questions that prompted students to think about mathematics. When she moved and began teaching from a new curriculum that did not provide those questions, she was challenged to get students to participate in thinking about mathematics. With this backdrop Natalie consciously made efforts to raise the level of mathematical thinking and discussion in her classes within teaching strategies typically used in such a class, namely lecture, or interactive lecture (also identified as guided practice). She said:

I don't like to [randomly] call on a kid. I don't like to say ok "Matt would you do this problem" because if Matt doesn't know how to do it then that's going to make him less likely to answer later. So I don't want to call on a kid who doesn't want to offer. So finding a way so that, if they do check with a partner, check your answer, or somebody and then be able to answer my question, then I should be able to call on anyone. (Natalie, Interview 1, October 2, 2009)

Natalie had the goal to avoid calling on a student who was not prepared to answer, but overall, she wanted students to participate, and to be ready to participate. Because of this goal she provided opportunities, such as conferring with a partner or working in groups, so that her students would have the preparation time necessary so that they could be called on to share their thoughts or solutions.

Source, commitment, and efficacy to preparing and encouraging students to participate in classroom discussions.

Natalie's goals to prepare and encourage students to participate in class discussions were likely prompted, in part, by her former use of a problems-based curriculum. Indeed, embedded in this discussion was her lament that students were not used to having to discuss ideas. When she taught using the Core-Plus curriculum, she explained that the questions were already prepared for her and furthermore that students had come through a problems-made middle grades curriculum that made it easier for her to expect students to participate in mathematical discussions. She explained, "When I taught with the core-plus curriculum it had more of the questions there for me. The questions were just embedded in the students work....They haven't had to do that. Their way of learning hasn't been that style" (Natalie, Interview 1, October 2, 2009).

This challenge to enable students to participate and provide them an environment in which they would feel comfortable sharing was an issue that Natalie brought up in two of our three interviews. In the last interview she said:

One of my goals is to get closer to 100 percent of my students engaged and involved and just doing the math rather than just sitting back and not saying anything or talking to their friend or whatever. It's very hard for me. It's something I still struggle with I guess keeping them involved and willing to share. The kids don't want to go up to the front they don't want to write on my board. They don't want to answer out in class even when they probably have the right answer. Maybe they're afraid that they have the wrong answer and then they're going to get made fun of. So just kind of overall I just want more of my kids

to feel comfortable about sharing in class. (Natalie, Interview 3, October 8, 2009)

Her challenge to get students to participate is a common one for teachers whose goal is to have rich classroom conversations. Natalie believed that part of her effort had to involve making the classroom environment a safe place in which students felt comfortable sharing their ideas. This excerpt also provides the best information from the interviews relative to her sense of commitment and efficacy. That is, she struggled with getting students to be willing to share, indicating a low or medium level of efficacy. Her commitment towards these goals however seemed quite high as both by what I observed in her providing space and encouragement in class to get students to participate, and also by her expression of trying to get 100 percent of her students to meet these goals.

Making Changes in the Instructional Routine to Meet the Needs of Learners and Struggling Learners

Natalie made slight changes in the instructional routine or format on a frequent basis. For example, on the first day students worked mostly individually, but were encouraged to check their work with a partner. On the second day the students worked in groups. Natalie circulated through the room meeting with different groups but did not hold whole class discussion. I asked Natalie about these slight differences and she explained that on the first day she had intended to use groups, but found so many of the students struggling that she had to pull them back and work with them as a whole class. By the second day of observation she felt more confident that they would be able to work through problems in groups. She said:

I feel like the way I chose group work today because I had already presented the lesson. I felt like there were enough of them that could work together and do the problems that they could just work together where I could go around. It wasn't a new enough skill where I knew every group was going to struggle and if every group is struggling then ok I've got to pull you back whole class. (Natalie, Interview 1, October 2, 2009)

Natalie's effort in this example and her choice to do group work or whole class guided practice work was contingent upon the students' abilities. She reasoned that if most of the students were struggling she would not be able to meet their needs if they worked in groups, so she conducted the class in the pattern of guided practice explained. The goal embedded in this decision was to meet the needs of all learners and struggling learners especially. Indeed she further explained her decision to use group work on the second day:

Probably more so that I could focus on the ones that really needed some of the basic skills first. The ones that I know are really really struggling. I'm hoping that allows me to get to the ones that are at the very low end. Because a lot of times I don't differentiate my assignment based on their ability. They all had to do all of the worksheet. The only other way to get around that is helping those [students] I knew needed help. (Natalie, Interview 1, October 2, 2009)

And where did she learn which students needed help? In the bell work and homework check segments of her class.

Natalie's goal to support the struggling learners surfaced repeatedly in our interviews and was verified by my observation of her instruction. Unfortunately I failed to ask about her source, efficacy, and commitment. However, because I observed her repeatedly meeting and working with a few select individual students who she had identified as needing extra help, I am convinced that her commitment was high.

Making Changes in the Instructional Routine to Engage Students

Natalie switched from individual to group work between her first and second day. On the third day students took notes. On the fourth day students used electronic clickers. On the fifth day the students took a quiz, and on the sixth day students used whiteboards. Natalie explained these changes and uses of different formats as serving two central goals. The first was to keep students engaged, and the second was to hold students accountable. In this section I will address her goal to keep students engaged. In the following excerpt Natalie explained:

My constant goal [is] keeping kids engaged. I want my ideal classroom every 25 of my kids would be working on the math when I asked them to do it and participating in class. Something I've been thinking about this year is different ways, what can I do to get the kids engaged more, more of them on task and doing the problems. So I've tried the clickers, I've tried working in partners more. Thursday and Friday the learning specialist is going to let me use her white boards, but she's also going to be in here and we are going to try to have kids work problems on white boards and then show their answers so we can kind of keep a tally when she's in here of how many of them are doing them correct or incorrect. And hopefully use that data somehow. So a lot this year I've been thinking about what are different ways to present my lesson so that I can get more kids involved. (Natalie, Interview 2, October 6, 2009)

This excerpt illustrates her goal to raise the level of student engagement through changeups in the instructional format.

Source, commitment, and efficacy toward engaging students.

Natalie identified having a high level of student engagement as a struggle. This common challenge for teachers then was the source of this goal for her. In the interviews she further explained her desire to engage more of the students as stemming from both personal and professional inputs. She said, "That's kind of been a personal goal of how to keep them involved in my lesson" (Natalie, Interview 2, October 6, 2009). However, she additionally related, "I guess I got it from all the education we had about keeping kids on task and using every minute" (Natalie, Interview 2, October 6, 2009). In this instance she referenced professional development opportunities.

When I asked her to what extent she was going to be able to accomplish her goal of engaging the students she hedged. She said, "Maybe a little bit... I don't know" (Natalie, Interview 2, October 6, 2009). In another section of the interview on the same topic she said, "It's very hard for me. It's something I still struggle with I guess, that whole classroom management and keeping them on task and keeping them involved...I don't know." We must recall that Natalie had spent the majority of

her years using a problems based curriculum where she felt comfortable letting the students work. In this setting she was using more of direct instruction and voiced the challenge that her curriculum did not help her ask the thought provoking questions she had use of before. Regardless of this history, her goal to engage students was clearly on her mind, and her efforts in changing the format provide evidence of her commitment.

Using Technologies and Instructional formats to Raise Students Accountability

Holding students accountable was a goal embedded in Natalie's choices of instructional formats and use of technology. Natalie used a wireless overhead projector technology. She carried with her an electronic notepad that allowed her to write and project her writing on the overhead screen from any position in the room. Rather than just using this feature solely, Natalie, prepared slides for each class and could flip through them as one does with powerpoint or smartboard slides. She explained:

One reason that I like it is because I can be walking around amongst the students as I'm doing the problem. I'm not stuck to the board. A second reason is because I can just hand it over to the kid and have them do a problem rather than making them get up out of there seat and come to the front because some of them maybe are still a little shy about doing that. They're sitting in their seat, they're not right in front of the whole class. A third reason is these white boards are terrible, you can't hardly erase. (Natalie, Interview 2, October 6, 2009)

The second reason Natalie listed regarded helping students participate, a theme already discussed. The third referenced her avoidance goal of her whiteboards that she did not like. I followed up on the first idea she mentioned. I wondered what she liked about walking among the students. She explained:

Well I am not standing at the front. So If I need to come over and stand over here off to the side and help a kid or if I'm just coming and standing next to them, hoping that me standing next to them will make them stop talking, which it hasn't yet in my class, all of them. So kind of a classroom management reason behind it.

My main reason is to get around amongst the students and I can see if they're taking notes, or if somebody's not taking notes. I can get them back on track. I can give the board to someone else and I can go help another kid. I just like not being tied to the front where I am just standing in the front. (Natalie, Interview 2, October 6, 2009)

Natalie's reason for using the technology then served multiple purposes but chief among them was her goal to keep students engaged, or accountable, and within this effort, to assess her students.

Two other choices indicated her effort to hold students accountable. One of these was her use of electronic clickers. Though the response format the students used with these was multiple choice, she paired this technology with the expectation that her students would keep written notes of each of the problems.

The clickers are more for their accountability. Sometimes when I review if they're just sitting there, they are not going to do them all, maybe they copy off their friend's homework. So the clickers in class,

it's another way for me to keep every kid accountable, because they know and I can go back in my computer and I can look at their scores. I can look at their individual responses; compare that to what they had on their paper. Plus they have to turn in the paper so I can still see that they show all their work. They don't just copy down the answer, once the answer pops up on the board. So it's a way for me to hopefully get every student engaged. You know everyone of them is involved in doing it and trying. (Natalie, Interview 2, October 2, 2009)

Natalie used the clickers because they enabled her to keep the students engaged and accountable for doing their work. Similarly Natalie required students to show their work in class so she could keep them accountable as well as help them to track their solution process (an effort that references her goal that students learn to represent problems and solutions discussed in the subject matter goals section). On this topic she said:

I'm still trying to get them to show all those inverse operations, what they do as they do it. Because I know it's just going to get harder. Yeah, that's a one or two step equation, that's pretty easy. It's just going to get harder for them. It's kind of a routine thing. Get in the habit of doing it. And it leads into other classes too. They don't show their work they don't get credit. If I let them get by with it now then they're going to be in that habit. (Natalie, Interview 2, October 2, 2009)

Natalie's choices of instructional formats and materials consistently allowed her to monitor and assess her students as well as hold them accountable to her expectations and keep them engaged..

Source, efficacy, and commitment to ensuring student accountability.

Natalie had not always used technology to free her to ensure student accountability or to monitor and assess her students. She explained how this goal and strategy emerged for her:

Before I was using the Core-Plus and so it was more group work and I was just walking amongst the groups and I was talking to them. And I didn't have that technology. So if a question did arise and I saw it amongst all the groups then I had to go the front of the room and we did that problem. Then when I moved [here] and I was teaching more of a traditional, from a traditional textbook, rather than me just standing up in the front, I didn't really like doing that. Then I found out they have this board where I can move around more and even if I don't want to work in groups, then I can still be moving around the kids and seeing what they're doing as we're teaching the lesson.

(Natalie, Interview 2, October 6, 2009)

Natalie found that using the wireless overhead technology allowed her to better monitor students, something she preferred over being in front all the time. Natalie's commitment to this goal was evident in her activities in class. Regarding efficacy she said, referring specifically to the use of clicker's, "If I think about all of my classes today I was really pleased with how well the students were doing all of the problems" (Natalie, Observation 3, October 8, 2009). That she was pleased with how

well students were doing, indicates that she felt she was meeting this goal at least on this day.

Professional Goals and Orientation to Teaching

In the following section I provide one more area in which Natalie described goals. These goals provide further elucidation for the kind of classroom Natalie hoped to enjoy and related to her struggles in the classroom. I frame these as her professional goals and orientation to teaching. Natalie had several years of experience using a curriculum that she taught under a different format of instruction. The curriculum provided questions for students to work and think through so that they could develop ideas about the mathematics. The curriculum she used at the time of observation was more skills-based and she described as being more traditional. Natalie felt that there were times when she needed to be providing direct instruction in the manner typically employed when teaching the curriculum she was using. However, she also wanted to teach using alternate formats that she had previously used. She explained her present desire for how students would work in the class:

I want them to try the problem first by themselves. I want them if they are struggling to ask a partner. I want them to look and see if they did make a mistake if they can find it themselves. I want them to check the answer themselves. Not a you know “Did I do this right? Did I do this right?” I don’t want to always give them “Yes, yes yes.” but I’m trying to get them to do more of that by themselves. (Natalie, Interview, 1, October 2, 2009)

Her orientation generally, then, was to get the students to do more of the work on their own, to get them to see the sense of the mathematics on their own without relying on her.

Natalie explained the tension she felt at allowing the students to struggle: I think it was hard for me at first to not jump in right away and just give an answer and developing that skill of knowing... ok this kid needs an answer right now or he’s going to be so frustrated he can’t go on versus I need to let this kid struggle a little bit more because I think they can make it. I guess it is kind of a sense I guess you have to get from the kids once you know them.

I’ve almost gone back more to my traditional; you know I was taught in a traditional way, that’s how I teach now because that’s how the book is set up. I don’t like that and I’m trying to get away from that because I really liked letting the students work together and share their ideas and struggle a little bit, but yet, not struggle so much that they get frustrated. (Natalie, Interview 1, October 2, 2009)

Part of this challenge stemmed from her experience where formerly students would have been familiar with mathematics instruction that provided more working space to struggle and abstract.

Source, efficacy, and commitment to letting students struggle

Natalie related the challenge to allow students to struggle. She explained that whereas she previously would have done problems-based learning before moving to skills, she currently did things the other way around—building skills before

engaging in real life problems. Part of this goal and dilemma directly related to her prior experience with a different curriculum, but part of it related to a recent professional development for her she said was about “motivating the kids, getting them motivated to do it themselves” (Natalie, Interview 1, October 2, 2009). Natalie’s commitment and efficacy on some level was high because she tried to get students to do some work without her as in the guided practice segment’s of her lessons. She said, “I’d say it’s very important. It’s still kind of early in the year so I’m still trying to train them. But it is something I expect them to do” (Natalie, Interview 1, October 2, 2009).

Summary

In summary, Natalie’s subject matter goals involved teaching the symbolic notation of equation solving and learning to represent and solve problems using algebra notation. Furthermore, Natalie’s goals that supported student learning included: (a) promoting students knowledge of justification, multiple methods, catching mistakes, and getting started; (b) reviewing, introducing, and assessing through bell work and homework checks; (c) preparing and encouraging students to participate in classroom discussions; (d) making changes in the instructional routine to meet the needs of struggling learners; (e) making changes in the instructional routine to engage students; and (f) using technologies and instructional formats to hold all students accountable. These goals were linked together as they were drawn out during interviews. The source of her goals came from her own experiences, state frameworks and assessments, and her observations of students needs. Her commitment to her goals was evident in her instructional choices, and her efficacy was moderately high.

Appendix E: The Case of Adam

At the time of observation Adam was in his 17th year of teaching, but in his first year teaching high school students. Initially, Adam was certified as an elementary level teacher, he spent the majority of his years (13) teaching mathematics classes to sixth and seventh graders before moving to the high school level. Early in his career he and fellow teachers pieced together units preferring their own developed curriculum over published textbooks. Then the district adopted the Connected Mathematics Project (CMP) curriculum, a National Science Foundation funded problems-based middle grades mathematics curriculum. He used this curriculum for several years. Adam preferred problems-based, student-active curricula.

After serving as a middle grades mathematics teacher the opportunity arose for Adam to work as a math coach in his school district. As a math coach Adam observed and discussed teaching and learning with other teachers. While he was working as a math coach the school district adopted a new curriculum for the middle grades that Adam did not find appealing. Then, due to budget issues the school district decided to discontinue the mathematics coaches' positions. Not wanting to return to a new middle-grades curriculum that he did not prefer, Adam chose to go to work at the high school where the district offered an integrated curriculum using the Core-plus materials which, like CMP, was developed under National Science Foundation funding and is a problems based curriculum. By this time Adam had a master's degree in curriculum and instruction, had participated in and led leadership and training activities in the district, and was highly regarded by peers and University faculty who had associated with him.

Teaching Structure

I observed Adam teaching the Integrated 3 course, a 3rd year course using Core-Plus to mostly Junior and Senior level students. The focus of the unit under observation was quadratic inequalities. Because the curriculum was problems-based, students spent a lot of their time working through questions individually or in groups. This work was punctuated with whole class discussion led by Adam. Adam employed a combination of small group and whole class discussion.

To illustrate the context in which I investigated Adam's goals, I briefly outline the first day of observation. My observation began on the first day Adam introduced the new unit involving quadratic inequalities. However, he began the day with prompts devised to help the students reflect on their efforts and learning on the prior test and thus far in the semester. Then, after getting their new books for the new unit, he spent a few minutes discussing the learning targets for the new lesson. He displayed several learning targets for the upcoming few days, read each one and invited students to share with the whole class what they knew about each one. Then for the balance of the class students worked through a number of thought provoking questions written [by others in the mathematics department and aligned with the textbook] to help them investigate and realize various aspects of quadratic equations. Interspersed within this student work, Adam conducted whole class discussions related to the learning targets introduced at the beginning.

In the last 30 minutes of class Adam spent a few minutes working through a contextual problem that related a quadratic function to the profit a company could make depending on the pricing of their product. He asked the students to find the maximum profit, a task they had not previously encountered. Then, just before the end of class he gave the students a couple of questions to assess their learning of the day. This work set them up to engage in a new set of questions when they returned for the next class. The following three days classes were conducted in similar fashion, spending a majority of the time in student activity aimed at completing learning activities and punctuated with whole class discussions.

Overview of Adam's Goals

Adam was a reflective teacher who thought critically about the effectiveness of learning activities. He expended considerable energy and thought towards the messages that were communicated in his classroom. He thoughtfully worked to build relationships with each student. And he expected the best efforts of his students as well as himself. Adam engaged in building relationships with his students and worked to manage the messages he communicated to orient and organize the students to be in a ready state to learn. In the following I illustrate these and other goals as they are integrated into and can be inferred from Adam's activities in the classroom.

In the following sections I describe the goals Adam worked toward in his teaching. This case is organized into three sections. In the first section I describe Adam's subject matter goals. In the second section I describe Adam's goals that orient students to learning. These goals involve the expectations and efforts that Adam communicated and pushed toward to bring about the learning of the subject matter goals. In the third section I describe the goals that Adam had for himself as a professional. Within each area I report one or more goal themes, that is, sets of goals that were interrelated to each other, or that were related to particular activities.

Subject Matter Goals

As an introduction to the new unit, Adam displayed the following learning targets on the screen in class: (a) "I know and can apply the effects of a , b , and c of a quadratic equation in standard form $y = ax^2 + bx + c$;" (b) "I can use the quadratic formula to solve quadratic equations;" (c) "I can write inequalities to express questions about functions of one or two variables;" (d) "Given a graph of one or more functions, I can solve inequalities related to the functions;" (e) "I can describe the solution set of an inequality in one variable symbolically, as a graph on a number line, and using interval notation" (Adam, Video Day 1, October 12, 2009). Before beginning any other learning activities Adam asked the students to discuss with him and each other what these targets meant and what they knew about each.

Additional content goals emerged over the four days and were related in the interviews. I asked Adam to repeat his subject matter goals to uncover those he did not list in class on the first day. He said,

[Finding] the line of symmetry by using the opposite of b over $2a$. So, can they plug in the numbers? That really shouldn't be my goal but I'm finding I need to. Can they find a line of symmetry and know exactly what that means? What does that line of symmetry tell you? Then we calculated the minimum or maximum using that line of symmetry as

my x value, but I don't think they know that that is their xWhat I might do is... just give them a solution. Then ask them, "So what does [it] $(-2, 1)$ tell you? What does this mean in this problem? Where is that on the graph? Where do you find that in the work that is shown?" I might have them do something like that, have them just analyze, take a step back and birds eye view almost of what is all this for? What is it showing me? (Adam, Interview 2, October 20, 2009)

The language Adam used in this excerpt indicates an emphasis on both skills and concepts associated with finding and understanding the meaning of quadratic maximum and minimum points. It is also clear that he felt students were struggling with both. Later in the same interview he identified another area of concern. Regarding inequalities he said:

When I set it up an inequality now we can communicate all the values of x that fit this problem, not just where it's equal. With the inequalities it gives us the opportunities to communicate more precisely all the values of x that can fit whatever has been given. So that means they need to be comfortable with the symbolic notation, which they're still confused on, and the number line graph, which they're still confused with the symbolic and the number line graph. (Adam, Interview 2, October 20, 2009)

Adam recognized students were struggling to make sense of the symbols and representations related to inequalities and held the goal to support students learning these. Another content area that Adam found the need to address was order of operations and how the students' calculators required well-defined syntax to return the appropriate response. Specifically, the issue was that some students did not know that to square a negative number the calculator required the negative be placed inside parenthesis (e.g. if the students entered -5^2 the calculator returned -25 . They needed to write it $(-5)^2$ to get 25). Of this he said:

They were doing this quadratic formula with their calculators, they would type in negative 5 squared, if b was negative five. Well, negative 5 squared, on a graphing calculator, if you don't put negative 5 in parenthesis, then it's the opposite of 5 squared. It does 5 squared, then sticks the negative on it. So then they end up with negative 25 on their screen. And that's going to make it completely wrong. But the kids were just sticking numbers in there and letting the calculator go. And now we need to have a discussion over negative 5 squared [as opposed to] *in parenthesis* [italics added] negative 5 square. So now I've got new goals. I know the goals that are stated in the book, but now I've got goals for basic order of operations, practice. So warm-ups are going to have to come with some very quick bell ringers. (Adam, Interview 2, October 20, 2009)

We can see that these goals were not just a part of and fit with the learning targets he originally held, but that they also received special attention because he noticed students struggling with them.

Source, commitment and efficacy towards subject matter goals.

It is clear from the data already presented that his continued and additional emphases on specific goals existed because he noticed that students struggled with them. These ideas included the need to teach about calculator syntax and order of operations, also understanding and developing skill with finding maximums and minimums of quadratic functions, and finally the emphasis on symbolic notation and use of number line graphs to represent solutions to inequalities. However, these goals initially originated in sources outside of his experience with students as they were learning. When asked where he got his learning goals Adam reminded me that this was his first year at the high school and that he was unfamiliar with the state high school mathematics standards and then said, "I have to rely on the book and my professional learning team" (Adam, Interview 2, October 20, 2009). Adam initially relied on the goals embedded in the text he was using and the professional learning team with whom he worked.

Evidence of Adam's commitment to teaching these subject matter goals was found in his daily efforts and particularly in his identifying areas of particular difficulty for the students. Additionally, his commitment to teaching the subject matter was demonstrated in his persistence to teach other topics. For example on the 2nd day of observation his opening activity (warm-up) was a task from the previous chapter involving geometric proofs. As the class began he said to them "It's kind of a reminder of what we just learned. I really don't want you guys to lose what you just learned. It's my attempt that we retain what we learned" (Adam, Video 2, October 14, 2009). He created the warm-up to continue providing them opportunities to learn as well as to communicate that he expected them to learn it. This example illustrates his typical continued effort to address any content that was not well understood by the students after the unit test. He further indicated his high commitment to helping his students learn when he said, "I will keep hitting them with it. Just a little at a time" (Adam, Interview 2, October 20, 2009).

At the end of the observation cycle when asked about efficacy regarding getting students to meet the learning targets Adam said:

They are still confused with the symbolic notation, the number line graph, the interval notation, and being able to see on a graph where it is above and where it is below. But they'll get it before the test because I will keep hitting them with it and hitting them with it. Just a little at a time. (Adam, Interview 2, October 20, 2009).

Adam acknowledged the difficulty his students had learning and meeting his subject matter goals but had confidence that they would make sense of the mathematical ideas in time.

Goals That Support Learning

Presenting And Discussing Learning Targets

Adam made a dedicated and consistent effort not to just have learning activities, but to communicate what was to be learned by them. This type of communication permeated his instruction. As previously explained, he began the unit by sharing and discussing the learning targets. As this area was uncovered in the interview by asking about the activity at the beginning of class where he showed and discussed the learning targets, much of the following will be centered on this activity. When asked about the learning targets discussion Adam said:

I think it's important that kids see in front of them what the direction that they're going, what we are expecting them to do. It was a way to tap into some of their prior knowledge. What did they know about quadratics? Some of it started to slip out with the students. It's fun so I just went with it. My intention was just to share where we're going. These are the targets that we're going to be hitting today and in the next couple of days. These are the skills these are the idea, the concepts that we're going to be doing.... So basically it's almost, it's not really self reflection, but it's self knowledge or knowledge that you want students to have: Alright, here's where we are today. And this is kind of the pool that we're going to be swimming in today. These are some things we're going to encounter. And it's important for them to kind of feel grounded in a way and know where they're going. That's kind of the idea of giving those targets out. (Adam, Interview 1, October 14, 2009)

One of the goals then was to orient the students to the new content, but he also wanted to prompt and discuss students' prior knowledge. He related in interview that it was his first intention to simply share where they were going. But as students responded positively to these questions he asked: "Help me to know what the a , b , and c refer to." and, "What do you remember about quadratics?" (Adam, Video 1, October 12, 2009) he let the discussion grow. We can infer that beyond sharing the learning targets in the learning targets discussion he also wanted to draw out students' prior knowledge. Indeed, by nature of the questions that he asked it is clear that he wanted to hear what they knew; he wanted them to connect and frame their new learning in terms of prior learning.

Outside of the learning targets discussion on the first day it was observed that when beginning or ending activities as well as in small group discussions he directed the student thinking to the mathematics. For example, in one group interaction he directed a student to connect where a quadratic was below the x-axis to the number line graph representing that same thing. In another moment, as he directed all students to solve two quadratic inequalities, he asked them to focus on finding the values of x that made the inequality true. In other words, he did not simply ask students to do activities but to focus their attention on specific mathematical skills, ideas, objects, and connections while doing those activities. He made the mathematics explicit as opposed to ambiguously embedded in the activities.

Source, commitment, and efficacy to communicating learning targets.

Adam identified a school district initiative as one of the central sources of this goal theme. The school district in which he was situated had been engaged in a multi-year effort to incorporate ideas from the literature base known as *assessment for learning*. One of the central principles of assessment for learning is informing students of the learning goals. Adam said, "Every principal made it a thing for their teachers that you have to put your learning targets up on your board" (Adam, Interview 1, October 14, 2009).

Adam's commitment to this goal theme was evident during my observation as he reviewed or previewed the learning targets to aid in discussions intended to

summarize the math or to outline the activity ahead. In regard to his perceived effectiveness in communicating the learning targets in his learning targets discussion he said:

Obviously it's not the most effective, you know there's always ways I can do it better, but by turning it over to them, instead of me reading it or telling them prior knowledge, or even having a student from the back of the room yelling her prior knowledge, just letting them discuss it [is better] than just giving it to them. (Adam, Interview 1, October 14, 2009).

Adam hesitated to claim his effort as being highly effective, but he did not reflect on whether or not he should have shared learning targets. Rather, he reflected on the quality and efficacy of his method: presenting the learning targets on the board, reading them, sharing thoughts about them, and prompting students to talk about them. Adam was concerned about how he used his time in class. In various ways across the observations he repeated the learning targets or pointed out what mathematics was to be learned in his activities.

Communicating the Expectation to Learn And Developing Students Self Reflection And Assessment

The first lesson I observed was the first lesson following a unit test. Adam began that day by engaging students in a reflection activity. The students were asked to write responses to the following questions: "What new learning occurred for you so far this year? How hard did you work on a scale of 1 to 10? How well did you do on the test? Will you change anything [in terms of work or study habits for the new unit?]" Students worked quietly and were told to keep their responses private. They did not share their responses with anybody, not even him.

Multiple messages were intended to be communicated in this specific activity as well as throughout all his interactions with students. First, all the intended messages Adam desired to communicate fit within an overarching or integrating goal. Adam reflected:

All the years of teaching I've often thought how [do I] set and [establish] a classroom where the kids stay engaged and the kids want to learn and the kids keep asking questions? Now I don't think I have those ideal classrooms yet, I'm still working on that. (Adam, Interview 1, October 14, 2009)

The essence of this goal is to engage students, to get them to want to learn and to ask questions. He related several supporting goals. He said, "Part of that was I want them to self reflect. Another one is there was an expectation that you learned something... I'm hoping to set up, "you were expected to have learned something and how big is your list?" (Adam, Interview 1, October 14, 2009) Adam also hoped to change the student apathetic mindset that his class was "just a third math credit" (Interview 1). He said, "I still get the sense that that some of these kids are blowing it off. Like, if they do a minimal amount of work they can pass. And that's all that's going to be necessary for them to do" (Interview 1). Adam worked to communicate that he expected their best efforts towards learning, and that performing a minimal amount of work to pass the class was not acceptable.

The following excerpts further delineate messages about working expectations Adam worked to communicate. Each of these quotes came from Adam in the first interview when I asked, “Tell me what you’re trying to accomplish with this activity?”

1. How hard did you work? How well did you do on the test? The equating: I work hard, then my score will show up. I’m not collecting homework points. And so sometimes they, when I give them something to do they ask, “Is this for points?” And I’ll say the standard reply for me, “It will help you do better on your tests and quizzes. It will help you learn. So, indirectly, yes, it is for points.” I’m trying to equate those two, you work hard and you’re going to do well.

2. I want them to reflect on how could they have worked harder? Was it possible in their workday to put forth any more energy than what they did? In the classroom could they have worked harder? And that’s what that “will you do anything differently?”

3. I’m not so sure how good they are at defining when they’re stuck, and how badly they’re stuck. And if we could improve that at all, I think it turns them into better learners, then they kind start seeking and advocating and asking questions. (Adam, Interview 1, October 14, 2009)

These goals can be summarized as expecting learning, equating hard work with success, not allowing minimal efforts, being conscious of one’s efforts and developing the ability to self assess and monitor progress.

Perhaps the greatest message he tried to communicate was that he expected learning to occur. His goals in this area included: (a) to promote student self-actualization—that they become advocates for themselves and develop a learning mindset; (b) that students develop a habit to self assess both their effort and their learning; (c) that they learn that hard work leads to success; (d) that they understand that he expects them to be learning and that he will follow up to promote their responsibility in this way; and finally, (e) that they cannot simply put forth a minimal effort for a passing grade, that he expects their best effort in his class. In other words, he expected high-quality reflective learning to occur.

Source, commitment, and efficacy to communicating working expectations.

Where did this set of goals come from? Adam said:

The questions that I ask myself regularly popped into me as an instructor—I wanted you guys to be asking yourselves these questions. And maybe it’s because it helps me stay on top of my game when I do that. I think it’s going to be beneficial to them that they stay on top of their game. (Adam, Interview 1, October 14, 2009)

Adam identified himself as a highly reflective teacher and stated this orientation led him to implementing reflection activities for the students. He further said, “the kids will pick those things up. The kids will learn what it is that you value the most by what you pay attention to, or what you say, what you do” (Adam, Interview 1, October 14, 2009). He was fully aware that teachers communicate expectations in

subtle ways and so this goal theme and grew out of his own disposition and experience in the classroom. He reasoned that because it helps him, it will help his students.

Adam's commitment to thoughtfully and carefully communicating working expectations in the classroom was high. He said:

You can't just say at the beginning of the year and expect it's going to latch on. I think you have to live it and your actions need to be congruent with what you're saying as well.... And I'll still be working on it the last day of school" (Adam, Interview 1, October 14, 2009).

Adam knew that to make his messages meaningful he had to commit to them in his actions and across the school year. So while the learning and working expectations discussed here were communicated through the reflection activity, the in class observations as well his words here demonstrated that these same expectations permeated his working relationship with students throughout all aspects of his instruction.

Regarding his efficacy in communicating these particular messages and expectations through the reflection activity he said:

Oh I've been better... You know I just wanted them to think about it. I didn't want to cram it in their head. I didn't want them to cry or laugh or whatever about the activity. I just wanted it to be one of those times where it's important to think about where you're at right now, and lets take a moment and rate yourself. Take a peek. I think for the purposes of what I was going for I think it was fine. I wasn't going for any major major thing. I think you do that little bit little bit little bit and little bit and it becomes effective because it becomes something natural that they pick up and they start doing themselves. (Adam, Interview 1, October 14, 2009)

So while he did not say as a result of the reflection activity that every student understood his expectations, it is clear that he was committed to sending those messages and that in time he believed the students would know and understand them.

Distributing Mathematical Authority And Encouraging Academic Risk Taking

Adam wanted students to develop mathematical power and realize that they could reason and make sense of mathematics for themselves. Additionally he worked to encourage students to think on their own and take academic risks. With these goals in mind he consistently organized instruction to allow students to struggle with important mathematical ideas. The following interview excerpt illustrates his goal in this area:

I'm trying to establish in there and it's taking a while, but it will get there I believe. Like I said, the last day of school I'll be doing that. It's trying to establish the culture of "I'm not the only authority in here." You have peers sitting around you that if you probably put your heads together can do some good thinking together and you can share and I'm going to expect you to turn and talk and communicate about math. And I'm not the only one who knows the answer. And that's part of the reason why I do that, not only does it, I feel like it engages more kids,

but it also sets the expectation again. Here's another chance, or here's another thing he's asking us to do, he's asking us to talk to our partner and communicate about math. He's going to do that everyday. So that becomes: He values this. He values us communicating and talking with one another. (Adam, Interview 1, October 14, 2009)

A few moments later in the interview Adam expressed the following:

It's important that I'm not after the right answer all the time. Because that will shut students down I think. If the end all, be all, what I am only concerned about is whether they get the answer right or wrong. Well we're going to make mistakes, and the whole idea of practice and learning is we're trying things we're not going to get it right, but that's when you ask questions about it. So I try to treat errors as opportunities to learn. (Adam, Interview 1, October 14, 2009)

The two goals related here are to distribute mathematical authority and to encourage academic risk taking. He did not want students to look to him as the only source of right and wrong, he wanted them to have the ability to discern for themselves the strength and validity of their own and other's mathematical reasoning. Furthermore he worked to establish an environment wherein students could be wrong, and not be penalized, thus fostering a propensity to take risks and try things as they engaged in mathematics.

Source, commitment and efficacy to distributing mathematical authority and encouraging academic risk taking.

This goal theme was derived from several sources for Adam. One of these sources was his exposure to problems-based curriculum. He said:

I learned through teaching reform and letting go of my authority in the classroom and giving it to the students, which really the learning belongs to them. It's not me giving them the learning and the more I step back and just gave them questions and expected them to think about it and for them to talk about it without me getting involved, the more I learned about math. (Adam, Interview 1, October 14, 2009).

It was also clear that his experience as a math coach further cemented his feeling about this goal theme. He said:

I have witnessed this as a math coach, some of the teachers would be so structured [that] students were not allowed to write an answer down unless the teacher had written that answer up on the board. It was that structured. And then when they gave the kids an opportunity to do a problem. Well the kids could only do it once the teachers would, they would preteach. They were using a reform curriculum, but they were preteaching some stuff, and then they'd turn the kids loose on those problems. And they would write down their answers but then when they got to the next problems, they would have to wait and move on until the class was ready. So those kids got in such a mode where they were afraid to try anything without the teacher showing them how to do it first. And now I'm teaching in a traditional class and I see that all the time. I give the kids a problem to do and they look at me, "when are you going to show us how to do that?" And

so they're always looking towards the teacher for guidance. And so wanting to get across to them that they can do them without being told every step of the way. I've seen too many kids afraid to even start. (Adam, Interview 1, October 14, 2009)

Observing classrooms where students were not encouraged to think about the mathematics for themselves further developed Adam's already decidedly student active orientation to teaching. A probable source for this goal that Adam did not cite was the assessment for learning literature. Adam had exposure to this literature and this goal theme is firmly embedded in that literature.

Issues of efficacy and commitment are embedded in the excerpts illustrating this them. Regarding commitment, Adam said he expected to work on towards this goal to the last day of the school year. Regarding efficacy, there were two different answers. First, that he will get there, that he believes he will get students to understand that he believes they have mathematical authority, that he is not the sole authority, and second, that he may not achieve the ideal as indicated by his reference to work on it to the last day. I take this language to reveal that while he believes in the goal and believes that he can get students there, he also accepts that he will have to persist the whole year through, that there will not come a time when he will no longer have to work towards it.

Homework And Grading Policy: Promoting Learning And Mastery, Avoiding Negative Identities And Harmful Policies

Adam sought to avoid certain effects of grading that he believed were harmful. To mediate the harmful effects of grading Adam had experimented with his grading and homework policy. He explained:

I think grades unfortunately have placed certain identities on students. And I think students walk in the classroom with their number, "I'm a D student." If you've got a D in my math class, I think they walk in thinking my identity is like a scarlet letter, "I'm a D math student." And I think it can, it's not very motivating to them, especially if you've got an F or a D early on in the learning process. If at the beginning part of a unit you start off with an F or a D, traditionally, you'll never, that F or D will always weigh down, it will weigh everything down, even if you get a 90 percent for the unit test. Why should that F impact what the student knows now? And so that's what I'm trying to communicate to the kids. And boy they just love that... If you want to decide you want to change your habits and work harder, you can, and your grade will immediately show who you are. You can escape your identity of the past very quickly by changing what you're doing in the classroom.

In essence, his goal was to devise a policy that held off the grading and promoted learning because when a student learned the mathematics, previous scores relative the topic were replaced with the new one representing their current state of learning.

In the course of a unit Adam typically employed several quizzes, target learning checks, exit slip assessments and other forms of formative assessment. Target learning checks, for example, occurred before a quiz and served to help him

adjust instruction for a student or for all of the students. The same was true for exit slip assessments. These were recorded, in the grade book but they held no weight towards a student's grade. In fact, they were replaced by quiz scores, and quiz scores were ultimately replaced by test scores. In this way, Adam hoped to communicate to students that their effort would be rewarded. Adam provided students with multiple opportunities to master the material. If they did poorly, they would have another chance to learn, and another chance to show that they had learned. One part of Adam's goal in this area was to provide a policy that limits for students the risks of not knowing the subject matter early in the learning process, and at the same time reward students for learning and provide the space and time to do it.

Adam explained in the first interview that at the beginning of the year he had told students he would not be taking homework for a grade. Curiously, in the interview conversation he said he regretted having told the students this. He said he regretted it because it led students to not doing work outside of class. However, part of the reason for not taking homework was also influenced by his goals to use in class time well. He said,

I'm trying to change at the beginning of the class period and during the class period to engage them even more during class... If I could engage them authentically at a higher level than I'm doing now, I still want to get them engaged differently with me at a higher level of engagement for the 95 minutes while they're in the class period, then we may be going a lot further than, and if I don't do any homework we may be getting a lot more accomplished, a lot more thinking, a lot more long term learning happening if I can get that accomplished. So then the homework question kind of just goes away. (Adam, Interview 1, October 14, 2009)

The other side of his goal, then, is to increase the quality and quantity of student engagement during class. If he can do this, then the question to give homework goes away. Adam wants his students to learn, but doesn't like what homework does to the learning environment. Instead he provides multiple formative assessments and implements a policy that promotes learning and minimizes harm to students' grades as these assessments lead to a summative assessment. Although students are not given homework, he makes a special effort to engage them more fully during the moments he has them in class.

Source, efficacy, and commitment to Adam's homework and grading policy.

The sources of Adam's goals in this theme stemmed directly from his personal experience and perception of the grading process. Some of this is indicated in the first excerpt in this theme when he explained how he felt grades placed identities on students and these were often harmful and demotivating. Related to not taking homework for a grade and alternatively enhancing the level of engagement of students in the class he said:

I don't think homework should be part of the grade. It's practice, you're learning. I think it encourages students to cheat. They're trying to show the teacher, they're not doing it to learn.... Homework sets kids off. It gives them a ton of stress. When they show up and when

they walk into the classroom, they're already upset because they didn't have their homework and then they're going to get in trouble. Or they're going to copy from somebody before they get to class so they can show me they've got the homework done. And that's dishonest. So you kind of drive them to be dishonest with some of your expectations.... I don't think homework should be part of the grade. It's practice, you're learning... They're trying to show the teacher, they're not doing it to learn. (Adam, Interview 1, October 14, 2009)

He further recalled as a student there was a lack of thinking during class. "No thinking about math, and then when I got home to do homework there was still no thinking. I was just following the process" (Adam, Interview 1, October 14, 2009). From these excerpts we learn the concern Adam had for his students, his belief regarding the destructive and harmful influence of homework and grading on students. In essence these concerns are the sources for his goals in this area. He modified his policy to avoid these harmful effects. He wanted to promote honest learning, not doing assignments for a grade or the teacher. He wanted to have students thinking about the mathematics, and he wanted them to know that at any time, with effort, they could change their mathematical identity from a negative, depressed, and oppressing identity to a positive identity.

As with other goals Adam was strongly committed to enhancing learning through his grading and homework policy. He said:

I really believe in my heart I can get kids to work without collecting [homework]. I can get them to work and want to do it and want to succeed and want to understand without giving them a grade for it. (Adam, Interview 2, October 20, 2009)

Adam's high commitment was evident not just in his words, but also by virtue of the homework and grading policy itself. And in another sense, his commitment came through his dedication to high quality student engagement that has also been discussed.

Adam's sense of efficacy in this theme was high as evidenced in the anecdote he shared:

So a girl who had an F, she's the one who handed me her phone the other day. She had 90 percent on that test, but she got an F on the first one, she was still at a d minus after the quiz. She called her mom in the middle of class, she gave the phone to me and said, "Tell my mom." She walked in today, with a unit project for her world studies class, and I heard the students saying, "What's gotten into her? First she get's an A in her math test, now she's doing a project for world studies." This is a student obviously who needs motivation to work. I think she just, that A, I think she realized, I can do this. And she went home and she did her world studies project and she came to school with that, and I hope they reward her as well, and it can just turn her life around. So I think little things like that with grades, boy they can be so harmful to people. And I think it, we're always trying to get it

right and I'm still experimenting with some things. I think I've done some things right with that. (Adam, Interview 1, October 14, 2009).

Adam felt he had done some things right, but as has been the case with other goal themes, he intended to keep thinking about it and experimenting with his policy to engage students at a high level, reward learning, and minimize learning risks.

Conferencing With Students: Supporting Individuals And Groups In Learning

A large portion of each class was conducted as students worked together in groups on investigations or problems. Adam spent this time moving from table to table working with students and groups of students in need of help. During these times Adam holds several goals: (a) to "get around and talk to every student and hear what they're thinking mathematically" (Adam, Interview 1, October 14, 2009); (b) to "try and figure out a way to get them to the learning without showing them or telling them" (Adam, Interview 1, October 14, 2009); and (c) to support and challenge the students mathematically (inferred), both for the students sake and as a positive public relation effort with parents. On this last point he said:

The best PR for any math program is the kids go home feeling like they were supported in the classroom, and challenged. And I'm still working on that. But I want to be that support for them so that when they go home and they talk to their parents they can communicate, "yeah my teacher is supportive and my teacher helps me." (Adam, Interview 1, October 14, 2009)

His first goals are to listen in at each table and hear the students' mathematical thinking and to help them learn without telling them. In working to meet these goals Adam also meets the last goal to signal to parents that the curriculum he uses is worthwhile.

Because supporting and challenging individuals and groups learning occupy a large portion of each class I will illustrate his efforts with a few examples. First, the reader should know that Adam's goals are contextually dependent upon the student in need. Some students need more mathematical support than others; some need more encouragement, and some need more challenge. Some only need him to listen. During the 2nd observation students began the day with a geometric proof warm-up problem from the previous unit. He chose this problem because students were not at the level of mastery he expected. During this exercise he related that one of the stronger students was struggling. He spent some time with her and found that she had mistakenly identified the sum of two angles of a triangle as summing to 180 degrees, she had viewed these angles as both being formed and on the inside of parallel lines. Because the lines were not parallel she could not make this assertion. I asked Adam about the interaction he had with this student. He reported:

I was trying to get her to see. In this triangle, "What else do you know about this?"

[She replied] "Well I know the triangle is 180. Oh but 2 of those angles can't equal 180, three of those angles equals 180."

So then [I asked her]: "Which one of those are you sure about?" And I started to repeat them both. I had started with the right one, and she pointed to it and she said, "this one I know." And then I think she figured it out from there. ...And so I didn't have to tell her what to do,

just had to kind of get her to look at [it]. (Adam, Interview 1, October 14, 2009)

Adam explained his effort in this interaction was to avoid telling her or correcting her mistaken idea and to help her evaluate or consider and use her own knowledge and how it applied to this problem.

Adam's effort to help this student recall and use ideas that she already knew, in turn, met his other goals such as distributing mathematical authority and raise the level of engagement during class. His goal was to listen and support her learning and to get her to understand the mathematics without directly telling her what to think and do. It supported his goal to provide positive public relations messages to parents, by supporting students in their learning. It supported his subject matter goals and his goals to communicate and distribute mathematical authority. He reiterated:

I even said to one [student], "You know what? All I did was ask you one question." And again it sends the message, "The answers are within you, not within me, if you ask yourself the right questions. If you learn to ask yourself the right questions you can solve a lot more problems when the teacher is not around." (Adam, Interview 1, October 14, 2009).

He wanted students to learn to ask themselves the same type of questions he asked them so that they could become autonomous learners.

Source, commitment, and efficacy to *conferencing goals*.

Direct information from the interviews regarding Adam's commitment and efficacy and the source of this goal theme are scant. The source of the goals in this theme are likely internal and related to his disposition to the mathematics and his experiences and beliefs about the teacher's role in problems-based courses. By observation it appeared that Adam was deeply committed to working towards these goals across the school year. Regarding efficacy, he commented specifically about not giving students answers. He said, "I'm not always the best at not giving direct answers to them. But I try to pause and let them tell me what they're thinking and maybe ask them a question to get them to think differently" (Adam, Interview 1, October 14, 2009). In terms of not giving students answers he claimed to not be the best, his perception of efficacy on this one area was not 100 percent. Nevertheless, my observation was that he rarely gave students answers. Still, his hesitancy related to his sensitivity to students level of perseverance. I share more about this equivocation in the next goal theme, which is highly related to this one: building strong relationships with students.

Building And Maintaining Positive Relationships With Students

Adam began speaking about relationship building in the first interview when we discussed conferencing with students. He said:

I want them to know that I will listen to them, and I will be there to assist them.... I want to keep those relationships pretty strong with the students, speak to them very calmly and let them know that I'm there. (Adam, Interview 1, October 14, 2009)

He further discussed his priority to build relationships with students during the second interview when he discussed one particular student with whom he described his relationship as fragile. He said.

I need to be careful not to blow the relationship with her. The rule was with Jennifer, with all students really, you've got to be careful about their peers and how they look in front of their peers. You can't empower them too much in front of their peers, and you definitely can't take away their power in front of their peers. They'll take advantage of that. (Adam, Interview 2, October 20, 2009)

He then described a confrontation he had with her where he had to assert a rule. She reacted negatively to the confrontation and he went on to describe his relationship building with her in these words:

So I'm trying to nurse her back in to feeling comfortable in the class.

Making her feel like she is a part of it, and she has valid ideas and it's ok, that was back in the past. (Adam, Interview 2, October 20, 2009)

In this goal theme we have Adam's goal to make the room comfortable for students and building strong relationships, which include: listening and *being there* for students.

Additionally, these goals are connected to promoting learning. In this area Adam recognized a balance between caring for students and challenging them to learn. He said:

I don't want to break a relationship with the student. I don't want them to feel ever, as if I've disrespected them, or not treated them in a respectful way. Sometimes I think I'm too nice on that end. I don't want to have a child mad at me. I don't want a student to leave the classroom mad at me. And maybe I don't push a kid hard enough because I've pushed them hard enough and if I push them any further they're going to be mad. (Adam, Interview 2, October 20, 2009)

But he continued by describing some confrontations he had with students where he had challenged them to the extent that he feared he had damaged his relationship with them:

I said to some kids that I got really in their face with and I had to go back and talk to them and say, "I hope you understand why I did that, and here's how we can both avoid this in the future." So I want to make sure I go back to those students just to repair that relationship.

(Adam, Interview 2, October 20, 2009)

Adam was highly sensitized to both challenging learners and having relationships with them. From this excerpt we learn that he tried to balance the two, but was ever mindful and reflective about erring on either side. We learn that he tried to avoid challenging a student to the extent that they are mad at him, but we also learn that when he does challenge them and they respond negatively that he works to rebuild the relationship.

Source, efficacy, and commitment to building relationships with students.

I asked Adam the source of this goal for him. He said he went into teaching for the students. He then said he had asked colleagues where they would put themselves if they had to choose between caring for the students, or, focusing on the

mathematics. He placed himself in the camp of caring for the students. He closed his thought with an interesting question “To be an effective teacher where would you put yourself?” (Adam, Interview, October 14, 2009). Adam has a strong belief that to be an effective teacher you must care for the students and build strong relationships. Adam’s sense of commitment and efficacy are high. He said:

I know that I’ll be successful, the teaching. I’ve had conversations with my wife, I do not have the best teaching techniques... I have the relationships I build with the kids and the kids work because they know I care. And they want to achieve because the relationships...I think the relationships with the kids is really going to take you a lot further than any little tiny strategy that you did to keep them engaged. Although I try to put those in there obviously. (Adam, Interview 1, October 14, 2009).

This interview excerpt helps us to know how important those relationships are to Adam, but also that he sees those relationships as the reason for his success. However, it is also clear that he is very concerned about implementing any and all strategies to promote student learning, so building relationships is not his only strategy, but a key strategy for him.

Challenging and Supporting Individual Students

A top-level goal for Adam is to assert that all students follow his directions and stay on task. He said, “That’s part of my strategy is to make sure they are staying on task” (Adam, Interview 2, October 20, 2009). On this theme he spoke of students who had not learned the routines he expected or who passively were defiant to his learning and working expectations. In each instance he stayed with the student until they cooperated and complied with his requests. He would not allow his students to disobey. While this goal applied broadly to how he approached teaching and will be described in greater detail below, supporting goals were found that complemented this top-level goal. These other goals are to motivate, support, and challenge each student in their individual need.

Adam’s goals to motivate, support and challenge each individual student in their own way is illustrated in the following example. At one point during the observed lessons the students were supposed to use the quadratic formula on a problem, but one student avoided this. He had factored instead. Adam explained:

I could look at it as being, against my rules, you know I’ve asked you specifically to do something and you’re specifically not doing it. So he’s one of those kids, and I don’t want to give up on those kids. And if I ignored that, and let him continue to go through a class period without following my instructions then he learns, “Ok there’s some class periods he’s not going to come check on me. And it’s ok for me not to do this.” Or if I went by and saw that he had just factored it and I was ok with that, well then next time I want you to use the quadratic formula. I’m sorry that you misunderstood the directions. If we left it at that then I think that would have taught him something too.

If you let a kid get off the hook when you ask a question in class and the kid doesn’t know and says, “I don’t know.” And you move to

another kid, well a lot of the kids in class just took note. [They think] “All I have to do when he asks me a question is say I don’t know.” And that’s how I look at those moments. I don’t want to be stubborn. I don’t want to draw my line in the sand with this, but kids do take note of stuff. They learn quickly how you operate as a teacher. Again part of this was, I want you to do this. There’s a reason why I asked you to do this. I guess a goal going out from here is to get that to change in him. That if you get stuck on something that there are things you can do to get unstuck. (Adam, Interview 2, October 20, 2009).

Adam said he did not want to be stubborn, but his goal that students comply with his requests is not something he is willing to compromise on. Adam knows that students take note of what is really expected. He is cautious of making a request because he knows if he does not follow through to see that students comply that they will learn that some expectations can safely be ignored. With the student in this example, Adam expected cooperation. The issue was two fold: first, not doing as instructed, and secondly, avoiding a learning activity because it was hard. Adam expected the student to learn to use the quadratic formula and stuck by his side in this challenging task to ensure that the student did as was asked, and learned what was to be learned.

In addition to seeing to it that students did the work he expected of them Adam had other goals with individual students. According to their need some students he emphasized relationship building, with others he emphasized challenging themselves and finding challenges for them to prevent boredom.

Source, commitment, and efficacy to challenging and supporting individual students.

Information about the source of this goal were not obtained in the interview, but can be inferred from his already described caring disposition and his firm belief in his professional responsibility to teach all students. Adam’s commitment and efficacy towards this goal are related in the following interview excerpt:

When do I give up on a kid who has already given up? I don’t think I’ve got it in me. At the end of the year I’m still going to be working with those kids. And it’s ok if I don’t succeed. It’s ok. I’m not going to win them all, but at least I want to show them an example of someone who’s going to keep pushing them towards a specific goal and the goal that I have, is to keep working in the face of when you’re stuck. Keep working. You can learn. You can with a little bit of trying and it’s ok to be stuck.

Part of me thinks, “yeah a lot of responsibility is on those little kiddoes, they’re not being advocates and they’re old enough to know. But as the professional in the room I have to know that they’re not all going to ask questions and there is too much at risk for many of them to ask the questions. (Adam, Interview 2, October 20, 2009)

Again we learn that Adam does not expect to be completely successful, but we also learn that he is not going to quit or abandon his goals to keep each student learning. He also knows that the students are not likely to look out for their best interest and

that, as a professional educator, he knows it is his responsibility to look after them and teach them, even when they would rather quit.

Personal and Professional Goals

At the end of the 2nd interview I asked Adam about his personal and professional goals related to teaching. Two goals formed with his mathematics faculty colleagues came through a concern about the juniors and seniors of which in previous years as many as 50 percent had D's or F's. The goals formed among these colleagues were: (a) to "increase the amount of engagement the students have in the classroom. Using every minute productively" (Adam, Interview 2, October 20, 2009); and, (b) to "look at grading differently and how it can motivate or unmotivated students" (Adam, Interview 2, October 20, 2009). Goals in both of these areas have already been discussed.

Adam also held several personal goals for himself as a teacher. These goals related to his unique circumstances of having been a middle grades teacher and having come to the high school. He said:

Personally I've got to get to know the curriculum at a level much deeper and wider than what I'm teaching. So each day I work at going through the problems and trying to get into the heads of the authors and making notes about high school, how it's a little bit different. (Adam, Interview 2, October 20, 2009)

I'm still feeling a little iffy about the content, it's a new curriculum for me. I feel like in some way I'm over my head a little bit, in that I'm not prepared, I don't know what questions they're going to ask me, I've never taught this before. (Adam, Interview 2, October 20, 2009)

The goal and concern here have to do with knowing the curriculum well and knowing it well enough to organize learning activities and respond to student questions and challenges.

Adam further related goals and concerns as they related to his standing with other teachers. He said:

Although I started off this year telling them I'm going to come and ask questions, and I feel like everyone would answer my questions, which is good, but, you got to be careful, "Well let's not give Adam this class, because he can't handle the math. Or let's give Adam the easy classes." I end up with a herd of kids that are way behind in school and it's because they think they my math is not up to par. So I've got to protect that a little bit, but I have to be true to the kids at the same time. I can't be someone who doesn't know the content. (Adam, Interview 2, October 20, 2009)

Here we learn about the tension Adam felt protecting his image and his need to be true to the students, to be one who knows the content well enough to teach it.

Summary

The goals Adam held have been organized into the following three areas: subject matter goals, goals that support learning, and personal and professional goals. Adam had a well-defined set of subject matter goals. He orchestrated learning activities to help students learn the subject matter. In this effort he had goals related to: (a) communicating learning targets; (b) communicating learning expectations;

(c) distributing mathematical authority and encouraging academic risk taking; (d) modifying grading and homework policies to minimize harmful effects and promote mastery; (e) building and maintaining positive working relationships; and (f) challenging and supporting individual students. His personal and professional goals involve knowing the curriculum and the content well enough to teach the students while working to avoid negative perceptions from his colleagues regarding his content knowledge.

Adam was introduced as a reflective teacher. I close his case with an excerpt from our interviews that encapsulate all of his goals and his commitment to them as a teacher. He said:

I'll try something new everyday maybe between hour to hour just to see if it will increase their engagement. And I'll reflect on whether it didn't or did. But I know there's ways I could get better. So I'm not going to continue to do what I've always done, well I guess what I've always done can't be defined because I've always tried new things. I mean I want to continue to make improvements, and I will all the way til June. I'll still be making improvements and trying new things and thinking that I need to engage the students better and challenge them at a higher level. I think all kids can be motivated. You'll see them shooting free throws until 9 o'clock at night, but they won't do the math. So how do you reach that level of motivation and commitment with the kid? So I'm still going to be looking for that magic bullet. (Adam, Interview 2, October 20, 2009)

Appendix F: The Case of Sarah

Sarah was in her fourth year teaching high school mathematics in a high school of just under 2000 students in a mid-sized city in the mid-West of the United States. Sarah had earned her master's degree in curriculum and instruction and has since been accepted into a PhD program in mathematics education. Since she began teaching she had been involved in the *Assessment For Learning* initiative from the district and was a leader on this initiative in her high school. Sarah had taught only integrated courses using the Core-Plus curriculum until the year of observation in which she also taught Geometry using a traditional textbook. Sarah was recommended to this research by University faculty not only for her developing expertise, but also because of her tendency to reflect deeply about her teaching and verbalize her thoughts.

Teaching Structure

I observed Sarah teaching the Integrated 4 Honors course, a 4th year course using Core-Plus to mostly Juniors, but also with some Sophomore and Senior level students. Classes met every other day for 95 minutes. The focus of the unit observed was titled *Families of Functions*, and involved developing an understanding of the transformations (stretching, reflecting, translating, etc.) of various function families. As a problems-based honors level course Sarah organized her students into groups. She also facilitated their developing a working schedule within their groups to learn specified topics by set quiz dates. This means that each group was responsible for developing a time line for learning the subject matter, for organizing and planning what sections of the text they would work through, and for working to meet the time line in preparation for quiz and test dates that Sarah determined. This allowed the groups to work without interruption or need to wait for other groups before moving on. With this organization Sarah spent the majority of her time conferencing with groups and held very few whole class discussions or presentations.

Overview of Sarah's Goals

Sarah's goals targeted students working schedules, their efforts, but more importantly, their thinking and learning of the mathematics. She avoided providing any formulaic thoughts that students might memorize, and consistently helped students by asking them questions to help them draw out the ideas for themselves that they needed to progress. She was mindful of students' work ethic and organized students group seating assignments to enhance their motivation and diligence in their daily work. She also was conscience of individual students' needs to be challenged or supported in their learning. She devised and modified her grading policy to promote learning, sometimes on an individual basis. Sarah was active in her school *Assessment for Learning* leadership and made efforts to collaborate on lesson planning. She was especially concerned to avoid teaching in ways she felt were ineffective.

In the following I organize Sarah's goals into three areas. The first regards subject matter goals. The section that follows includes her goals that she held to support student learning. The final section regards Sarah's personal and professional goals for teaching mathematics.

Subject Matter Goals

I observed Sarah's class learning about the graphs, functions, and tables of families of functions under various transformations including translations, reflections, stretches and compressions. In her own words she explained:

It's a lot of details that go along with an x-axis reflection, a vertical translation, and a horizontal translation. And so there are a lot of things that go with it. Writing a function based on a graph. Given the function show that, if I gave you a graph, and I said it was f of x , and I gave you a g of x is negative f of x plus 3, so what would the graph look like now? So go back and forth between the function and graph, and also this book brings back coordinate rules. So we talk about coordinate rules a little bit. Writing them or interpreting them, and then, what's happening to specific points, and what's happening, what general things can you say always happens to the x intercept the y intercept or the min or max when you do these different types of transformations. So a lot of different things that go along with it. And some are real world applications, of do you want this graph to have this starting point, and what type of function would this be, and what would you have to do to come up with that function. (Sarah, Interview 1, October 30, 2009)

Sarah's students worked to meet these goals in their groups as she moved from group to group to facilitate their learning. Finer detail of her specific mathematical efforts with individuals and groups will be illustrated later. Suffice it to say, the goals listed above were her subject matter goals, although some finer grain goals were revealed as she met with groups on specific problems.

Source, commitment, and efficacy to the subject matter goals.

When asked about the source of her subject matter goals Sarah explained that she relied most heavily on the curriculum materials from the textbook as the source of her goals. She further explained how typically she would rely on the measurable learner objectives from her school district, or even develop goals in collaboration with other teachers, however, for this course she was the only instructor at her site, and the school district did not have measurable learner objectives established for this course. She said her goals were "really just the goals the book had set, and I didn't really change much about this one... the curriculum set the goals for me and I was ok with that" (Sarah, Interview 1, October 30, 2009).

Sarah's commitment to teaching and meeting these subject matter goals was evident in her continued effort each day to help students understand the ideas, more of which will be discussed later. Her sense of efficacy was similarly high. She said, "I don't foresee them not reaching a level of mastery overall on these goals" (Sarah, Interview 1, October 30, 2009). However, in the second interview she explained that she did not expect them to come to that mastery level quickly, but gradually. Particularly in the area of vertical and horizontal stretching and compressing. She said:

The days goals weren't to understand vertical stretching and compression or understand horizontal stretching and compression. It was to look at one function and see if we could come up with what happened to go from this graph to this graph. It was really to look at

one specific function and see what happens and I was completely ok with them not even feeling confident.

I think once we do a couple more they'll definitely be able to come up with it. I think the book starts to do enough that they can start to make a connection after they apply it to several things, but if not then I will just have them graph a bunch of things in their calculators. I'll give them a list and help them so they can generalize. (Sarah, Interview 2, November 4, 2009)

In this excerpt she also indicates her commitment to returning to the ideas if students are not making sense. She also targeted other specific areas in which she felt students had progressed further than others and also explained how she would provide additional learning opportunities in those areas slow in developing. For example she explained that a couple of her students were still "iffy... writing coordinate rules. For the most part they have it, but some of them don't" (Sarah, Interview 2, November 4, 2009). She continued in explaining that she felt that most students understood vertical translation, but more of them struggled with horizontal translation, especially when there is more than one x in the function, and that they also struggled with where to represent a horizontal translation in function notation. Her sense of efficacy, then, was specific to each area of her subject matter goals, and her commitment was to returning to areas of weakness.

Goals That Support Learning

In the following section I detail several goal themes that Sarah held to support students learning the subject matter. One of the first visible and unique goals was her organization of the learning schedule wherein individual groups planned to learn the subject matter by specified dates. Her goals within her choice of groups and seating assignments make up the second theme. Sarah held a set of unique goals as she met and worked with individuals and groups. These goals make up the third theme. The fourth theme regards her goals related to assessment and homework. Finally I discuss her goals for individual students. Each of these themes relates a particular part of Sarah's teaching and learning organization within which she held specific goals that targeted student learning.

Directing Students to Self-Pace: Reducing Down Time

Sarah was teaching Integrated 4 Honors for the 2nd year. She had previously taught other integrated courses. Sarah had developed a routine in her Integrated 2 courses where she would outline the work for the students to do and hold class discussions frequently throughout class. A typical charge to her students would be to complete a couple of problems in 20 minutes or so and then have a class discussion. However, with the Integrated 4 Honors class she felt like she was holding the students back by stopping them so frequently. So on the first day of observation she instituted a self-pacing program. She assigned groups to plan their activities and learning around set assessment times from her. When asked what she hoped to accomplish with this organization she said she hoped that:

They're never sitting in class, feeling like they're waiting. I want them to feel like they can keep on learning. Keep on doing problems, they don't have to wait for me to say, "Ok yes now you can move forward." They know what's coming up and they can go ahead and do it if

they're ready for it. So I hope they do that and they just keep on working. The other thing is, I hope that they start to learn this idea of this quiz is covering this content, and it's kind of up to you, the way you want to work through it and the order you want to do things, and if you want to do it all in class or if you want to do some of it on your own and then come back and check your answers. So I'm hoping that they have a little more freedom to do what/how that works best for them and the pace that works best for them, and the order and everything. So I'm hoping they start to decide those things for themselves, rather than the teacher always saying you have to do this. (Sarah, Interview 1, October 30, 2009)

Her two top goals for this effort were to allow students to keep learning and not be so punctuated by group discussion that was not needful and also to develop a greater sense of responsibility for learning subject matter. She believed this would allow students to make their own decisions regarding how to learn and how to pace their efforts to best meet their learning needs.

Source, commitment, and efficacy to directing students to self-pace. The source of this effort for Sarah came from her perception that she needed to allow students to move more freely through the content. She explained:

I had taught Integrated 2 the year before, so I was very used to, they work on the investigation for a while, but then we stop to kind of clear up some misconceptions some groups are having. So I was used to setting, like ok here's what I need you to do in the next 20 minutes, I need you to do these 2 problems. And then us talking about them and then saying ok, now I need you to go ahead and finish the last 3 problems. It was very sectioned off. So that just the approach I took when I started teaching Integrated 4 Honors, and I realize there were times that I thought we needed to stop and talk as a class, and everyone would just kind of stare at me like we already know that. Like we all have the right answer why are we talking about this? And they all were so concerned with always having the right answer, that they worked so hard together, and they worked so well together, that if there's anyone that had it off, they figured it [out], the rest of the group helped them figure it out, and they had it corrected. I realized that I was standing in their way by saying ok I want you to stop after this problem. Or even taking their time to discuss something that they already knew and didn't have any questions about. I was like, I need to get out of their way.

Not only did she move to this plan because she felt like she was slowing students down, but also because she felt like they were self monitoring their understanding and ensuring that each other was successful, thus taking up that responsibility themselves and hence not needing class discussions to address issues. She had always done lots of conferencing with students, now, because she was allowing them to move forward without pausing, she just did more and held fewer whole class discussions.

Sarah's commitment was evident by her implementing the idea in this, a 2nd year. Additionally, her commitment was evident in her efforts to support the student run schedule. At the end of each day she asked the students reflective questions about their progress on their schedule and whether they would have to do any catching up. She also felt fairly efficacious with directing students to plan their learning. She explained how she perceived her success the previous year, which added to her willingness to do it again in this year. She said:

It got so I planned out the whole unit, when the quizzes were going to be and I said, here's when the quizzes are going to be this month or whatever, and I let them do it, and it worked so well for the majority of them. There are a couple of students it didn't work for. (Sarah, Interview 1, October 30, 2009)

Overall, Sarah implemented this feature into her classroom to allow students to move forward without interruption and also to increase the students' personal responsibility toward their own learning. She developed this plan through observation and reflection on how best to help the students learn. She committed time in class to get the program started, and at the end of each day to maintain it. She thought that it worked for most students. The students for which this plan did not work were a special concern for her, and this leads us to the next goal theme. *Group Work Expectations and Seating Chart: Supporting and Challenging One Another*

Sarah organized her students to work in groups. She organized groups for two distinct purposes. The first was to promote discussion among students that would prompt them to think deeply about the subject matter. The second was to enable her to work with students when they needed her most. She explained her philosophy and goals:

We spent a lot of time at the beginning of the year talking about there are definitely times where working in a group can benefit you and there are times when you actually need to see if you can do a problem by yourself. Because ultimately I'm going to ask you on a quiz or test can you do this without discussing your options with somebody else?

But sitting in groups, there's a couple different reasons. Definitely they challenge each other. If someone is saying something or putting down an answer that is wrong, that there's someone there that is catching them and either noticing it's wrong or asking them why, or even if it's right asking them why to make them think better, "How could I explain this to somebody." Or maybe if they explained it they'll realize they did think of something wrong. And it's actually taking a little bit of my job, if they have someone else to say, "Wait, how did you get this answer?" That's not the same thing I got. That they can challenge each other because that forces them all to think a little deeper.

The other thing is to help me out honestly. I don't like to stand in front of the room and explain things. I would rather explain it to an individual when they're actually to the point that it's going to make

sense to them and they're ready for the explanation or ready for the next question. Then I'm going to give them. So I like to do that as a group, but there is no way I could actually go around and talk with each individual student about all their questions. Not only do they answer each other's questions, so that they need me a little less. But then if I go to talk to a group, I can kind of clear it up for 3 people at once. I don't know if I would be able to teach the class the way I do if they weren't in groups. To help minimize their need for me to be next to them. (Sarah, Interview 1, October 30, 2009)

Sarah wanted the students to challenge each other, to push each other to think more deeply and to catch each other's mistakes. The second goal is an extension of the first. By organizing groups she could have more students needs met at once and direct her own efforts to those who are in greatest need of teacher support. In other words, organizing groups enabled her to meet her goal of working with students when they were ready to learn.

Sarah further explained how she supported students and thought about group work. Sarah did not require students to work lockstep with one another. She explained how students pacing within a group often balanced where one student might need more time on a problem, but then a different student would need more time on a different problem. So she allowed them to work flexibly, not lockstep, but she was still mindful to organize groups so that their pacing was not too far out of sync. Although she allowed students to self-pace and organize, an unproductive group was unacceptable. For this reason, and to promote productivity she assigned seating groups. She said, "I had a couple of groups that I just wasn't comfortable again with working and so I decided I was just going to try another arrangement to hopefully get some group work that's working together" (Sarah, Interview 2, November 4, 2009). So another part of this goal theme was to organize groups to be productive and at the same time, avoid or lack of productivity.

Within this interview conversation she identified at least two students for which their seating assignment was a particular concern. One student tended to be shy she said

She was really quiet and didn't ever talk at the beginning of the year, and I was concerned with if it was a sex issue because with some of those students with the different religions, they aren't comfortable working with a student of the opposite sex. Especially females so I have to be careful about that. So I was really surprised when she hit it off with Kyle and works really well with him, so I just kept her with him. (Sarah, Interview 2, November 4, 2009)

Once she found a combination that was mutually beneficial she kept them together. Another group was unproductive with one particular student who was not doing well academically. She said:

I have a few students who just will not hardly do the book work at all, and so those were all sitting together when I let them choose their seats, but then I had such an unproductive group. And it would've been ok, two of them had a good grade, but one did not, and so I decided that I didn't want them to choose to sit there anymore

because well this kid was just sitting there because they were his friends and it was hurting his math grade. But I don't think he, because of peer pressure would say "Hey, I don't want to sit with you guys because I'm not getting work done." Even if he had come to that realization that he shouldn't be sitting there I don't think he would say that to them and get up and move. So that's why in this class I decided to give assigned seats originally.

Sarah's goal was to have productive groups and for that reason she strategically assigned students where she thought they would work well.

Source, commitment, and efficacy to organizing students in groups to support and challenge one another. As has already been discussed, one of the reasons behind her decision to organize students into groups was to promote learning and productivity. But her decision to use a seating chart in this class was unusual. She explained, "This year, I have a lot of students especially in [this] class that just don't really stay on task at all" (Sarah, Interview 1, October 30, 2009). This prompted her strategic choice of seating assignments. Her hope that students challenge and support each other in their groups came partly from her need to distribute help to the students. If they met these expectations, not only would they help each other learn (the purpose of any teaching organization), but this would also allow her to meet with learners after they had done some of their own thinking and when they needed her most.

Sarah was committed to a strategic seating assignment as evidenced by her re-assigning a seating chart within 2 days after the first. She assigned seats to students the first and third day of observation. Her commitment to promoting student's challenges and support to each other was tacit in her classroom. She had discussed her thoughts on group work with the class at the beginning of the school year, and these students had spent several previous years coming through this sequence of mathematics courses where group work was promoted and the idea for students to support and challenge each other was standard. While I observed no direct communication from Sarah regarding these goals I do not doubt that students understood the expectation. Furthermore, she explained her efficacy on this point. She said:

And this class I haven't gotten them to challenge each other as much as I would like for them to or as much as I've seen other students in other classes challenge each other. So I don't know if that's going to come with me rearranging them more or what. (Sarah, Interview 1, October 30, 2009)

Although Sarah did not perceive that students were challenging each other as much as she would like, it was clear from observation that students were supporting each other and that occasionally challenges did occur. I asked her about one group interaction and she said:

That group had a big argument about that, trying to defend their case. So that hopefully made them think about it a little more even though no one ever convinced the other person that they were actually right. But hopefully they learned something from each other. (Sarah, Interview 1, October 30, 2009)

While she wasn't completely satisfied with the class as a whole, she was committed to reorganizing seating charts to further support students, and she was having some successes. While it is true that students were self-pacing, that did not mean she allowed them to be unproductive, she expected them to be doing mathematics. *Conferencing With Students: Helping Students Consider, Recall, Think About, and Generalize*

Because Sarah organized the class so that students had few interruptions, much of her time was spent moving from group to group helping them. Several interactions were recorded on video and discussed in the interviews. Her goals in these interactions were typically to avoid telling students rules, and to prompt them to consider specific characteristics or aspects of the mathematics in question to help them understand a particular idea. In the following excerpt Sarah related an interaction with a group who was struggling with the task to identify families of functions that could be used to generate a given graph. Specifically, a girl in one group was wondering whether a function from the inverse power function family $f(x) = k/x^n$ could produce a particular curve. She explained:

I started to ask her "What are some things we knew about inverse functions?" Because I wanted her to see, we talked about that they had an asymptote on the x-axis and the y-axis. So I wanted her to think about that. That's what I asked for next. Next I asked her to think about where the inverse functions never existed. And she said on the x and y-axis. So I wanted her to kind of decide if that was going to help her say that this would be a possible type of function for this graph, or if it wouldn't. So I wanted her to think about if that would help defend it. Or say that "No it's not." Just making her think about the actual qualities of each type of function. (Sarah, Interview 1, October 30, 2009)

Her central goals in this exchange were to prompt the student to recall and consider particular characteristics of the inverse power function family and use that to make a decision about whether this function family could produce a given graph.

Two additional examples illustrate her typical pattern of interaction and goals when she worked with groups or individuals. In the following the students were struggling to change the period of a cosine function from 2π to π . Students had previously worked through a trigonometry unit and had learned to do this type of horizontal compression. In fact, they had even developed a rule for changing the period of the basic trigonometric functions. In this unit they were learning about stretching and shrinking in both horizontal and vertical directions, but had forgotten the rule they had made for the trigonometric functions.

I was hoping, when I was writing things on the board, I would just kind of draw them back to how we came up with a little rule. And we did that if you take 2π divided by b gave us the period. (Sarah, Interview 2, November 4, 2009)

In doing this she did not write the rule on the board, rather she asked them questions about changing the period from 2π to π , and to 8π , to prompt them to remember the relationship between the period of and the b -value in a standard trigonometric function. She further said:

More importantly, if any of these kids are going to take the ACT six months from now, and they have to do something like that I want them to be able to, if they can't remember; they could reconstruct it really quick. So that's why I'm trying to get them to write some stuff down, like "What happens when I do to this function? Oh yeah I remember this is what happens." I'm hoping if we try it with a couple simple examples, and the hard thing for them is trying to change the period to something that doesn't have a pi in it.

So it's a lot easier for them if you say I want the period to change from 2π to 4π . And then they're like Ok got that. Hopefully I can get them to think of those couple of easy examples each time or remember how it's done if they can't just remember how they did it. (Sarah, Interview 2, November 4, 2009).

In this example Sarah tried to help the students redevelop the relationship between the b value of the function and the period. She tried to help students remember the relationship by giving them easier period changes, but overall her goal was for the students to develop or redevelop the relationship as opposed to memorizing it.

So far, I have used examples that illustrate Sarah's efforts to recall and use information and to develop or redevelop mathematical relationships. In this final example, Sarah was trying to help students generalize an idea by providing examples for them to consider. The students were learning about horizontal translations and working to formulate where in the function notation this shift would be represented. She explained:

I didn't really realize this. The book, the very first problem has them make a table for $f(x)$, $f(x + 3)$, and $f(x-3)$. And they call them $f(x)$, $g(x)$, and $h(x)$. And so they wrote the x values and then they wrote the y value. It was a specific function, it was absolute value. So they actually found the y values, and they made this table so it had four rows: the x values then 3 sets of y values. So they made that, and then they were supposed to talk about the coordinate rule. It looks like when you looked at the table, weren't the y values just going up each time? This is your set x value and the y values were what were changing. So yeah, if you look at that table, that sure is what's happening. You're x values went up and your y values went down. So then I thought wow, that was almost like a bad thing to do right there because now they're thinking it's a change in the y not a change on the x -axis. So I didn't want her to look at that for a minute, so I was like let me think of some other things she could look at. So I was trying to hurry and come up with something. Because I had just realized what a problem that was for 2 groups.

And did you hear me say let's do y equals x . And I said, "Nope, let's not do that one." No first I said let's look at y equals x squared. Well then I was getting the other side of the parabola's outputs. So then it was deceiving again now the left side was crossing over when I moved it over. I was like "Ok this is another bad example, let me come up with something where we can look at it." So I came up with y equals $2x$, so

we graphed some points, and then we graphed some points on y equals 2 times the quantity x minus 3 [$2(x - 3)$]. So graphed some points and I was fully expecting her to say, but the graph looks like it's up higher or lower I guess and she didn't.

So I was hoping, it was actually an Integrated 4 Honors student last year who explained it to class this way that made sense to the rest of the students, so that's why I've been trying to say it this way a little bit. If you have x minus 3 in the function, like you're x values have to be 3 higher to get that same output you got on the original function. And he said, "So the whole graph has to happen 3 later on the x axis." And that helped the students understand it more than anything that I had done. So I'm like OK I'm using that one, I wrote it down in my book and I looked at it last week and I was like ok I got to remember to explain it the way he did. That's what I was trying to get her to see. We had to put in an x value that was 3 higher into this new function, than we did the original function to get that same output. So we had to move everything 3 higher on the x axis, for this graph. So it actually had to move over to get that same height. We had to go over further on the x axis to get that same output. So I was hoping she would see it that way. I think the book, it is a little more like, you're doing something to the input, rather than doing something to the output so that's why it's effecting the x . Because if you did f of x and then after that did plus 3, you're affecting the output. And if you do f of x minus 3 you're actually effecting what you're inputting into the function, so that's affect on the x -axis.

And I don't want to just say, you add to go to the left and you minus to go to the right. I never want to say that out loud. I hope to never say that. Because I don't want them just to memorize that, which that's what they're going to do. That's fine. But I want them to really think about it first so I hope to never ever actually hear those words come out of my mouth.

In this extended example Sarah explained her challenge to provide a clarifying example to teach about horizontal translations and how several she chose did not clarify the mathematical idea. She further attempted to explain the idea that you have to put in an x -value that is 3 higher into the new function $f(x - 3)$ to get the same output as $f(x)$. She wanted students to understand this idea and connect it to the function notation, but she avoided simply telling them add to translate a function left and subtract to shift the function to the right because she wanted the students to think about it and understand why that is so.

In brief summary, Sarah's typical interactions involved her trying to prompt the students to consider or realize specific mathematical ideas. Her efforts involved asking students to recall ideas, look across multiple examples, and think about certain things to make sense and abstract the mathematics, realize a relationship, or evaluate the merits of an idea. Many other interactions were discussed in our interviews, but I have chosen just three to illustrate her typical patterns and goals.

Source, commitment, and efficacy to meeting students' real-time mathematical needs. The source of her goals were twofold. First, due to the organization of her class with students working in a lecture-less environment, her goals were derived contextually through observation and interaction and were specific to each instance. In other words, her goals changed in terms of content as she met with students working to make sense of different content. The second source of her goals, to work in the manner that she did, that is to help students perceive mathematical ideas through her questioning while avoiding telling is a goal more deeply rooted in her teaching orientation that flowed through all of her interactions. These sources were derived through observation and analysis of Sarah as a whole and not through direct statements from her.

Her commitment in the area of this goal theme was evident by her persistent and consistent approach to helping students make sense of mathematics without direct instruction. And her commitment to teaching the particular mathematical ideas encountered was strong in that she worked with students until they understood, or prompted them to keep thinking and planned to revisit the ideas in subsequent days and interactions. In this sense her commitment was high as long as she perceived students needs on a mathematical idea.

Sarah's sense of efficacy could be seen to vary according to her success with each interaction. Sarah's sense of efficacy in this goal theme was strongly tied to her sense of efficacy related to subject matter generally. That is, it varies, but is likewise connected to her commitment to revisit topics until students understand.

Checks, Quizzes, Tests, and Grading: Promoting Learning, Delaying Scoring

Sarah devised her homework and assessment policies to delay the grading aspect so as to allow students to make mistakes and learn without being penalized. For example, she did not give credit for doing homework or working through the investigations. Instead, she gave what she called a *check*. A check was administered every couple of days to assess students learning of mathematics central to those days of work. She explained:

I never really wanted to give points just for working the investigation because that's, you should want to do that to learn, not do that for points. So I came up with ways to, you know the way you're going to get points for doing this, is you're going to learn it, and then I'm going to give you a couple of questions, and if you can do those, it's like giving points for doing the investigation. Really it should be the quiz, you're learning this for the quiz. That's where your points come in. If you do this, you're going to learn it and then you're going to do well on the quiz, and that's how you get points for learning. (Sarah, Interview 1, October 30, 2009).

In essence she wanted students to understand that she wanted them to do the homework for the sake of learning, then she would provide opportunities for students to prove their understanding to her. She continued:

However I didn't like the fact that if someone wasn't getting it, it was hurting their grade. Then I thought, I don't really expect that they have it perfect today, I really don't care if they don't have it perfect until the quiz or the chapter test maybe, or the semester final. It's ok if

they're not a hundred percent today. So then I didn't really like grading it harshly, and then a kid getting one out of five points, and being like "oh my gosh I don't understand this." I wanted them to be like keep learning it the next couple weeks, til he could have a five out of five. So, I don't necessarily refer to it as an opportunity for points because sometimes I don't even put them in the computer, and sometimes I do. But every single one that I've actually put in the computer. I've allowed them to either retake, or make corrections, [because] I want them to continue learning it. I don't want it to be like a final like, "Oh you didn't learn it that day, tough!" I wanted them to keep learning it until they learned it.

Her delay in taking student work for a grade was to promote student effort in learning and working until they had learned and understood. Her grading policy was modified to support and accommodate her conception of the learning process, to support the goal that students keep working until they learn, and to avoid the demotivating aspect of grading before students have been allowed to master the content. This excerpt also contributes to our understanding of her subject matter goals. She did not expect mastery of subject matter upon first exposure, she expected mastery to develop over time and further provided an accommodating grading policy that supported mastery learning over time.

Source, commitment, and efficacy to promoting learning and delaying grading through Sarah's assessment policy. As has already been mentioned, the source of Sarah's goals in this area was her orientation to how the learning environment should be organized. For example, the following quote related her reason for not taking homework for a grade. She said, "It might not be their work; and I don't want to punish students' grades. If they either didn't do it, or just don't aren't a 100 percent with it yet." In this excerpt her idea to delay grading to allow students to gain mastery is further confirmed, and we also learn a reason or source for why she avoided taking homework for a grade, she was uncertain that the work was the students. Sarah was very mindful to organize the learning activities and manage her interactions so that students were prompted to develop mastery and put forth meaningful thought Her assessment policy reflected these efforts. For example, she explained how she delayed discussing a quiz the same day students took it because she was uncertain how she wanted to go about it. She said:

I don't want to just say this is the right answer, and then them just try to memorize the answer. I want them to think about it, rather than just, memorize, "oh I should have put 4, let me remember next time if I get to correct I just need to write down a 4 and not even know why." So I felt like telling the answer wasn't going to help them learn anything. (Sarah, Interview 1, October 30, 2009)

This excerpt illustrates Sarah's deliberate approach to organizing learning activities so that learning results.

Her commitment to her goals in this area were clearly demonstrated by her enactment of assessment policy and learning environment expectations. The source excerpt above illustrates her commitment which was further evident in a statement she made about a quiz she gave prior to my observations. She said:

And so the last [quiz] I gave was a pretty big one, before you came. And I actually made a little rubric for it. It was 12 points because it had some intense work on it. And I made a little rubric, and gave it back so they could specifically see where I had taken off points of the rubric. They could talk with their group but they had to put their pencils away so they could talk with anyone in the room about what they did wrong, how would you fix it? Then I made them separate from each other and get their pencils out and now fix everything that they had done wrong. So I wanted them to have some opportunity to fix it or keep working on it.

Her commitment was certain. No statements were made about her perceived level of efficacy within this goal theme. My observation and perception was that although she may not have been satisfied with all measures of her students' learning, she was fairly content with her overall approach to delay grading and thereby foster mastery learning.

Providing the Learning Needs and Supports for Individual Students

Sarah was mindful of and held goals to support individual students learning needs. When asked about goals for individual students Sarah explained goals for several students in three areas, subject matter, social issues, and motivation issues. She described one student who seemed to always know all the content already, or who learned it very quickly. She said:

I've got to come up with something to actually for him to do in class because I don't want him to feel like it's a waste of his time to be here for an hour and a half every other day. And I don't want other students to feel dumb because he can get a hundred percent without even working. And I don't want them to feel like it's ok to sit there and not do anything, because they actually need to do an hour and a half work every other day to be as successful as he is. So when you were here on Friday, I put those problems up on the board, those were mainly for him. And I didn't even know if other groups would even get to them but I knew already he had read all the investigations and he had gotten a hundred percent on the little half sheet that I just checked to see how well they're doing and I knew that I wanted to give him something that would challenge him. That was the whole reason I came up with those. (Sarah, Interview 2, November 4, 2009)

Two goals evident in this excerpt are first to challenge the strong student, and secondly, to challenge the strong student so that the other students see him working: to communicate that everybody is working. This goal to keep everybody working connects with her goals previously discussed to have all students on task and moving forward.

The social part of this goal theme for individuals was embedded in her seating assignments that she purposefully chose. One example she shared was a girl she had found to be quiet. When at last she found someone in the class that she responded to well, she kept her with him when she changed seating assignments. She said:

For some of them they have questions and they're not willing to ask people in their groups, so some of them I tried to move them with people they would talk to or feel comfortable with. I had one who wasn't talking and now I've moved her with this new seating chart and I kept her, I moved her with the same person so she would keep talking. (Sarah, Interview 2, November 4, 2009)

She continued and explained how another side to this social aspect was providing encouragement to particular individuals:

So there's definitely social things for some of them, and then there's content with some of them too. And some of it is finding someone who is a little more patient to work with them, helping them feel like even though they are not moving as fast as everyone else they're going to get it. (Sarah, Interview 2, November 4, 2009)

Sarah wanted her students to be successful and challenged, and had identified specific needs with various individuals. Some of them needed more mathematical challenge, some of them needed a positive social situation in which they could engage, and some of them needed encouragement.

Source, commitment, and efficacy to providing the learning needs and support to individual students. The source of this goal theme for Sarah appeared to be internal. No direct information regarding source was obtained through the interviews, but she held this orientation to support and challenge individual students in ways appropriate and unique to them. Her commitment was strong as she provided specific accounts of meeting these individual's needs whether it be extra challenge problems, or a specific seating assignment. Her commitment and efficacy is accounted for in the following quote:

I would say by now I'm starting to really see where people need help and what things can help them be more successful, like on an individual basis. It takes a while to get there. It's hard only to see them every other day to. But I think with most of my students I'm there.

Sarah's challenge was that she only saw her students every other day, however, she felt that she was getting to the point where she knew them well enough to accommodate them and provide instruction or other supports to help them learn. It is evident that she intended to find ways to support each student in her class.

Long-Term and Personal Goals for Teaching

End of Year Learning Objectives: Figuring It Out and Not Memorizing

I asked Sarah what students would come away with from her class: She responded:

A persistence to solve a problem, that they understand that they have a lot of resources to try to figure out a problem, so whether that means they can make a table or sketch a graph or use their graphing calculator some way. That they have the skills to problem solve and they understand they have the skills to problem solve. Like, "I know that I have things that I could try." Overall that would be one of my biggest goals. I don't expect my students to maybe have all of this stuff down, but they're able to reconstruct it really quick and pull up things

when they need them. They understand how things work so they can figure it out. (Sarah, Interview 2, November 4, 2009)

In previous goal themes Sarah indicated her avoidance goal related to students memorizing mathematical ideas and relationships. She touched on that idea again with her phrasing that she did not expect her students to “have all of this stuff down.” Instead, she wanted students to be able to reconstruct and figure things out when they needed them.

Source, commitment, and efficacy to promoting problem solving and avoiding memorization. When I asked Sarah about the source of this goal she spoke from her personal experience and philosophy regarding mathematics learning. She said:

I think that just even me, there’s things I don’t memorize. I am a good memorizer, but there’s still things in math that I don’t memorize and every time someone says something that I have to stop and think about it for just a second, So it’s like I reconstruct it in my head really quick. Sometimes a student will ask me question and I actually try something in my calculator real quick. And I’m able to figure it out in maybe one second, but it’s because I had to think back through it, like how it worked.

Sarah actively discouraged memorizing while promoting reasoning and sense-making because she felt that memorizing was not as important as making sense. She believed in the power of reasoning when memories failed.

When I asked about her sense of efficacy to develop students reasoning power she responded with the following statement that also captured her commitment.

There are always a few students who either I don’t do a good enough job with not giving in to them eventually or, even if I finally get them to think about the way something works, and I say, “yeah you did that right.” then they just try to memorize. So then they don’t remember how it worked, they just try to memorize something. Which, gosh, that doesn’t usually work, trying to memorize every math thing you ever learned. For these students it just doesn’t work, they haven’t done it enough to just have things solidly memorized, they need to be able to come up with it. So I think that for the most part we’ll get there, but there will probably be some exceptions to it. I try to make them see, I try to never just tell them a generalized rule, ever. Then I think that by helping them recreate the process every time even if I have to help five groups recreate it 3 times this year, by golly by the end of the year hopefully they’ll see they can do that by themselves. Hopefully by me continually doing that the next time they’ll be like, “she’s going to make us go through that whole process again, let me see if I can figure it out again really quick.” So they’ll start to just do that naturally.

(Sarah, Interview 2, November 4, 2009)

Sarah was very committed to this goal and felt that she would have success with most students. She wondered about her ability to help students make sense and worried about making statements, after she pushed students to do the figuring, that would trump her efforts. After a push to make sense, she worried that a confirming

comment would negate her efforts as students might choose to memorize the end result of the process. But overall, she felt that she would get most students to develop their mathematical reasoning so that they wouldn't have to memorize. *Preparing Students for Pre-Calculus; Having a Positive Experience with Integrated; and Becoming Stronger Mathematicians*

Sarah had a concern about the preparation of her students for pre-calculus. Not only did she want students to be well prepared, she also wanted them to have a positive experience and perception from the integrated course. Sarah lived in a community that had used a problems based mathematics curriculum in classes from Kindergarten to 12th grade. But the schools had recently changed to a traditional curriculum in the levels K-8. At the high school level students were given the option of taking the integrated curriculum or the more familiar and traditional algebra pathway. She explained:

I really don't want any of them to leave here with the impression that integrated math didn't serve them well. That's a reality of what's being said in our community. I really don't want that. I don't want any of them to walk out of here at the end of the year and feel that they didn't learn the math that they needed to learn. I really don't want that to happen. I want them to feel like I enjoyed doing this curriculum, I learned so much from it. I am a good math thinker now. So that's not an issue with them. I really want to avoid that issue.

Hopefully they walk out with the actual knowledge that they need to move on to calculus. So me making sure I cover all the content that I'm planning to cover and exposing them to all of that stuff so that they don't see something for the first time that they should have already seen in the next math class they take. That's another goal is to get where we want to get. (Sarah, Interview 2, November 4, 2009)

For Sarah, these goals were strongly linked. She wanted students to be well prepared, and this would, in part, help her meet the goal that students have a positive view and experience with the curriculum. In addition to being well prepared and having a positive experience, she wanted her students to become good math thinkers.

Source, commitment, and efficacy to providing students a positive experience with the integrated curriculum and preparing them mathematically. The source of this goal theme appeared to come from her personal philosophy. She valued the integrated curriculum and values preparing students to become stronger mathematically. Her commitment to this goal theme was evident through all of her efforts in the classroom, many of which have already been discussed. Her perceived sense of efficacy in meeting these goals is stated in the following:

I think that I'll have everyone to that point by the end of this year, I don't see that that will be a problem. And part of it comes from, when they go take the ACT and they feel like they did as well as their friends that are taking the algebra pathway. So there might be a couple of exceptions of students who feel like they didn't do as well as they expected themselves to do. Hopefully they won't blame it on the fact

that they took integrated. I hope that we get there with everybody, but I think last year, I had so many that were so successful on the ACT last year when they were in integrated 4 honors, that that really helped boost their confidence that this was a great choice for them. I had a couple of students last year during their junior year get a 34 on the math for the ACT, and integrated 4, so they I think they all saw “ok this worked well for me.” And I have almost everyone in there got at least a 30 on it that had taken it. I don’t think that I had hardly any that got below 30 on the math part. (Sarah, Interview 2, November 4, 2009).

Some of her efficacy can be attributed to the historical achievement of her students on the ACT relative to their peers. This contributed to her overall value and commitment to both the integrated curriculum and her own teaching efforts. She felt successful.

Personal Goals for Teaching: Improving the Self

Sarah was active in her school community supporting the effort to more fully realize the goals of the Assessment for Learning initiative. She also strongly believed in collaboration and wished she had another integrated 4 honors teacher to discuss ideas with. In these ways, Sarah was a fully active and participating member of her high school community with an aim to improve the teaching and learning there. More personally, she held three goals within her classroom towards improving her teaching. The first of these probably led to the others. Sarah did not want to be complacent with her teaching. She said:

I don’t want them to ever think that I’m content with what I’m doing. I don’t want to be known as the teacher who I’ve heard people talk about, that does it the same way all the time and it’s not working and they keep doing it and they’re not going to change the way they’re doing it. I never want to be anyone to say anything even close to that.

Sarah’s goal was to consistently modify her teaching to avoid practices and policies that were not working.

The other two goals she held for her improvement in this year were to develop greater working knowledge with a new technology, the TI NSpire, and to improve her ability as a facilitator. She said:

One of my major things is trying to get them a little more comfortable with using the NSpire. So the day before you were here, that’s all we did for an hour and a half was an activity using them. I had them last year as my first year. I’m the only one here with a classroom set. So I don’t have anybody to talk to about it and there’s not really anybody else who knows how to use it. So I went to this thing this summer to try to figure out how to use it and I got one for going to the thing so that’s helped because now I have my own. That’s one of my goals of teaching, is how can I incorporate it a little better into some of the things we’re doing and get comfortable enough with it myself that I can help them when they use it?

Being a better facilitator, that’s my job that’s my role in this type of class that I have. Just getting them to keep thinking, getting them to

keep moving, not to stop, and question them and make sure they can really understand and verbalize and explain what they're doing. I want to be this facilitator that allows students to progress at the rate they're comfortable and for them I struggle with quiz dates and does everyone take them at the same time. I want to be better at doing all that but then, some kid gets to a point sooner than another kid and I don't know what then I do with them sometimes, so it's hard. (Sarah, Interview 2, November 4, 2009)

These two goals to better incorporate the TI Nspire and to improve her ability to facilitate learning were significant part of Sarah's thinking as I met with her.

Source, commitment, and efficacy to improving her teaching. The source of these goals were more internal than external. One could argue that her involvement in the assessment for learning district initiative may have prompted some of her thoughts to avoid complacency, but no direct statements were made. Similarly her interest in becoming a better facilitator seemed to derive from personal reflections. Her goal related to the TI-Nspire was similarly from her own disposition. She said, "There's no push from anybody that I use it" (Sarah, Interview 2, November 4, 2009).

Sarah's commitment to these can be sensed in her struggle with each. She struggled with the issue of timing in her facilitation of the class. She continued to modify policies and practices to better meet the students needs as in her evolving grading and homework policies. The fact that she used a technology that no one else was yet using demonstrated her commitment to her use of the TI-Nspire.

Perceived efficacy within this goal theme is difficult. She made no direct statements and she conveyed an interest in improving and modifying her efforts as well as a certain sense of confidence that what she was doing was effective.

Summary

Sarah held goals to organize her teaching and improve her teaching in ways that she felt were supportive and challenging to her students. She was strongly committed to helping students make sense of the mathematics for themselves, to recall, to evaluate, to generalize, and realize mathematical properties relationships and ideas. She held goals to help students feel comfortable and to always be on task. She organized and re-organized her homework and assessment policy to promote student learning, reduce the risk to students' grades during the learning process, and to promote students taking greater responsibility for their own learning. For herself, she held goals to avoid complacency and find ways to improve her ability to facilitate and time classes and incorporate a new technology. Her goals also included teaching and supporting individual students to feel comfortable and working in the class and challenged mathematically.

Appendix G: The Case of Caleb

At the time of observation, Caleb was in his 10th year of teaching and 7th year overall at a well-esteemed private school. For a majority of years at this school Caleb had been teaching the Algebra 2/Trig course to sophomores and juniors. This was an advanced class that went deeply into the trigonometry. Caleb was the technology coordinator at the school and also coached many sports. At the time of observation, Caleb had obtained a master's degree in public policy and was pursuing an Educational Doctorate degree in educational leadership. Caleb was highly regarded as a teacher by parents, students, faculty, and the administration.

Teaching Structure

Caleb began each day by checking students' homework for completion. Then he took questions regarding the homework and worked out these problems on the SMART™ board. Then he methodically delivered lecture notes and engaged students in discussion using prepared slides that followed the development of content in the textbook. His presentations included formal mathematical theorems and definitions followed by examples to be worked out, some of which he did himself and others that he invited students to solve. He often reminded the students of key points and cautioned and alerted them to common mistakes. He also included a bit of levity, which made the class feel comfortable. He frequently called on students to call on other students to come to the board rotating between males and females. Students were not allowed to refuse, but he told them that if they didn't know what to do they could ask the class. The students, for their part, were helpful, friendly, and respectful. His pacing was relatively quick. The lecture and discussion took most of the time in the class. Usually he closed the discussion with 5 or more minutes in his 50-minute classes. In closing he reviewed instructions for the homework, assigned homework, then provided the remaining time to the students to begin working. They were allowed to work in groups or individually while he circulated through the room answering questions. This pattern was repeated each of the four days I observed Caleb.

Overview of Caleb's Goals

I observed Caleb teaching a unit on polynomials. Specifically he taught topics related to finding roots through synthetic division. Caleb wanted to challenge his students mathematically, but help them to meet that challenge. He worked to build student confidence and wanted them to be problem solvers. Caleb wanted students to remember with understanding rather than without and used several devices in his lecture and discussion to aid students' memories. He provided multiple resources so that students could easily review and learn from homework and lectures.

In the following case I divide Caleb's goals into three sections. In the first section I describe his subject matter goals. In the second section I detail a number of goal themes related to Caleb's instruction and organization that he held to support student learning. In the final section I discuss course level and professional goals that influenced his day-to-day teaching.

Subject Matter Goals

At the time of my observation Caleb was in the middle of a unit on polynomials in an Algebra 2/Trigonometry class. Headings on his teaching slides the first day included: (a) factoring the sum and difference of two cubes; (b) the factor theorem; (c) polynomial long division; (d) synthetic division; and (e) the remainder theorem (Caleb, Video 1, November 16, 2009). In the three subsequent days Caleb taught lessons on topics including the location principle, and the rational root theorem. Much of his emphasis was towards teaching processes to find roots of polynomials. In addition to teaching symbolic processes and strategies Caleb also taught students to use graphical representations to identify likely rational roots. Within Caleb's goals to teach students these topics he said:

We talked about roots and zeros and I want them to understand how the roots and zeroes work and how they relate to each other. What is the factor, what is the zero, how does that relate, how does that look on a graph? How does that work together? (Caleb, Interview 1, November 17, 2009).

So they have to understand ok, I found a zero, so what does that mean? If the zero is 2 then that means the factor is x minus 2, and they can piece that together. (Caleb, Interview 1, November 17, 2009).

Making sure that they understand when and how they can use synthetic division because we used it for a lot of different things....

We're trying to teach zeros and roots and factors and how they all relate and how dividing can give you more factors, and how you can find all these zeros, and what's the importance of them, and how that can relate to things we have done in the past, and then let them know this is going to come up again in the future. We need to make sure we understand these concepts. (Caleb, Interview 2, November 19, 2009)

A main thrust in Caleb's classes was to use synthetic division to factor, to find roots, and to find remainders. He wanted students to learn the theorems that informed their use of synthetic division. He wanted them to understand the relation between factors, roots, and zeroes; how these look symbolically as well as graphically; and how these topics connected to prior and future subject matter.

To give the reader a more clear idea of what some typical instruction looked like I include an excerpt where as the class asked questions of Caleb about the homework he responded to a question about the rational roots of a polynomial:

When we go over the homework we are pretty much just step-by-step going through the steps. It's really not even so much about solving the problem as it is going through the steps to solve the problem so that they have that in their mind to get them ready for the quizzes and the tests, or anything else. I don't care if they can solve a particular problem I want them to know how to solve all problems like that so we need to go through the steps. So on the problem like you have here [finding rational roots of a polynomial], we talk about how do we find the possible rational roots and we remind them that we look at the factors over the constants. And they're the numerators and the constants of the leading coefficients and that's the denominator. But the ones that ask questions said, what are those numbers for again? So

we had to point them to the graph and said, When you look at the graph, and you see where the x intercepts are, are there any x intercepts that fall into one of these numbers in the box, that are possible rational roots? And can we use them to plug into our synthetic division, and find out if it is an actual zero, and then once we find out it's an actual zero, if it's a cubic polynomial then what's left over is a quadratic and now they know how to solve all the quadratics because we just did a chapter on quadratic equations. So mainly it's going through the steps so that they remember, "Ok I'm solving this kind of problem I need to do this, this, this, and this." (Caleb, Interview 2, November 19, 2009)

This example illustrates how Caleb worked to help students know the process for finding rational roots by using the rational root theorem, choosing likely roots by examining a graph, using synthetic division to verify a choice and reduce a cubic polynomial to a quadratic polynomial that students already had skills for solving. A great deal of Caleb's effort was directed toward helping students connect the processes with the ideas and alerting students to key points and common mistakes.

Source, efficacy, and commitment to teaching students the aforementioned subject matter. The source of these subject matter goals was most likely the textbook Caleb was using. But he also had a bent toward connecting skills and ideas, not that the textbook he used wasn't organized that way, but as is demonstrated in the excerpts above, he believed in *relating* ideas. Caleb's commitment to teaching these topics was evident in his daily instruction and repeated return to subjects he felt students were struggling with. Caleb was a confident teacher, though he knew some students were struggling he generally felt effective in his instruction. He said: "There are some kids that are just not fully pulling together how all the concepts are working together" (Caleb, Interview 2, November 19, 2009). Then he spoke about the class more generally, "I feel pretty good that typically in my classes I would say a large percentage gets pretty good understanding of concepts (Caleb, Interview 2, November 19, 2009). Nevertheless, Caleb was mindful of the struggling learners, and I address his goals in this area in a section below.

Goals that Support Student Learning

Helping Students Learn What To Do and When To Do It: Preview, Review, and Repetition

Caleb put in place several features that provided opportunities for students to review the principles and skills he taught. These include: structuring the lecture and discussion to parallel but not duplicate the text; previewing homework by explaining the instructions; providing on-line video of each class; and, checking homework the next day. Caleb believed in repetition and each of these features of his teaching provided such. On the topic of repetition Caleb said:

I think the big thing on that going back to what we do is I probably over simplified synthetic division so I wanted them to say every time "numbers below the line we multiply, numbers above the line we add." So that's one of the things I try to do in class is make them keep repeating over and over again, what we do, what we do, what we do, what we do, and then it gets stuck in their mind. But again like the

whole this is the factor that they leave out, we'll say that all the time. The other thing that's nice about this too, is we just finished a section or chapter on quadratic equations, so this is review of stuff that we've already done. This factoring of $x^2 - 3x - 4$, that's why I could say things like, "What two numbers multiply to equal negative 4, and add to equal negative 3?" because that's how we came up with our factors, that's all stuff that we've previously covered. So we just use the same language when it comes up again. (Caleb, Interview 1, November 17, 2009)

In this excerpt Caleb described his use of repetition and how it extended beyond his lecture to his use of language from one chapter or book to the next. But his goal was not to teach repetition, his goal was to teach students the ideas, what processes to use and how to use them. Repetition was merely the teaching strategy for accomplishing this. Additionally, in the middle of this excerpt is a point he made about reminding students to avoid the common mistake, which contributes to his goal to learn what to do or what not to do. Caleb also explained how in the course he was teaching that they used a separate book for trigonometry, but they "keep the language the same and usually that makes it a little bit easier for them because now they're hearing the same thing over and over again" (Caleb, Interview 1, November 17, 2009). In these ways Caleb made it his effort to simplify the learning for the students by using the same language so they would know what to do and thereby avoid needing to learn new phraseology.

Within Caleb's organization of lecture notes is yet another mode of previewing the content, homework specifically, so students would know what mathematics to do and when to do it. I asked Caleb how he organized his lecture notes, how he chose problems. He explained:

I grab problems out of the book and I grab directions out of the book because that's what they're going to see in the homework and that way they can have that language and they can go back in our book and look at that. I don't like teaching straight from the book because if the kid doesn't get the book then they're not going to get you either kind of a thing. So we kind of try to go from different approaches as we go through and it works out pretty good. (Caleb, Interview 1, November 17, 2009)

Here Caleb explained his effort to choose and organize his lecture notes so that the problems and instructions would align with the text, and yet he avoided using the lesson development from the text so that students would have multiple viewpoints and explanations of the same ideas and skills. This illustrates again how he organized learning activities in parallel to simplify the learning path for students. Caleb was not trying to *dumb down* the mathematics, rather he was trying to organize the learning activities in such a way as to enable the students to more readily make sense of it, to avoid disorganization that would obscure the ideas and processes he was trying to teach.

As he finished his lecture notes, Caleb consistently transitioned to the last few minutes of class where students could get started in the homework by rehearsing the instructions. Rehearsing the instructions was a feature easily

observed in the classroom, a feature that contributed to his repetitive effort to teach students to know what mathematics to do and when to do it. He explained:

What I'm really doing is just recapping what we already talked over in class. Because typically my notes are in the same order as the instructions, what they're going to be doing in the homework. A lot of times kids gets confused and they start intermixing the instructions. The other thing I like about going through the instructions too, is I tell the kids when they're studying for tests, "Don't study a bunch of problems. Because if you look at the problems that you've already completed, of course you're going to know how to do them, they're right there in front of you. Look at the instructions and then based on the instructions say, "If I get these instructions then I need to do this step, this step, this step." So now they're understanding the concept and what needs to be done, rather than saying, "Oh I know how to do this problem by looking at a problem that's already completed." So I like to reinforce the instructions and keep them consistent from homework, notes, quizzes, and tests. (Caleb, Interview 1, November 17, 2009)

Here Caleb explained his effort to review the instructions and focus on the instructions to help students know what they needed to do. Furthermore, he keeps these instructions consistent to avoid confusing the students. In similar fashion Caleb presented a quick review for an upcoming quiz by reviewing instructions for math problems. He explained,

I go over the instructions and say, "Ok these are the instructions and this is what we did with these instructions." So that they'll recall that. I really like to do the instructions again because then they say, "Ok when I hear these instructions I need to be thinking about doing synthetic division or I need to be thinking about long division." (Caleb, Interview 2, November 19, 2009)

These features in Caleb's classroom were for the purpose of helping students know what to do and when to do it.

To meet the needs of students who struggled with knowing what to do, Caleb provided video of each class lecture on-line. He explained that initially he video recorded his classes to provide instruction to a couple of students who for different reasons missed many days of class. Then he found that other students were using the video. He said:

Kids started saying, "Can you keep recording because I watch these videos to study for quizzes and tests and things like that?" So I've been doing it ever since for the last few years. [And] they're able to go back in and just rehash things, so they have all that stuff at their fingertips, and it's updated before they're out of school so by the time they get home if they need to see something they can see it. (Caleb, Interview 1, November 17, 2009)

He explained that the video allowed students to "rehash" problems. Similarly, Caleb took homework questions at the beginning of the next day. He said,

So then we review questions that they might have had at the beginning of class and sometimes it leads into the next class. So and I like to do that review that way it can be fresh in their mind especially if it's going to funnel into the next section. But also as a review to get them kind of sometimes kids get home and they have no idea even though they thought that they understood it in class. Usually they get on the website because I have a lot of stuff on the website but then I like to reinforce, Ok this is what we did and this is why we did it.

(Caleb, Interview 1, November 17, 2009)

Answering homework questions then met students' needs that were not met by the video, it provided answers to specific questions so the students could know what to do with specific problems.

Within this theme I have detailed how Caleb provided features that helped students learn what to do and when to do it. However, each of these features could also be discussed as goals in and of themselves, that is the goal to parallel lecture notes with the text, the goal to explain instructions for homework problems, and so on. But within these features was a coherent theme of goals, to help students know what to do and when to do it through the means of features that provided repetition. He made his lecture notes parallel the text; he recapped lessons by explaining the instructions for the homework; he provided video of his classes so that students could review how to do problems; and, he reviewed the homework each day to help students connect problems with what to do. While each feature held slightly different meaning and intent for Caleb, I have combined them because each of these features were used to help students know what to do and when to do it.

Source, commitment, and efficacy of features that provide review and repetition, that help students learn what to do and when to do it. The sources of these features are mainly from Caleb's personal development as a teacher. In time he found strategies or the need for strategies to meet students needs and to help them understand what was being asked of them. For example, he described how he came to explain instructions and keep them consistent across homework, quizzes, and tests:

I think I probably picked it up through not doing things as well as I could've when I was a younger teacher. What was happening is I would give them all these things and I then would write some instructions for a quiz and they would turn them in looking baffled and we'd go over the quiz and they'd say, "I had no idea what to do here." And I was confused, I'm like what do you mean we've done these problems? So I think it was one of those things to where the consistency reinforced their learning in that. But I don't really think I picked it up from anybody, I think it was just from This is not working what do I need to do to try and reinforce what needs to happen on these quizzes and tests. (Caleb, Interview 1, November 17, 2009)

The development of each of the features explained in this theme came as Caleb sensed a need to provide them to students as a means to reduce confusion and provide multiple resources for the students to review the material.

Caleb's sense of commitment to each of these features was high. Although Caleb made no explicit comment relative to his commitment to using these features, his daily use of them conveyed his resolve to using them daily. His sense of efficacy was similarly high. I separate two comments he made regarding efficacy as they relate to different teaching features. The first comment regarded his sense of efficacy towards his explaining of instructions. He said, "I would say it's effective in the sense that kids aren't saying I don't understand these instructions. Whether or not it's helping them solve the problems I would say for the most part it probably is" (Caleb, Interview 1, November 17, 2009). He felt similarly about his class web site and his posting of videos of class lectures:

So I think for the most part it's been pretty helpful for students. I think the repetition is helpful that's why I think the website and having the notes readily accessible for them I think having videos where they can watch it over again. That kind of stuff has really been beneficial to them. (Caleb, Interview 1, November 17, 2009)

Keeping Students Focused, Helping Them Remember And Understand

Caleb used several strategies to help students stay focused during lecture, and remember and understand the material. These include his calling on students to come to the board and work examples within his lecture and discussion; providing video for those who he felt learned more through auditory and visual senses; using student friendly language; and connecting new subject matter to subject matter previously learned. Within the lecture and discussion Caleb typically progressed by presenting definitions and theorems, then working out a problem that was connected to the definitions and theorems. Then he asked for a volunteer to come work the next problem. From then on, when he wanted someone to come to the board he called on the student who had previously been at the board and invited them to choose another student of the opposite sex, thus alternating between boys and girls. The students for their part, though they may have held some anxiety towards this device, cooperated completely. Caleb explained his goals for this activity:

It makes the kids a little more interactive and they're always on their toes because they know that they need to be paying attention because who knows when I might be called up there and they know that a lot of times I won't even call them, I'll say alright so and so you just finished, pick another student. It just breaks up the monotony when the kids get up there because usually something funny is done so the kids can laugh a little bit, have fun with it. It works out pretty good. (Caleb, Interview 1, November 17, 2009)

Caleb had several reasons for calling on students, some of which will be discussed later, but one of his primary reasons as illustrated here is it served to keep students engaged. For Caleb, keeping students engaged was a way to enhance the students learning.

One of Caleb's other goals within his strategy to call on students was to help students remember particular processes by associating them with the student who had been up to the board. He said:

What I like about them going up to the board is now kids can link problems with a certain person so I can say, "Remember when so and so did this?" they know exactly what so and so was up there for the most part. (Caleb, Interview 1, November 17, 2009)

In fact, later in the interview process I asked Caleb about an interaction he had with a student and he explained that he was prompting the student to remember a problem that a peer had done at the board. Again he explained that it was his intention to have students up at the board, in part, so that he could help other students remember particular problems through the association of problems with peers who had done them at the board.

In the area of helping students stay engaged, Caleb encouraged many students to not take notes. He explained his reason in the following two interview excerpts.

It gives the kids the opportunity to not worry about having to get all the notes down. They can print them out later. (Caleb, Interview 1, November 17, 2009)

Then I've got the kids that are the visual kids Those are the ones that I really encourage to watch the video again tonight and those are the ones that I say do not write notes in my class. So my goals for them is to pay attention and print out the notes, to pay attention so they'll have a visual concept of what's going on in here. My goal for them is to understand what's going on. (Caleb, Interview 2, November 19, 2009)

Caleb referenced his website for his goals here. He felt that many students needed to pay attention and not be so worried about getting down the notes. Therefore, he provided both the notes and video on-line, thereby, freeing those students to engage more deeply in lecture and discussion.

Caleb also promoted understanding and retention of ideas through his use of learner friendly language. This was a significant part of his identity as a teacher. He said:

We just did max's and min's and they talk about how the max is when your graph is increasing, and it hits a turning point, and is decreasing. So we simply call it, that's a hill if that's a max, and it's a valley if it's a min. And then you've got kids who live out in the country and they want to know if you can call it a mound and a ditch. And I'm like, "You can call it whatever you want as long as you remember." We teach them the correct mathematical terms, but then we also put it into terms that they'll understand as well, so that when they're taking the test, they can say, ok this is the mound and ditch or whatever they want to call it. So it's the same thing with a lot of that [topics]. I try to put it in language that's easy for them to recall. (Caleb, Interview 1, November 17, 2009)

Caleb's goal here was to present both correct mathematical language and learner friendly language that they understood and to which they felt connected.

On a variation of the theme of using student learner friendly language, Caleb taught some topics by connecting them to topics students already understood. In

particular, when he taught the topic on polynomial long division he began by illustrating long division with whole numbers. He explained his goal within this strategy:

To ease their minds. Sometimes the kids start getting all tensed up when they see things that they're not comfortable with. Well they're pretty comfortable with doing long division with numbers only. And the concepts for doing long division like they did in 5th grade and what we're doing with polynomials a lot of the concepts are the exact same concepts. So I think more of it is to ease them in, get them more comfortable, and then being able to show them "Look here we did this and here we're doing the same thing." So now they can kind of relate it to something that they know. (Caleb, Interview 1, November 17, 2009)

In this excerpt we learn that part of how Caleb thinks about teaching is to connect new content to already understood content. He does this to help students make sense of the new subject matter and to ease their minds. Using this strategy he helped students understand how to classify polynomials by relating this topic to the topic of classifying numbers, a topic they had covered earlier in the year.

In this goal theme I have illustrated how Caleb used different strategies to raise the level of engagement by calling on students and suggesting to some students to not take notes but to pay attention and review on line at home. Additionally he used strategies to help students remember and learn by linking new ideas to familiar language, and familiar previously understood topics

Source, commitment, and efficacy to keeping students engaged, and helping them understand and remember. Caleb did not explain the source, or his level of efficacy or commitment to all of these areas in this theme. He explained his effort to call students to the board as having many reasons, but perhaps only one source. He said he picked it up from observing other teachers.

I saw other teachers doing it, and I was wondering when I first started teaching, I was like man this would be a whole lot faster you can get more done if you just do it yourself, but then you start contemplating the understanding that goes along. You know the students are even more likely to ask a student that's up there a question than they are when I'm up there a lot of the times. So that works out pretty well too. But I think it also kind of keeps them thinking Ok I need to follow along with this because I could be called to go up there so there is a little bit of that going on. But also it breaks up a lot of the monotony, they don't need to hear me all the time. (Caleb, Interview 1, November 17, 2009)

Caleb related how initially he picked up the idea to call on students from other teachers, but additionally saw other benefits to call on students, which gave him further cause to use the strategy. He said calling students to the board opened a learning space in the classroom for other students to ask questions. He believed some students are more likely to ask questions of each other than him. I take this theme up in the next section.

Relative to source, Caleb similarly had many reasons for providing video and notes, on-line, to his students. He said:

Now they don't have to worry about writing down every single note. And I encourage them not to, because you have the kids that write down every thing the teacher does, and then they look at them when they get back and they don't have any understanding because they focused so much on writing down the notes, that they didn't focus on the instruction. (Caleb, Interview 1, November 17, 2009)

Originally Caleb began posting video to his website to meet the needs of absent students, but it has since evolved to providing a way to meet the needs of learners in his classroom who can focus more on meaning and less on note-taking.

Caleb did not explain the source of his goal to use learner friendly language, but he did comment on his perceived level of efficacy. He said he felt it "works pretty well" (Caleb, Interview 1, November 17, 2009). He further commented on how effective he felt about the strategy to connect new content with former content, such as when he taught polynomial long division by first reviewing long division with numbers. He said:

I found that to be effective only because I know the first time that I taught this and we went straight to polynomial long division it was not pretty. It took a couple days to kind of get them where they're figuring everything out. But when you show them how it relates with the easier problems that they're used to, it seems that we can get the understanding there a lot quicker. (Caleb, Interview 1, November 17, 2009)

Overall, Caleb felt efficacious with his goals to keep students engaged, help them remember and understand.

Caleb's commitment to these goals was again represented more by his actions in class and in service to his classes than through his words. During my time of observation with him, he frequently called on students and later helped others remember content by referring to those students who had been to the board. He posted video daily, and used learner friendly language in multiple ways in addition to those discussed here.

After School, Before School, During Class: Features that Enable Students to Ask Questions, Make Mistakes and Learn in a Low-Risk Environment

Caleb recognized that his expectations for students were high and that often students needed a learning space in which they could learn from their mistakes. He was also mindful of his students' anxieties to ask questions directly to him during class lecture and discussion. To meet these learning needs Caleb provided several features during and after class. In class features included his review of homework at the beginning of class, his calling students to the board, and his timing of class to allow a few minutes at the end, and his posting of all homework solutions. Out of class features included his maintenance of his website and his availability to meet with students before school. Regarding before school availability, Caleb said,

But one thing that I really emphasize here is that if you get stuck on some of your homework come in the very next morning we'll get it taken care of don't wait until the end of the week. And a lot of those

kids just need that one on one time where they can feel a little more comfortable like they're not holding back the other students. I think some of them have this apprehension that they're going to hold everybody back if they ask the question. So coming in in the morning they don't have that apprehension and we can work things through and now instead of worrying about what everyone is going to think when they ask this question they can just get their questions out and we can work them out. So those are the students where I say You need to come in tomorrow morning so we can talk some things out. And they'll complain about how they have to get up early to get here. But usually I'll have a pretty good group of kids who come in in the morning. (Caleb, Interview 1, November 17, 2009)

The goal here for Caleb, is to provide opportunities for students to learn, but in conjunction with other things he said in the interviews, his goal was to organize and provide low-risk learning spaces that helped students feel comfortable asking questions.

In similar fashion Caleb's short use of group work also supported his goal to provide low-risk learning spaces where students felt comfortable asking questions. He explained:

I don't mind them working together on homework, any of that stuff, I think peer learning has been very beneficial to a lot of them because they don't want to ask their teachers but they'll ask their friends right next to them. And some of the kids are really good teachers and they're very patient so that's why we also so the group stuff at the end. (Caleb, Interview 1, November 17, 2009)

Caleb felt similarly about calling students to the board. He said, "You know the students are even more likely to ask a student that's up there a question than they are when I'm up there a lot of the times" (Caleb, Interview 1, November 2009). Caleb also provided this type of low-risk learning space when he routinely asked for homework questions at the beginning of class and placed all notes and homework solutions on his website. Caleb wanted students to have many opportunities and venues from which to learn.

Aside from teaching features that provided low-risk settings that enabled students to ask questions, Caleb had a homework policy he designed so that students could make mistakes in the learning process. He said:

When I check homework I look for completion. I weight all my grades so homework is 15 percent of their total grade. And the reason why I check their homework just to make sure that they do it is I want them to try every problem, and so I expect them to try every problem and work as far as they can and they put marks next to the questions that they have then I can go ahead and check those later on. So then we review questions that they might have had at the beginning of class and sometimes it leads into the next class. So and I like to do that review that way it can be fresh in their mind especially if it's going to funnel into the next section. But also sometimes kids get home and they have no idea even though they thought that they understood it in

class. Usually they get on the website because I have a lot of stuff on the website but then I like to reinforce. (Caleb, Interview 1, November 17, 2009)

Furthermore, Caleb weighted his grades so that tests were 45%. He believed that this grading policy communicated the need to master subject matter, but also provided a low-risk environment to make mistakes. In fact, Caleb provided worked out solutions to every problem he assigned. These solutions were available during class work time as well as on his website. He said:

I don't want them to get so bogged down with getting frustrated not knowing where to go that they quit. And I'm trying to encourage them, "Don't quit. You can look and see what the next step is and you can say, "Oh ok I'm just forgetting this step."" And then they'll continue on. Same reason I don't take homework for credit, based on correctness, is because I want them to do every problem, if they do all but one problem, they only get half credit for their homework. I want them to do every problem, and I don't want them to get discouraged, so I think having the homework there is kind of a safety net for them to say, "ok I can look and see." But they know when it comes on a test they have to do it. So some kids I'm sure will go there and just copy down the answers, which is fine by me, because when it comes to quiz and test time, those kids are not going to benefit. Tests are 45 percent of your grade, homework is 15. So how beneficial is that going to be if they're just copying down answers? Not very. (Caleb, Interview 1, November 17, 2009)

Caleb described his goals in this area as wanting the students to do every problem and not getting so discouraged that they quit. He organized his homework policy to emphasize learning and minimized the percent that homework was worth to lessen the impact of making mistakes. Yet, he provided all the answers so that students could look and see and learn.

In one other area Caleb specifically articulated thoughts along this theme. When Caleb called students to the board they were often anxious. He explained: Well I don't want them to get up there with fear thinking that if they mess up everybody is going to laugh or something. And that's why I made the comment, because I always do, when they look at me with these I have no idea what I'm doing eyes. Like "You're the teacher now. You don't have to know what you're doing. You ask the class what to do and they tell you what to do." And that gives them a little more comfort and we're in a good situation here too where the kids really do respect each other and don't have a problem. (Caleb, Interview 1, November 17, 2009).

Caleb did make this comment consistently, and he did mitigate embarrassment and establish a safe classroom for students to learn even when they were uncertain. The essence of Caleb's goals in this theme were to provide a safe environments where students could ask questions, could make mistakes, could learn.

Source, commitment, and efficacy to providing low risk learning environments where students could ask questions, make mistakes and learn in a low-risk

environment. The goal in this theme, to provide learning spaces that enabled students to ask questions and make mistakes in low-risk settings, underpinned many of Caleb's teaching features. Where the goal was most clearly expressed was in relation to his homework and grading policy. When asked about the source of his grading and homework policy he said:

When I first started teaching I gave them the even problems because I didn't want them to know the answers because I [thought] they're just going to write down the answers. So I would give them the even ones and that was that and then when I started realizing that in the learning process scheme of things, them having the answers might be beneficial so they can work their way backwards or if they make a mistake they can go through their work, or they can see the work being done and see what steps are missing. But when I first started teaching I made it very clear that I was giving them problems that they did not have the answers to and they were going to have to make sure that they did it and figured it out and did it correctly. And now it's not so much about that, it's not about the correctness of it. It's about the understanding of the concepts and being able to figure it out. (Caleb, Interview 1, November 17, 2009)

As this goal theme was embedded across teaching features for which other goals were identified I did not recognize it as a theme to further query about the source, his commitment, or his perceived level of efficacy. However, in my judgment Caleb's teaching features provided the low risk environment that he was seeking and he seemed satisfied with those features as enabling students to ask questions, make mistakes and learn.

Challenging Students: Developing Their Confidence

"I never want to be known as the teacher that all the kids say take [him] because he's the easy teacher. If I'm ever known as that, that will kill me" (Caleb, Interview 2, November 19, 2009). Caleb wanted to avoid the label of being the easy teacher, and similarly wanted to be known as a challenging teacher. This particular goal, to challenge students mathematically, was evident in his selection of lecture and discussion examples, homework problems, and quiz and test problems. Caleb explained how he chose examples for his lectures and discussions:

I like to choose the more challenging problems because I really want them to think. I want them to look through it and say Ok how am I going to solve this problem? What did we do before? So I like to choose ones that are more challenging because I want them to be prepared when it comes to problem solving in general, but when we take the tests and the quizzes, my tests are going to be the ones that are going to be more challenging to them to make sure that they understand the concept completely, not just I know how to solve this easy 1 part of the concept problem. (Caleb, Interview 2, November 19, 2009)

So what I do for the homework is I make sure the homework is just as tough as any quiz or test problem I'm going to give. I say this a lot. I say, "I can't make a problem any more difficult than this. So I give

them all different scenarios punched into one problem and once they've got that down now they're comfort and confidence is a lot higher because they know they're not going to be surprised by anything at the end. I try to pick problems in the book that are going to be more like what I would choose. Because I make my own tests and quizzes, I don't like book tests and quizzes, I think they're, I don't think they're challenging enough. So I try to pick the most challenging problems in the book so they will complement what they're going to see, when we get to test and quiz time. (Caleb, Interview 1, November 17, 2009)

The goal to challenge students mathematically was expressed in Caleb's choice of lecture problems, homework problems, and quiz and test problems. He wanted to avoid surprises for the students, and at the same time, he wanted to build confidence for the students: that by doing challenging problems his students would gain confidence for his tests and quizzes. But in other ways he hoped to support them in his challenging course. The goal themes and their accompanying teaching strategies previously described helped him provide that support. One example from the interview, he said, "I just want the kids to succeed. I want them to do well, and understand what's going on in the class. So I'm here every morning an hour before school starts" (Caleb, Interview 2, November 19, 2009)

Source, efficacy, and commitment to challenging students and developing their confidence. Caleb explained how his selection and use of challenging problems, especially on the homework developed through experience. He said:

I think this is probably based on past experience and evaluation and watching other classes. And this really frustrates kids apparently a lot. They'll get there and they'll get these homework problems that are very minimal, the easiest possible problem you can have for the material being learned. And I'm sure the teacher most likely was "I just want to make sure they know the steps and the concepts." But then when it comes to quiz and test time they get these insane problems, that the kids are like "we've never seen anything like this." (Caleb, Interview 1, November 17, 2009)

In his experience, Caleb realized that if the level of difficulty of problems was different between notes, homework, quizzes, and tests, that students would feel frustrated. Because Caleb had a disposition to challenge students at the highest level, he chose to make the challenge uniform across these areas of his class. As this effort is rooted in Caleb's conception of teaching and given his overall concern to avoid being the easy teacher I consider his commitment to this goal as high. Caleb referred to his level of efficacy as he reflected on all the supports he provided for students. He said:

And it drives me crazy when you have these capable kids that are not challenging themselves. So those are some of the things that I think about. Am I giving them too much? Usually once I think it all out, I start thinking about the kids at the beginning of the year who said, "I don't like math, I'm not good at math." And then they end up continuing on to the accelerated Precalc and then AP calculus so I

stick with it. But I always have those doubts at the end because I'm not a spoon feeder, I don't like to spoon feed at all when it comes to those things. (Caleb, Interview 2, November 19, 2009)

Caleb's sense of efficacy was high as he reflected on the end result with students. He felt efficacious because he saw that students were leaving his class having overcome their fear and lack of confidence and moving on to additional challenging mathematics courses.

Meta-Level Teaching and Professional Goals

Developing Students Conceptions of Mathematics: Learning, Doing, and Connecting

Within this theme I explain Caleb's meta-level set of goals for teaching mathematics. Caleb wanted students to "understand the concept, not just memorize [to] get a good grade and move on" (Caleb, Interview 1, November 17, 2009). Further on this issue of learning and doing mathematics Caleb explained his main goal in teaching mathematics. He said:

As the year goes on in this class, it starts to be more of a here's all the tools and now you've got to use them to figure it out. Instead of right now we are kind of building up this toolbox for them. So at the end, now that they've got the toolbox, they've got to figure it out, they've got to do some discovery on their own. And they hate it at first, absolutely hate it. But at the end when they start solving things, that's when they get the most excited. So I think that's kind of the main goal is let's get them excited about the math, let's get them excited about learning and problem solving so when they get out, it doesn't matter if they remember all the stuff they've learned they've learned how to be a problem solver and how to figure things out. (Caleb, Interview 2, November 19, 2009)

Caleb wanted his students to become problem solvers. He spent much of the year building a set of "tools" that the students would use to solve problems. And in the end he felt that problem solving was more important than remembering all the details of things.

Caleb had developed and was developing projects and supplementary learning activities so that students could engage in and learn about practical applications of the mathematics. This helped him meet his goal, in part, to teach problem solving. He said:

My biggest goal this year is bringing in some practical examples of mathematics... I'm trying to bring more practical knowledge in. So trying to plan these things where [professionals] can come and talk about "this is why math is important, this is what it can do for you. This is how I use it in my career." (Caleb, Interview 2, November 19, 2009)

In addition to having people come to talk about how math is used in their careers, Caleb implemented at least one major application project regarding bridge design and construction. Part of this practical application involved building the sense of problem solving he wanted, but also met his goal to build student confidence and preparation for life. He explained:

It's a bridge design project but its all computer generated but all the math is there and everything else. So it's a really neat little deal. And we try to build the cheapest bridge where this truck can get over, it's all animated. And they get into groups so they have to work in teams, and it's a competition to build the cheapest bridge. Well kids will spend more time on that than anything I give them in the entire year. They will spend their weekends because now it's a competition and it's fun for them. But they'll spend all kinds of time on it. So that those kind of projects are really good for those kids that need to interact with the math to do the stuff and then apply the math. And we're trying to build more of that too into the curriculum just so they can see all the kinds of things that math is involved with.

I have kids that when I say you can work in groups, 5 or 6 kids that want to work by themselves. I tell them in real life you're going to be working with people, That has nothing to do with math, but it has everything to do with the whole purpose of preparing them for their life outside of high school. Confidence wise, I'm big on confidence, I think the kids, right or wrong, should have the confidence to try things, which is one of the reasons why we do the board, but also the bridge project, they'll try things and fail and some kids will get so frustrated because they'll build 15 bridges before they get one that even works, and they're not even trying to make it cheap, they're just trying to get one that works. So they'll get frustrated but that whole perseverance to keep on trying and keep on trying. And they'll [persevere] with the projects. And sometimes what I fear with math, just doing math out of the textbook, if they don't get something they'll just give up and that's not good. I want them to keep on persevering and so the projects they'll just keep working. (Caleb, Interview 2, November 19, 2009)

Doing projects and bringing in practical applications enabled Caleb to meet his goals to teach how mathematics is meaningful. These also helped him to teach perseverance, build confidence, develop group problem solving and people skills, and prepare students for life after his class.

Source, commitment, and level of efficacy to this goal theme. Little direct information was obtained regarding the source of these goals, or Caleb's commitment, and perceived level of efficacy. My observations and impressions were that the source of this goal might have been the math faculty at his school because he used the pronoun "we" when he explained the goal. He seemed to feel efficacious because he explained that students would spend more time on the projects than regular textbook work. He also seemed committed, explaining this was his biggest goal for the year, something he was trying to implement more of.

Personal Goals To Improve His Teaching And Students Learning

"I don't want to be complacent and so every year I try to say I'm doing something new this year, and not necessarily new for new sake" (Caleb, Interview 2, November 19, 2009) This expression indicates Caleb's personal initiative to improve his teaching. The focus of this theme is how and what he did to improve his teaching

and students learning. Caleb gathered information on student understanding and thinking from four different sources. Caleb learned and gathered this information from students who came to the board, from expressions on students' faces during class lecture and discussion, from students who came for help before school, and from the pre-calculus teacher that his students went to following his course. I was first apprised of this effort when Caleb explained his purposes for calling a student to the board. He explained:

Somebody will get up there and say something a little bit differently than I say something, and that might stick and then I write it down on my legal pad and I might steal that from the kid for next year. Or it might be something that somebody would say, "Oh I see when he did this." And it works out really well. Then a lot of times when we do things that have multiple ways of solving I like to have the kids go up there because I like to see what the norm is what do kids like to do more so than this. Kids don't like to write things in vertex form, they like to use the equation for the axis of symmetry and then plug it in to find the y. That's how they like to find the vertex. So it gives me an idea of ok, what are kids choosing more so than others so I can do more examples and that type of a thing. (Caleb, Interview 1, November 19, 2009)

Similarly he explained gathering information from students expressions and asking them what they understood when they come in for help before school. His goals in this area were to improve his own delivery of instruction, as well as gather information of students understanding of preferences.

Outside of his students Caleb had made an effort to ask the pre-calculus teacher about what his students needed to better understand. He said:

We do this every year, especially when I first started working here I said, "Ok what are the kids weak at when they come to you? What are they not doing as well as they should be doing at the beginning?" And when I first started teaching here he said trigonometry, so they really struggled with trigonometry. So we really started hammering trigonometry and then going beyond what our book has to offer. And the next year I asked again he said they're doing great at trigonometry. I said well what can we focus on to get them even more prepared? So when we go and talk to the accelerated pre cal my students tend to do better because they're more prepared for how he starts his class. (Caleb, Interview 2, November 19, 2009)

It is not clear if Caleb continued this effort each year, but it is clear that his goal was to improve his students preparation through seeking information on the areas in which they struggled.

Source, commitment, and efficacy to improving as a professional. The source of Caleb's effort to improve his teaching came from his own orientation. He said, "I cannot have greater expectations for my kids than I have for myself. I can't ask a kid to work hard and then me not put I the work" (Caleb, Interview 2, November 19, 2009). His efficacy seemed high as he indicated his students improving year over year as they went on to the pre-calculus class. His commitment was similarly high.

He explained, “I’m constantly using legal pads to write down what works what doesn’t work what do I need to tweak, what do I need to try sort of thing. I don’t use lesson plans I use legal pads and computer” (Caleb, Interview 2, November 19, 2009).

Summary

Caleb held goals to challenge and support his students to meet the challenge. He wanted students to learn the processes and link instructions to processes. He wanted to provide repetition to help students learn. He wanted to provide a safe environment and multiple settings in which students would feel comfortable asking questions. He wanted to teach students in both the language of mathematics that made sense to them, and the language of formal mathematics. He wanted to help each student succeed and to be prepared in life. He wanted students to develop confidence and learn to persevere. He wanted students to understand the applicability of the mathematics he taught and so he sought to introduce applications through projects and invited speakers. To meet these goals he utilized a number of strategies. Each strategy alone met more than one goal. I have organized goal themes according to central goals as opposed to by strategy.

Appendix H: The Case of Kathy

Kathy was in her 26th year of teaching mathematics. She had spent the majority of these years teaching 8th and 9th grade classes at a junior high in a mid-sized Midwestern city. During the year in which I observed Kathy she began teaching 8th grade mathematics using a traditional curriculum whereas the previous years she had used an integrated curriculum, the *Core-Plus* textbook and curriculum materials. She was therefore, teaching an 8th grade level mathematics class to 8th graders for the first time in 20 years by her account. Kathy was national board certified and held a master's degree in curriculum and instruction from the state's largest university. Kathy was respected among the mathematical community and participated in providing professional development to teachers across the state.

Teaching Structure

At the time of observation Kathy was teaching a transformational geometry unit wherein students were learning about symmetries and transformations on the coordinate plane. Kathy taught using a mixture of interactive lecture and group-based activities. Typically, the first parts of Kathy's classes were conducted in interactive lecture format. Kathy would explain the topic and then teach the main ideas by calling on students to share or explain various ideas, and make sense of the mathematics at hand. For example, on the first day of observation Kathy asked students to define line and rotational symmetry. She followed students' contributions by asking all students whether they agreed with their peers' definitions. She also prompted students to answer other's questions such as when a student asked how to find the degree of rotation. The other days she similarly delivered instruction by calling on students to explain or articulate their thoughts and inviting other students to comment. In the four days of observation Kathy also engaged students in video demonstration or hands on group activities where students further explored mathematical ideas. These activities were roughly equal in balance to her interactive lectures. These activities included using patty paper to learn about rotations on a coordinate plane, examining holiday and birthday wrapping paper to discern symmetries, rotations, and translations, and viewing animated short films to recognize that transformations are used in animation and other non-classroom contexts.

Overview of Kathy's Goals

Kathy wanted her students to be the best, to be recognized as coming from her class with strong preparation. She wanted her students to realize that math was "out there" not just inside the classroom. She challenged them through tough grading, but provided opportunities both in assessments and in classroom discussions to safely make mistakes and think about the mathematics. In assessments she held students to a high standard so they would know what was expected. In classroom discussions she encouraged students to listen to each other and consider for themselves the reasonableness of ideas. She pushed them to be precise in their language. She reduced their homework anxiety by setting a time limit. She provided opportunities for students to connect ideas within mathematical topics. In the following I detail Kathy's goals in terms of subject matter, classroom organization, and personal goals.

Subject Matter Goals

Kathy was in the midst of a unit on transformations on the coordinate plane. She described the unit goals briefly in these words:

We have six major goals for the entire year. So we are working on goal 3, which is just transform geometric figures on a coordinate plane. That is our big picture. So I want them to be able to take anything I give them, picture, coordinate pair, and work with the geometric shapes, they should be able to recognize geometric shapes, they should be able to transform them. They should be able to tell me which transformations preserve congruency, which ones don't. And then I gave them an outline of fourteen sub goals that have those components in it also. You should be able to reflect over an x-axis, you should be able to reflect over a y-axis. (Kathy, Interview 2, January 14, 2009)

Kathy detailed these sub goals in the following list:

1. Identify and draw lines of symmetry for any figure regardless of whether it is on the coordinate plane.
2. Identify angles of rotation for a given figure.
3. Plot points in a coordinate plane given an ordered pair.
4. Identify the coordinates of a point on the coordinate plane and describe its location.
5. Identify the geometric shape created by connecting points on a coordinate grid.
6. Reflect a figure, on the coordinate plane, and give the coordinates of the image.
7. Translate a figure, on the coordinate plane, and give the coordinates of the image.
8. Rotate a figure, by a multiple of 90 degrees about the origin and give the coordinates of the image.
9. Dilate a geometric figure by a given scale factor and identify the scale factor given similar figures.
10. Identify, write and follow algebraic rules for basic transformations.
11. Identify which transformations preserve congruency or similarity.
12. Describe the transformation given the rule.
13. Find missing angle measures in triangles, parallel lines cut by a transversal, and intersecting lines. (vertical, corresponding, supplementary, complimentary, and reflex angles).
14. Create isometric drawings. (Kathy, personal communication, January 19, 2009)

During my observations she addressed most of these items either in review or in working through new material. Specifically, Kathy addressed line and rotational symmetries of figures, and translations and rotations of points and objects on the coordinate plane.

Source, commitment, and efficacy to subject matter goals. Kathy did not directly identify a source of these subject matter goals, but I was given to know that

they had been developed either as a mathematics department at the Junior High, or within the school district. She made no direct comments regarding her commitment, but by observation she was clearly dedicated to providing instruction that supported students learning these topics and ideas. Her perceived sense of efficacy was captured in the following statement:

I think by the time we finish up, they're going to reflect today over x and y-axis on their homework, by the time they do that, then all of the transformations that preserve congruency will have already at least dealt with them. I don't think it will be solidified until we start really putting all of them out in front of them at the same time, and then having them really look at the similarities and differences in those moves. So that they can figure out with just looking at the ordered pair combinations what the transformation is without having to go through and graph the whole picture again. So exposure? Yes. Building the ordered pairs and the knowledge of looking at those ordered pairs, yes. Have they mastered it? No, not by far.

This excerpt relates specifically to translations and rotations, which was the major emphases during my observations. She knew that students had been exposed to the ideas and were developing competence but did not believe students had mastered the material. She believed that in time, as the students saw all of the transformations relative to each other that they would understand and she would meet her goals in this area.

Connecting Topics and Ideas and Developing Fluency

Kathy organized instruction to deepen students understanding relative to her 14 unit sub goals. Inasmuch as these were initially treated separately, she wanted students to understand how they were connected, similar and different. This goal was brought up as I asked why she had returned to one topic, translations, even though she had provided instruction towards it several times before. She said:

And I did that on purpose because we were leaving this and we were starting to go into rotations, but I want them to be as comfortable if I throw up a translation, and then I throw up a rotation, that they know that these are doing different things to those points. I keep throwing those in so that they realize it's a whole hodge-podge of things.

They're all tools and these tools will make things happen in different ways. And I just want them to keep them straight. (Kathy, Interview 2, January 14, 2010).

She explained further that the activities she would use to help students develop that knowledge:

And it's just a matter of there are very subtle differences I think in these transformations. And I just want them to keep them straight. Now one thing that I will do at the end is I have a matching game that I give them all the translations and then I have them group them into: these all translate to the left and up; these all translate to the right and down; these all translate; these rotate, these... So that they then will separate them into categories and then they will match their graph by just, without a coordinate grid on there, and then they'll have to match

the graph to the ordered pair, the transfer ordered pair to see what kind of transformation is happening. So that will happen. I also have a quiz, quiz, trade activity that they do where when we start to review for the unit and it will just have the picture and they have to say x plus $3y$ minus 2 to see the translations and the answers on the back of the card. So we'll do that. Those are all kind of culminating things when we start getting them all, so they can really practice those skills and know them like that (snaps fingers).

Her goal was that her students know the mathematics well and know it well enough to differentiate and discern between ideas within the larger goal to transform geometric figures on the coordinate plane. Her emphases explained at the end of this excerpt was not just that students know these ideas and understand the differences, but also that they have fluency with them.

Source, commitment, and efficacy to connecting topics and ideas and developing fluency. Kathy identified the source for these goals as stemming from her personal experience as a student. She said:

I think one of the things that I feel like as a math student that hindered my learning of mathematics is that my teacher only showed us one thing, and we could only look at that one thing and then, as soon as we looked at it, we took a test on it and then we moved on to the next little thing. And then we took a test on it and we moved. (Kathy, Interview 2, January 14, 2010)

In this excerpt Kathy explained an experience as a student she thought was not supportive to learning, and so she held the goal to not isolate mathematical ideas, but to help students see them as connected to each other. Her commitment was evident in her efforts. Her perceived sense of efficacy was explained in these words: "I think after we play with them enough they'll keep them separate." (Kathy, Interview 2, January 14, 2010). She recognized that students might not initially distinguish the ideas, but she felt that in time they would understand the connections and differences.

Distributing Mathematical Authority: Helping Students to More Deeply Realize the Mathematics for Themselves

Two central teaching strategies for Kathy involved calling on students to explain and articulate their thoughts and engaging students in mathematical activity to realize mathematical ideas. Two examples introduce this theme. During one of the observations Kathy was reviewing a quiz with the students. The students had misidentified a shape as having rotational symmetry. She passed out patty paper and asked the students to trace the shape and then rotate it on the original to examine the symmetry. She explained:

I wanted to make sure, that patty paper, you know they can trace that out really easy and then fold it. And then most of them when they did that said, "I can't get it to work." And so they figured out it didn't work even though I was saying it, it's still they're ah-ha moment. Oh yeah that didn't work. Those spokes aren't going the right direction or whatever. (Kathy, Interview 1, January 12, 2009)

In other words, Kathy used this activity to help students more clearly see the idea involved in the rotational symmetry for themselves, which they had confused before and did not understand well after previous instruction.

The second example involves an interaction between Kathy and an individual student during a whole group discussion. They began to discuss line reflection and Kathy asked a student to explain a line reflection in her own words. In the interview Kathy explained:

We've talked about the lines of reflection in class. But instead of me just going through and saying it again, and again, and again, I want somebody else to say it because I figure even if only one kid says it they've practiced it. And then I keep hitting around the corner, you know every time I see an opportunity, "Ok who knows what that is." So I'm not the one that's the giver of information. (Kathy, Interview 1, January 12, 2010)

The student responded with a definition too vague for Kathy. So she asked the student to further clarify and added, "I'm picky Kelie" (Kathy, Video 1, January 11, 2010). In the interview Kathy explained her goal:

A lot of kids, especially in the transformations in geometry in the whole thing, they use the same words to describe 20 different things when they say it cuts it into two equal parts, it doesn't matter if it's a reflective part, it doesn't matter if it's a rotated part. It's two equal parts and they don't understand that we really need to know that it's not just cut into two equal parts, but it's also mirror images of each other. That's the whole thing about reflection symmetry. So I wanted her to make sure that she didn't stop at two equal parts. (Kathy, Interview 1, January 12, 2010)

In this excerpt we learn that Kathy wanted the students to verbalize and articulate the ideas, but she also insisted that they be as mathematically accurate as possible, she wanted them to know the critical points of the idea.

The central goals embedded in this theme are that she wanted students to see things for themselves, she wanted to involve them as much as possible to be doing the work or articulating the mathematical ideas, and she wanted to avoid being viewed as the "giver of information." I further detail this theme by describing a phrase Kathy frequently used in her discourse that fits in this theme. Kathy often asked her whole class and occasionally individuals "Do you agree?" She explained her purposes for using this phrase:

I'm trying to get them to listen to other people, I know that's one of my worst aspects is I don't get the kids to listen to each other enough. So that's one thing. I ask them "Do you agree?" because I want the kids to be able to feel comfortable that they can give a wrong answer. And I also want the kids to be comfortable that they can say, "No I don't agree." I want them to stand up for themselves if they don't agree for something. Don't just take something. So I really want them to really challenge when people say things.

And then I try to make it where the kid that even is wrong doesn't feel that they can't make mistakes; where it's not destructive, but it's constructive.

I want to train them that I'm not the giver of information; they are the giver of information. They can teach each other things by just looking at patterns in mathematics, and looking at what's happening. And to take a chance, I don't want them to look at me every time somebody says something "Is she right?" I want them to be able to siphon out some of this stuff and say, ok, is it really right, does it mesh with what I'm thinking. (Kathy, Interview 1, January 12, 2010)

Kathy explained that she began the year with an activity where she introduced this idea. She had students tell truths and lies and the rest of the class had to determine whether they agreed. Her goals with this device were to promote listening, to develop a discourse community where disagreement was safe, to encourage students to be thoughtfully responsible for their understanding.

Source, commitment, and efficacy to distributing mathematical authority.

Kathy identified three sources for the goals in this theme: (a) reform curriculum, (b) district leaders and initiatives, and (c) professional development opportunities. She explained:

I fought reform curriculum for years. I mean I was a traditional teacher I got up there Ok let's open our books to page 1, we're doing page 1 today, we're doing page 2 tomorrow, we're doing page 3 and we just go cycle cycle cycle. When I was traditional I was the mathematical authority. Whatever I said, this is you do it, and this is how you will do it. But as I've gone through the reform curriculum, [district leadership] pushing me, having us do the [professional development] stuff. Even though I gripe about having to go on Saturday's, you know. But I will tell you that one bonus of that is it does help you think about letting the kids have more freedom. (Kathy, Interview 1, January 12, 2010)

She identified these three sources as pushing her in the right direction and particularly pushing her to think about letting kids do more of the sense making. This goal theme came across clearly in her instruction as she provided activities and pushed students to explain and reason for themselves.

Kathy's perceived level of efficacy took into account challenges of both telling and alternatively letting students make sense for themselves. She claimed a 50 percent sense of efficacy. She said:

I let them flounder *a lot*. Especially I mean we're at the very beginning of this unit. So I want them to be able to do this...

It is extremely hard, because kids have always been told. The kids don't come with it. It's not innate. And so I think that is hard. I mean I try to push them to see. I don't know if the attention spans are there to really focus completely where I need them to go all the time. So I always pull the safety net, and by the end of the unit we discuss, "Ok now let's break this down again, let's look at goal one. What is it that goal one is really trying to tell us?" And if they give me the wrong

thing, “Well, let’s think about this again.” You know I’m coming back, I put them out there, on the diving board, but if they don’t do a good dive, I’ll coach them again, and say, “Ok well let’s look at that again.” You know.

There are times that I want to shorten it and get it done and I’ll tell them, it’s not probably as effective, but it gets the job done. (Kathy, Interview 1, January 12, 2010)

Kathy was generally quite committed as is evident in her language letting them “flounder a lot” and yet occasionally she needed to “get it done and... tell them.” She felt like she was somewhat successful in meeting this goal, but she identified challenges to her goal, namely the students having always been told and that they have to learn and develop their ability to reason mathematically for themselves.

Assessment Goals: Policies That Promote A Positive And Productive Learning Disposition While Avoiding Student Disengagement

Kathy devised her homework and assessment policies to hold students to rigorous standards while promoting student engagement. This goal theme was first uncovered as I asked Kathy about her grading scheme on the quiz. She had not given a traditional letter grade or even points, rather, she used a scheme that communicated student attainment and development to specific mathematical understandings. She explained her goals:

I don’t want to grade them on their first try because, some of them that’s the first time they’ve ever seen this. I want to see what they know even though I pretested them on those concepts I still wanted to see what they knew on that objective. But I didn’t want that to be a final. Because I grade pretty tough on these kids and I want them to understand that it’s ok to grade tough, that they’re not being penalized. Over the years I found out that if I grade as tough as I do and I put a grade on it, as soon as they see the grade, they don’t even want to look at the test. But if I don’t want to put a grade on it I can grade all kinds of stuff.

I want to avoid them internalizing that as a grade and not internalizing that as a “I didn’t get that right.” I want them to look at those problems and say, “I didn’t get that right,” and hopefully look at, “Why I didn’t get that right.” and take the variable of grade out of it. Because many of these kids, once they see that D, because a lot of them would’ve gotten a D on this, as soon as they see that D, they “I’m a failure, I’m a D student, I can’t do this.” (Kathy, Interview 1, January 12, 2009).

The essence of Kathy’s goals in this theme were to motivate further learning and to avoid the demotivating feelings and disengagement of the learning process students might suffer through giving summative grades early in the learning process.

Kathy also implemented a unique homework policy to contribute to students learning. She explained:

I tell my kids, “Only work for 15 minutes at home.” That’s it! I want to know what they can do in 15 minutes. I find that for the most part I

get more participation in homework when they know they have 15 minutes.

I don't want them to be, "I've got 2 hours of homework." And the ones that will do it, will kill themselves doing it, and the other ones say, "I can't get all that done, I'm not even going to try." (Kathy, Interview 2, January 14, 2010)

Similar to her goals regarding her grading and quiz policies, her homework policy served an assessment purpose to discern students understanding in a limited time frame, but more to encourage learning and engagement and to avoid disengagement with large homework assignments.

Source, commitment, and efficacy to policies that promote a positive and productive learning disposition while avoiding student disengagement. Kathy did not comment directly about the source of her assessment policy but it is likely that it stems like her homework policy from years of experience in addition to the professional development experiences she had. About her homework policy she said: "That's been developed over the course of 26 years" (Kathy, Interview 2, January 14, 2010). She was committed to the goals in this theme as evidenced through her enactment and maintenance of the policies. Regarding her efficacy in avoiding student disengagement and students internalizing a quiz grade she said: "Most of the time they understand that if there's not a grade, they don't internalize it as being a negative thing for some reason. They just don't. It doesn't bother them as much" (Kathy, Interview 1, January 12, 2010). Regarding her perceived level of efficacy on her goals with her homework policy she said:

And some of them really do challenge themselves I'll say, "You really got all this done in 15 minutes?"

And they'll say, "Well I really did it a little longer." But they're really trying to push themselves to get more done. So when I restricted it, they, not everybody, but still I had a higher percentage of kids that were completing their homework on time. If you give a smaller set of homework, and you ask them to get that done, it's so much more effective than giving hours of homework that nobody does. So that's really turned out pretty good this year. Parents like the fact that it's 15 minutes of undivided time. (Kathy, Interview 2, January 14, 2010)

Overall Kathy felt very effective with these policies. At the very least she felt that she was getting more students to complete their homework.

Math is Out There and You Can Learn It: Helping Students Realize Mathematics Exists Outside the Classroom and They Can Learn Mathematics

Throughout the observations Kathy made reference to and provided activities to help students realize mathematics existed outside of the classroom. This goal theme was drawn out when I played a video for her wherein she held a discussion with students about line reflections. She said:

I keep, putting this up here (hands on both sides of her face mirrored) so they can see that. Trying to tie it to their real life. And when you say goals, if I had to write my whole obituary and say what is it I want to accomplish in my life, it's to have the kids understand that math is out there, that math is not something you use in a classroom that you'll

never see again that you hate. I want them to have fun. I want them to enjoy and to apply it. I want them to be able to say, "Yeah it does happen." That's my goal. (Kathy, Interview 1, January 12, 2010)

To meet this goal Kathy not only explained how line symmetry applied to the human body, but how transformations were used to make wrapping paper and also in making digitally animated films. She explained that at the end of the year she hoped students would: "Like math and understand it's out there, and they can do it. They can take the tools and apply them" (Kathy, Interview 2, January 14, 2010). This quote introduces additional elements to this theme that she wanted students to have the tools, to be able to apply them, to like math, to believe in themselves that they could learn the mathematics.

In this theme, Kathy wanted to promote success and improve students' attitudes towards mathematics. She wanted to avoid having students develop negative mindsets towards mathematics. She said she hoped to avoid having them think:

That they're stupid. And the fact that they don't have it yet, but they can get it, and I don't want them to think it's an impossible task. I want them to keep an open mind. I don't want them to think it's over, that "I'm already a failure, I've always been the lowest math student." If they don't know it yet, it's still possible if they put the work in. (Kathy, Interview 2, January 14, 2010)

On this end Kathy discussed her efforts with individual students, how she tried to avoid confrontation with students but at the same time demanded students engagement and effort. Her efforts in this area were also highly visible as she used multiple strategies to address off-task behavior. She felt a sense of responsibility to each student. She said:

I just feel like if somebody doesn't pay attention to them as an individual and really think about them, those guys are going to be out there somewhere doing a job, probably really poorly, and I haven't done what I could do to help them. (Kathy, Interview 2, January 14, 2010)

This clearly weighed on her mind as she thought about particular students and all students generally. She wanted her students to be successful, to encourage the discouraged individuals, and to help them realize math is part of their lives and not limited to the classroom.

Source, commitment, and efficacy to helping students realize math is out there and they can learn it. Kathy did not make any statements regarding the source of this goal, but it clearly emanated through her instruction as she provided windows to the out of classroom world in which mathematics applied. Regarding her perceived level of efficacy she said:

It's kind of fun when kids come back and tell me later "You know I never liked math before, but now I like it and it's not as scary and it's easier for me to ask questions if I don't understand." I'm hoping that they feel like they have a solid background and I've been honest with them and I don't try to cover things up. I hope they walk away saying "Yeah, it is useful and it is something that is going to advance me in

life.” And most of the time I get lots of kids that come back and, graduation time especially they’ll come back and “I just wanted to say I’m graduated, that I’m glad I had you as a math teacher.” (Kathy, Interview 2, January 14, 2010)

Kathy’s sense of efficacy was high as it related to helping students be generally successful in math. She made no specific comments about her efficacy regarding helping students realize math is not limited to a classroom setting.

Meta-level Teaching and Professional Goals

Yearly Improvement and Providing Helpful Resources to Students and Other Teachers

Kathy’s goal in this area can be introduced in her own words: “If I can make somebody else’s life easier I will. That’s kind of my drive” (Kathy, Interview 2, January 14, 2010). This quote applies to each of three professional and meta-level teaching goals. First, she wanted to improve her own teaching. In the year of my observation she was using a new textbook and this caused considerable challenge to her. She said:

I feel like I’m not as organized, especially this year I’m feeling really out there, because a new book that I hate, that I don’t think has a lot of good material in it. I’m recreating the wheel, and I’m organizing. When I say recreating the wheel, not necessarily, I’m stealing from things I’ve done over the years, but just putting it all into a condensed format where next year I can build on it more, and I try to take good notes on what worked, what didn’t work, what took too much time, what could I have done in shorter amount of time if I had done this differently? So just taking more notes and figuring out how I can make it better next time. (Kathy, Interview 2, January 14, 2010)

By taking note of her activities and collecting activities around central ideas Kathy intended to improve her course for the next year, hoping to make it more coherent and effective for future students.

In addition to improving the delivery and content of the course, Kathy wanted to develop and share resources with her students. She explained, “I’m really hoping that my units would be so organized that the kids are building more of a solid resource that they take with them. I want the kids to have something of that nature” (Kathy, Interview 2, January 12, 2010). Finally, Kathy enjoyed preparing and sharing resources and otherwise helping other teachers. She explained that when other teachers are trying something interesting she wants to be there. “I want to be there and helpful. If they have a project and they can’t figure it out then I’m going to be jumping in to help them manipulate some of the things.” (Kathy, Interview 2, January 14, 2010). She also liked sharing resources and things she had made at teacher conferences.

Source, commitment, and efficacy to improving her own instruction and providing resources to others. I was unable to ascertain a source related to Kathy’s drive to be a better teacher, or to provide resources to others. However, it is likely the sources of these goals were internal. However, she did identify a source for her goal to provide students with resource packets. She said, “I can think of different things that I still have in my possession that are useful to me, and it helped me through college classes” (Kathy, Interview 2, January 14, 2010). In other words, she

had these resources as a student and found them helpful and wanted therefore wanted to pass on similar resources to her students. Her commitment and perceived efficacy related to these goals are unknown as they were not obtained in the interview, but like the other goals that she shared with me it is likely her commitment and efficacy on this were the same as for those, relatively high.

Summary

Kathy felt a high sense of responsibility to enabling her students to be successful with mathematics and in life. She was teaching 8th grade mathematics to 8th graders for the first time in roughly 20 years and was challenged to develop the curriculum in a coherent fashion. She wanted students to make sense of the mathematics for themselves as much as possible and worked to avoid being seen as the “giver of information.” She wanted students to make sense of the mathematics in its depth. She organized her assessment and homework policy to promote student effort and learning. She wanted her students to realize how mathematics existed beyond her classroom. Finally, she wanted to improve and share resources with her students and other teachers that might be helpful to them.