Developing Noticing of Student Thinking at the Secondary Level through the use of Video Clubs: The Case of one Rural, Idaho School

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Authorization to Submit Dissertation

This dissertation of Abraham J. Wallin, submitted for the degree of Doctor of Philosophy with a Major in Education and titled “Developing Noticing of Student Thinking at the Secondary Level through the use of Video Clubs: The Case of one Rural, Idaho School,” has been reviewed in final form. Permission, as indicated by the signatures and dates below, is now granted to submit final copies to the College of Graduate Studies for approval.

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Abstract

This study addresses the questions: (a) How does teacher noticing affect decision making around selecting and implementing classroom tasks?, and (b) How does engaging in video club meetings focused on teacher noticing affect teachers' ability to identify and utilize pedagogical strategies which promote student thinking? A single-case study design was used to address these questions, as the project represented a bounded case of three teachers comprising the entire secondary mathematics teaching staff of a rural school district. Teacher noticing of student thinking was the primary contextual lens for examining teacher change during the study. Data sources included observations, interviews, videos of video club meetings, classroom artifacts, and researcher field notes. Individual teacher data was coded and patterns were identified which were then used to create categories. These categories were then examined across the three teachers for the entire case of Sometown School District. The pertinent findings of this study were all teachers demonstrated: (a) increased levels of teacher noticing of student thinking using van Es' *Teacher Noticing* framework (van Es, 2011, p. 139), (b) recognition of qualities within tasks which lead to increased student thinking, (c) increased ability to develop and adapt tasks for classroom application, (d) improvement in facilitation of discourse during task-based lessons, (e) increased ability to anticipate and sequence student strategies to promote discourse, (f) shifts in teachers' curricular vision, (g) evolving beliefs regarding classroom culture, (h) transformations in Pedagogical Design Capacity, and (i) changes in perceptions regarding collaboration.

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CHAPTER 1: Introduction

The media and public sentiment have emphasized the importance of mathematics understanding among students for many years. Often, as in the case of the report published by the National Mathematics Advisory Panel (NMAP) in 2008 and similar reports produced decades earlier (National Commission on Excellence in Education [NCEE], 1984; National Defense of Education Act, 1958), mathematics education is directly tied to the United States' future economic viability. The advent of the Common Core State Standards for Mathematics (National Governors Association Center for Best practices [NGA Center] & Council of Chief State School Officers [CCSSO], 2010) raises the threshold for what students should know and be able to perform in K-12 mathematics (National Council of Teachers of Mathematics [NCTM], 2014). The Common Core State Standards for Mathematics (CCSSM) are a "call to take the next step" (NGA Center & CCSSO, 2010, p. 5). With the trend towards using high-stakes, standards-based assessments to evaluate both teachers and school districts, there is an immediate need for teachers to examine their classroom practice and evaluate the impact of these practices on student learning (NCTM, 2014).

According to the National Council of Supervisors of mathematics (NCSM) the methods in which mathematics has been previously taught, and is still being taught in some places, often fails more than half of the student population (NCSM, 2014). The NCSM view the CCSSM as an opportunity for social justice; a means of promoting mathematical understanding for every student. "Associated with this is the requirement that mathematics be presented, not as hierarchical, logically consistent, and rule-based, as at present, but as ideas-based (Neyland, 2004, p. 70). This is a useful shift because, as Boaler (2008) claims, many students are unable to navigate the traditional instructional system long enough to arrive at the content they would find interesting and/or applicable to their future plans.

"Attention to education is not just rhetoric" (Stigler & Hiebert, 1999, p. 1), but with focus placed squarely on world rankings, national preparedness, state testing, and district Annual Yearly Progress, it sometimes becomes difficult to see beyond the arbitrary, and instead refocus on children's development of mathematics.

The NMAP (2008) recognized, as did others, the state of the U.S. mathematics curriculum being a mile wide and an inch deep; educators attempting to cover all mathematics topics at a grade level were forced to rush through content, not allowing students to fully explore nor understand materials. "A large part of the standards-based reform is built on the view that mathematics itself has become more computational and less formal" (Kilpatrick, 1997, p. 957), and mathematics as a school subject merely "examine[s] children's grasp of things taught by the teacher rather than the children's understanding" (Lerman, 1990, p. 60). Therefore, if one believes "learning with understanding makes subsequent learning easier" (NCTM, 2000, p. 20), then one must pursue avenues to create and improve student understanding. The CCSSM attempt to bring coherence to what has become a fragmented and ever-increasing set of standards for the K-12 system (NCTM, 2014).

Problem

An issue facing teachers is the CCSSM create an impetus for evaluating current pedagogical strategies and the implementation of available curricular resources (Lloyd, Remillard, Herbel-Eisenmann, 2009). There is an increased urgency in secondary classrooms where clear progressions of standards do not yet exist and many textbooks continue to be organized in formats which do not easily create opportunities to reach the depth of knowledge required by the CCSSM or the subsequent tests of student learning (NCTM, 2014). Leinwand (2012) recognizes "changing the traditional curriculum and shifting time-honored instruction practices requires a degree of self-confidence and a

willingness to take risks that the teaching profession has rarely reinforced" (p. 73), which can further stifle a willingness to discuss teaching practice. Professional isolation is a common occurrence (Leinwand, 2012; NCTM, 2014), but may be more prevalent in rural, secondary classrooms where teachers have no teaching partner and limited access to outside professional development. Shulman (1987) cautioned that teaching with a lack of collaboration among peers limits understanding of one's own practice.

Furthermore, Smith (1996) discusses the potential loss of efficacy in teaching for secondary mathematics educators attempting more reform-based approaches, such as those necessitated by the CCSSM. "Teachers who control and interpret texts are the intermediate authorities for students on matters of mathematical truth" (Smith, 1996, p. 391), but within a CCSSM paradigm student authority is the ultimate goal (NCTM, 2014). Resistance to new methods of teaching can be a predictable response from teachers who have found success with more traditional pedagogies. The culture of "nothing risked, nothing failed" (Leinwand, 2012, p. 79) is prevalent in U.S. schools. Conversely, in CCSSM "the currencies of the mathematics teacher (if lecturing is rejected as an effective means of promoting concept development) are the posing of problems or tasks and the encouragement of reflection" (Simon, 1995, p. 141), which inherently means risk taking. Teaching this way takes longer and creates various, potential setbacks for teachers, which can further reinforce previous models of instruction based on telling content to students (Franke, Carpenter, Levi, & Fennema, 2001; Guskey, 2002; Heibert, 1999; Nicholls, Cobb, Wood, Yackel, & Patashnick, 1990; Schifter, 1998; Simon, 1995; Simon & Tzur, 2004; Stein, Smith, & Silver, 1999; Wilson & Berne, 1999; Wood, Cobb, & Yackel, 1991).

With the uncertainty of new teaching approaches evaluated through standardized testing, changing one's teaching approach can seem unwise to classroom teachers (Ellis & Berry, 2005; McGee, Wang, & Polly, 2013; Smith, 1996). The fact students in classrooms

with reform-based teaching do no worse than their traditional classroom peers on standardized tests does little to mitigate fears (Ellis & Berry, 2005; Frykholm, 2004; Hiebert, 1999). Resisting reform-based teaching makes sense on some levels (Gitlin & Margonis, 1995), but continues a pattern of mathematics education which does nothing to prepare students for a problem-based work environment. The CCSSM were designed to address short comings in more traditional, skill-based teaching (NCTM, 2014), but as secondary teachers are often educated in systems not aligned with these views, they are sometimes left with more questions than answers.

Gruskey (2002) suggests teacher change will only occur after a teacher has experienced success in his or her own teaching; taking a model to the classroom and experiencing success is a vital piece of a teacher changing not only her beliefs, but practice as well. “Teachers need learning opportunities that focus on their practice. They need to engage with other teachers to learn what works under what circumstances to develop as ‘connoisseurs’ of effective practice” (Loucks-Horsley et al., 2003, p. 40). In larger districts these successes are accomplished through mentorship between teachers, educators working with a mathematics coach, or through structured collaboration. The unfortunate reality is rural schools often lack the resources and/or time to make these opportunities possible in the subject of mathematics education.

One of the largest shifts required for enacting the CCSSM is the pedagogical considerations necessary for developing a new framework of classroom expectations (NCSM, 2014). The Standards for Mathematical Practice described within the CCSSM prescribe how students should engage in mathematical activities from kindergarten through the end of high school and indirectly define the role of a successful teacher (NGA Center & CCSSO, 2010). Groups such as the NCTM have emphasized the need for a change in culture which promotes student thinking and active participation for years, the adoption of

the CCSSM are the first time students, and teachers, will be evaluated on their ability to demonstrate these attributes (Leinwand, 2012).

Defining characteristics such as perseverance, reasoning, use of structural components of mathematics, or simply making sense of a problem are not measurable in traditional high-stakes testing, but are critical to implementation of the Standards for Mathematical Practice (NCSM, 2014). Teachers need to be able to recognize when students are and are not engaging in the practices. They also need to develop opportunities for students to demonstrate these norms and ultimately evaluate whether the experience creates a meaningful change in student thinking about mathematics (Danielson, 2007). Teachers need a way of looking at their classroom practice and making decisions.

Purpose

Teachers are ultimately the ones who make instructional decisions at the classroom level, but there is an inherent struggle between intentions of curriculum designers, teacher content understanding, student needs, and the expectations dictated by both state and local stakeholders (Ball & Bass, 2000; Pimm, 2009). Within the CCSSM, teachers are called upon to use mathematical tasks which, engage and offer opportunities for higher levels of thinking (NCTM, 2014). The CCSSM state “mathematical understanding and procedural skill are equally important, and both are assessable using mathematical tasks of sufficient richness” (NGA Center & CCSSO, 2010, p. 4). Using a classroom task requires attention to how students are thinking about the task and their strategies for solving it (Stein, et al., 2009). Teachers may not have previous experiences implementing and modifying tasks (Ball & Bass, 2000), but this can be developed through structured reflection (Smith & Stein, 2011).

One, often underutilized, means of shifting professional practice, such as using mathematical tasks for instruction, is the use of classroom video and subsequent reflection (Leinwand, 2012). The role of the educator is to judge his or her own knowledge and use that knowledge to best decide the course of study within the classroom (Dewey, 1938). “It is of course, an art to create open learning situations or a sequence of them which are not boundless and which allow the recognition of the learning process clearly in the succession of learning situations” (Fruedenthal, 1978, p. 179), but this type of teaching is not a natural part of how many teachers have experienced learning mathematics (Ellis & Berry, 2005). The need to develop a “professional vision” (Sherin, 2001, p. 75), a means of interpreting classroom events, can help guide teachers in understanding their own practice and then focus them on critical aspects of their own pedagogy. A teacher’s ability to recognize, decipher, and act upon a student’s mathematical thinking is an essential pedagogical consideration and is a major theme of reform literature (Ball, Lubienski, & Mewborn, 2001; Jacobs, Lamb, Philipp, 2010; Jacobs, Lamb, Philipp, & Schappelle, 2011). Ultimately, the review of classroom episodes on video allows teachers to focus on how students thought about the mathematics and make adjustments to future teaching (Schifter, 2011).

Teachers must integrate various levels of curriculum documents and synthesize these into their own curriculum vision (Cirillo, Drake, Herbel-Eisenmann, & Hirsh, 2009). According to Ball and Bass (2000), ideas defining good practice emerge from examination of decisions teachers make in the enactment of curriculum; analyzing decisions at a classroom level create a context for understanding generalized notions about teaching. With guided experiences, teachers can become better at recognizing the choices they are making in the moment and reacting in more productive ways in the future (Jacobs et al., 2010).

Sherin and Star (2011) dub events where teachers recognize a substantial classroom episode as “noticing events” (p. 68). Expanding on this idea of noticing events, Jacobs et al. (2010) define professional noticing of student mathematical thinking as the ability to decipher understandings held by the student and then use this insight to respond in ways, which promote further understanding on the part of the child. Mason (2011) suggests teachers should engage in noticing practice so they may act differently in the future; attending to classroom details hones an educator’s sense of possibility. Because classroom experience does necessarily predict one’s ability to notice and utilize noticing events, professional development with teachers becomes an avenue for developing skills in this area (Jacobs et al., 2010).

The research area of teacher noticing could offer some insight into how teachers implement the CCSSM Standards for Mathematical Practice, and in particular how they implement classroom tasks. The complex nature of the mathematics classroom, when tasks are a regular part of instruction, creates a situation where teachers must be able to instantaneously process and respond to the actions, or inaction, of each student in his or her classroom simultaneously (Sherin, Russ, & Colestock, 2011). As a matter of course teachers will need to focus on certain aspects and ignore others. It is within the teacher’s interpretation of what to notice that he or she has the power to change cycles of habitual response and adapt to new models of teaching (Mason, 2011).

Research Questions

As a result of the aforementioned problem for supporting teachers, and the need for continued studies, this study answers the following research questions: How does teacher noticing affect decision making around selecting and implementing classroom tasks? How does engaging in video club meetings focused on teacher noticing affect teachers’ ability to identify and utilize pedagogical strategies which promote student thinking?

Research Approach

This study gathered information concerning the lived experiences of secondary mathematics teachers in a rural setting who engaged in a video club as professional development, with intent of increasing their ability to notice events related to student thinking. A qualitative methodology was chosen, specifically a single-case study, as a result of the interpretive nature of the data to be collected and the structure of the questions that were answered (Yin, 2009). A single-case study design was chosen because this study took place in one particular school, with teachers representing only those individuals teaching mathematics at the middle school and high school level within the district, constituting a bounded sample (Creswell, 2007; Merriam, 2009; Stake, 2010; Yin, 2009).

Researcher Perspective

The researcher has been employed for seven years as regional support person (Regional Mathematics Specialist) for school districts in a geographical region comprising one-sixth of a large and diverse state. In this position the primary goal has been to support teachers as they transition to the CCSSM and embrace their roles as facilitators of mathematical understanding through critical consumership of textbooks and other curricular materials. Within this broader goal, there has also been a focus on the development of teacher knowledge and pedagogical enactment of mathematical content at the classroom level. Assessing mathematics “teacher capacity” (Stein & Kaufman, 2010, p. 678) and addressing teacher perspectives of best practice are crucial aspects of this process. Building relationships with practitioners has involved framing reform objectives at both a classroom and district level.

The high value placed on research-based materials within the era of standardized testing has necessitated applying recommendations of groups like the NCTM at a district

and building level. To this point, much of the researcher's current work with schools has not been validated through the rigors of implementing and carrying out well-conceived research studies. Although conducting interventions with multiple districts with similar student and teacher populations has a certain reliability for those served, it remains anecdotal at best. This project, in part, sought to formally assess a single intervention and present these findings to the broader field.

Researcher Assumptions

This project assumes teacher noticing is a skill which can be learned (Jacobs et al., 2010; Mason, 2011; McDuffie et al., 2014; Sherin & Star, 2011) and collaboration is an essential part of understanding one's own practice in the field of mathematics education (Leinwand, 2012; NCTM, 2014; NCSM, 2014; Shulman, 1987). The use of video clubs creates a structure for reviewing practice among groups of teachers (McDuffie et al., 2014; Schifter, 2011; Sherin, 2001) and this process of reflection, when specifically focused on mathematical tasks and the instruction of those tasks, creates a deeper capacity within the teacher for analyzing instruction and planning for future lessons (Ball & Bass, 2000; Stein & Kim, 2009; Stein, Smith, Henningsen, & Silver, 2009). Subsequently, teachers can develop better tasks, and these tasks will produce opportunities for students to learn content in meaningful ways (NCTM, 2014).

Rationale

Teachers naturally attend to those classroom episodes most pressing at a given moment. Erickson (2011) described this as being "triangle-like" (p. 24) with the ultimate purpose being action. Because action is pre-supposed, it becomes of great interest to examine how these teachers choose to select the areas they address and those they do not. The extent to which a teacher's capacity (Brown, 2009; Cirillo, et al., 2009; Stein &

Kaufman, 2010) relates to these decisions is equally important. If teachers are lacking in particular content knowledge or the ability to identify critical topical understandings (e.g. the possession of a focused vision or lesson goal), the ability to identify useful classroom episodes becomes difficult (NCSM, 2014). Mason (2011) suggests teachers should engage in noticing practice so they may act differently in the future; attending to details may hone an educator's sense of possibility. How teachers internalize this is a relatively new construct and beckons more research to better understand.

From a more practical perspective, teachers who engage in conscious decision making regarding the impact of their own teaching have a greater chance of anticipating how students may respond to the tasks posed in the classroom (Sherin & Star, 2011; Smith & Stein, 2011). Through the process of planning lessons with several possible strategies in mind and set questions for each of these strategies at hand, teachers can be better prepared for addressing situations which arise (Smith & Stein, 2011). Reviewing teaching episodes provides educators a necessary lens for analyzing student thinking and understanding opportunities they can draw on in the future. This was particularly important for the participants in this study as they teach only one section of each class and do not have a means of clarifying content as the day progresses, as would secondary teachers in larger schools where they have multiple sections of a single course.

The application of knowledge concerning how rural mathematics teachers approach their job may seem to be an issue affecting only the least populated states in this country, but Beeson and Strange (2000) make the point that states with larger urban centers and high populations may also contain a large number of rural communities. They go on to give the example that "More rural Americans live in New York State than in Idaho, Montana, Nebraska, Nevada, North Dakota, South Dakota, Utah, and Wyoming combined" (Beeson & Strange, 2000, p. 7). Better understanding the experiences of rural teachers may provide

some insight into the ways teachers in these locations approach planning and instruction in mathematics.

Limitations/Delimitations

This study does not suggest the results are directly applicable to every research situation. The sample size for this study reports data from one rural school district, which contained only three teachers instructing all mathematical courses from sixth grade through “senior math” at this school. The relative small number of teachers involved in this study creates the situation where data may not encompass generalizable results, but this was not the direct goal. The process of capturing the lived experiences of rural teachers engaging in structured teacher noticing created a worthwhile case to examine the impacts of this type of investigation.

Measures were taken to ensure saturation of data and these will be explained thoroughly in chapter three of this document. Briefly, the researcher conducted multiple observations of each teacher on days where tasks were filmed (task days) and days where instruction was not filmed (non-task days) to gain a better understanding of the holistic picture of practice. Both formal, semi-structured and less formal interviews were conducted with each teacher at the beginning, the middle, and at the conclusion of the research project to document the *in the moment* belief of the individuals. Multiple artifacts were collected including the researcher’s notebook, email correspondence, teacher reflections, worksheets, task planning work, and student work samples. Although this is a relatively small population to study, a wide range of data were collected and available for analysis at the conclusion of this project.

Definition of Terms

Curriculum. For the purpose of this study, curriculum was defined as the operational curriculum, or "what actually occurs in practice through the enactment process" (Remillard & Heck, 2014, p. 708) when teachers utilize available standards, instructional materials, and assessments of learning. Resources may be produced externally, such as in the case of a textbook or web-based materials, locally by the classroom teacher, or may represent a conglomeration of textbook and teacher derived resources.

Mathematical Task. Stein, Grover, and Henningsen (1996) characterize mathematical tasks as problems "having more than one solution strategy, as being able to be represented in multiple ways, and as demanding that students communicate and justify their procedures and understandings in written and/or oral form" (p. 456). This definition distinguishes tasks in this project from mathematical exercises provided by the teacher to students for the review of a concept or the practice of a particular skill.

Noticing Event. Sherin and Star (2011) clarify this term as those episodes occurring during instruction which teachers recognize as having significance in some way. These are the events which teachers consider meaningful.

Professional Teacher Noticing. Jacobs et al. (2010) describe noticing of children's mathematical thinking as requiring three components (a) attending to student thinking, (b) interpreting student understanding, and (c) responding to student thinking based on what has been noticed.

Professional Vision. Goodwin (1994), although referring to ethnographic studies conducted by anthropologists, defined professional vision as "socially organized ways of seeing and understanding events that are answerable to the distinctive interests of a

particular social group" (p. 606). Sherin (2001) applied this same construct to both the work of teachers and educational researchers.

Reform Mathematics. This term was given to instruction of mathematics that supported the development of students' conceptual and procedural understanding of content. It is a vision of mathematics education perhaps best articulated by Principles and Standards for School Mathematics published in 2000 by the NCTM.

Rural. The Idaho State Department of Education (ISDE) uses the following two criteria created in Idaho Senate Bill number 1165 to identify rural schools:

1) There are fewer than twenty enrolled students per square mile within the area encompassed by the school district's boundaries; or 2) The county in which a plurality of the school district's market value for assessment purposes is located contains less than twenty-five thousand residents, based on the most recent decennial United States Census (ISDE, 2015-16 Rural Districts as defined by Idaho Code §33-319, 2015).

Teacher Capacity. Stein and Kaufman (2010) describe this as a teachers' knowledge of mathematics for teaching, a teacher's education, the classroom experiences a teacher has had, and the mathematics professional development the teacher has experienced. The blending of these four components created a means of describing the teacher's facilities in approaching the process of teaching.

Video Club. Sherin and van Es (2009) define a video club as a meeting where a group of teachers "watch and discuss excerpts of videos from each other's classrooms" (p. 21). For this study, video club referred to a meeting of all participant teachers and the researcher where edited video was shown from each teacher's classroom depicting tasks the participants implemented with students.

Conclusion

Chapter one outlines the study which was conducted and has provided an overview of the problem, the purpose of the study, research questions, the researcher's perspective and assumptions, a rationale for significance, and prevalent terms which will be referenced throughout the document. Chapter two provides a deeper understanding of the literature related to the terms listed in chapter one and conveys the theoretical underpinnings of this project.

CHAPTER 2: Literature Review

Mathematics education has often been publicized in relation to its impact on both the economic and political security of the United States. The National Defense of Education Act of 1958 [NDEA] stated “the congress hereby finds and declares that the security of the Nation requires the fullest development of the mental resources and technical skills of its young men and women” (NDEA, 1958, section 101, p. 1581) and specifically referred to science, mathematics, and modern foreign languages as areas needing the targeted focus of the educational system during the onset “America’s position in the world may once have of the Cold War. Similarly, in *A Nation at Risk*, The National Commission on Excellence in Education [NCEE] (1984) claimed “America’s position in the world may once have been reasonably secure with only a few exceptionally well-trained men and women. It is no longer” (NCEE, 1984, p. 6). More recently, in the final report of the National Mathematics Advisory Panel [NMAP] (2008) it was stated “the eminence, safety, and well-being of nations have been entwined for centuries with the ability of their people to deal with sophisticated quantitative ideas. The safety of the nation and the quality of life …are at issue” (NMAP, 2008, p. xi). This relationship between mathematics education and the perceived security of the U.S. has been a long and sordid history; the role of mathematics educational research is to assist teachers in delivering content aligned with helping students be part of a competent citizenry, which implies understanding what is learned and being able to apply mathematics to building new knowledge.

A Brief History of Mathematics Education in the United States

The first printing of *The Schoolmaster’s Assistant: Being a Compendium of Arithmetic Both Practical and Theoretical* by Thomas Dilworth in the United States was completed in 1773 (Jones & Coxford, 1970). This was a popular resource for early teachers of mathematics, akin to textbooks used in modern methods course taken as part of a

teacher preparation program. The prescribed pedagogy of this resource was to state a mathematical rule, demonstrate examples of the rule to clarify its workings for students, and then to assign similar problems to be completed through applying the information from the lecture (Jones & Coxford, 1970). For many, this may seem to be a familiar model of learning mathematics content (Hiebert et al., 1996).

The passage of the *Northwest Ordinance of 1787* required the construction of schools across the country and this meant education would become more accessible to the masses. Universities realized the need for more uniform entrance requirements as increased numbers of students were applying for admission. This led to the development of the National Education Association's [NEA] Committee of Ten in 1892, which focused on secondary education requirements (Kliebard, 1987). The committee's recommendations created the expectation for algebra and geometry to become subjects taught within the high school curriculum (Jones & Coxford, 1970). In 1895 a similar group organized by the NEA, the Committee of Fifteen, was developed to consider the elementary curriculum. Their work suggested the need for teaching arithmetic, until this time a high school course, in the elementary grades (Jones & Coxford, 1970). With the rise of competing theories in the relatively new field of child psychology, many felt the recommendations of these groups did not meet the needs of all high school students (Kliebard, 2002).

With an eye to the German schools of the time, the *Cardinal Principles* report was commissioned in 1918 to create comprehensive high schools which differentiated curriculum based on prospective vocational interests and societal responsibilities of students (Kliebard, 2002). This expansion of the curriculum taught in high schools deemphasized the subject of mathematics and relegated it, in some situations, to a status of application possibly surfacing in other courses (Jones & Coxford, 1970; Kliebard, 2002). Jones and Coxford (1970) state this was a low period for involvement of the mathematics

community and led to the neglecting of both the high school and elementary curriculums for several decades with “major research of the period… directed chiefly by educational psychologists” (p. 132). Not until the end of the Second World War did universities reenter the domain of curriculum development.

The advent of the cold war and subsequent space race which was spurred by the launch of Sputnik in 1957 by the Russians, ushered in a new era in mathematics education in the United States. The connectionist psychology of Thorndike and behaviorist theories of Skinner were replaced by discovery learning which emphasized students understanding and manipulating mathematical ideas in tangible ways (Woodward, 2004). Fueled with monies provided as a result of the NDEA, the School Mathematics Study Group, which represented a loose conglomeration of university mathematics and mathematics education faculty, began writing its curriculum which was proclaimed as “new math” in 1958 (Spring, 1989). The goal was to revitalize the academic rigor of the K-12 mathematics system (Woodward, 2004).

Spring (1976) discusses how schools of the 1960s became places where the “academically talented” (p.44) were identified and cultivated and how the system was not designed to teach the masses, but instead focused only on those with the highest potential. Kline (1973) claims new math took on an air of intellectualism, which favored terminology, axiomatic learning, and symbolic manipulation over applications to other subjects, particularly the sciences, which was in direct conflict with the promise of discovery learning. “The neglect of applications [was] noted and deplored even by some advocates of the new mathematics” (Kline, 1973, p. 93). Although the precedent of the textbook dictating both the curriculum and methodology of instruction had been loosely established from the time of the Committee of Fifteen (Pinar, Reynolds, Slattery, & Taubman, 1992; Sherin & Drake, 2009), the advent of School Mathematics Study Group and similar texts asserted this stance more

firmly (Remillard, 2005; Spring, 1989). These factors in conjunction with the lack of professional development for teachers led to a return to basics movement in the 1970s (Woodward, 2004).

Peressini (1998) cites “when teachers continued to implement the new educational system, parents became dismayed as the importance of their children’s ability to read, write, and compute seemed to diminish” (p.556). The publication of *A Nation at Risk* (NCEE, 1983) provided the public with an accounting of factors threatening American schools. The woeful results of the Second International Mathematics Study added more debate around the effectiveness of school mathematics (Shoenfeld, 2004). The wholesale rejection of the curricular shifts perceived as the failings of new math in the 1970s created a chasm between supporters of traditional arithmetic and those promoting less computational-based approaches. The NCTM published An Agenda for Action in 1980, which purported the “exclusive focus on basics was wrongheaded, and that a primary goal of mathematics curricula should be to have students develop problem-solving skills” (Shoenfeld, 2004, p. 258). This polarization produced a dichotomous break leaving two groups who were set for a war over both epistemology and pedagogy.

The NCTM emerged in the 1980s and 1990s as a voice for student mathematical literacy and conceptual understanding, which was in direct opposition with back-to-basics supporters (Kilpatrick, 1997; Schoenfeld, 2004). Although the NCTM was active in reform movements from its inception in 1920, at no other time previously had the group taken such a strong stand. The publication of the Curriculum and Evaluation Standards for School Mathematics (NCTM, 1989) and the Principles and Standards for School Mathematics (NCTM, 2000) further solidified the group’s role in directing public policy because “standards, after all, are policy documents” (Woodward, 2004). Not all were fully satisfied

with the direction taken by the NCTM and old debates between applications of mathematics and formalism in mathematics education continued to arise.

The *Principles and Standards for School Mathematics* (NCTM, 2000) established six distinctive principles for mathematics instruction and five standard areas encapsulating critical content from kindergarten through twelfth grade. By this time most states had adopted standards documents related to the 1989 NCTM standards (National Research Council [NRC], 2001), which meant the predominance of the NCTM's influence in guiding how mathematics was taught nationally. This drew criticism from many sides. Some parent groups felt the new standards relegated them to the role of passive observer in the education of their children and desired a return to the more basic math they learned as students (Peressini, 1998). University mathematicians such as Hug-His Wu lamented the lack of formalism in the current standards and stated "what is at the heart of such fuzzification is the deliberate attempt to ask questions so vague that students would feel comfortable in tendering partial answers" (Wu, 1997, p. 6). Although many in the field of mathematics education supported the moves towards a more constructivist framework, Kilpatrick (1997) seems to capture the NCTM's role as architect of reform when he states "reform movements in mathematics education turn out neither as advocates hope nor as detractors fear" (p. 961).

The NMAP (2008) bipartisan report reenergized the need for more coherent standards. The description of the American mathematics education system as being "broken" and needing to be "fixed" (p. xiii) was a call for action. The NMAP (2008) specifically identified curricular content, learning processes, teachers and teacher education, instructional practices, instructional materials, assessment, and research policies and mechanisms as key areas for improvement. As states moved forward in evaluating their current standards for mathematics the National Governors Association

Center for Best practices [NGA Center] & Council of Chief State School Officers [CCSSO] (2010) released the CCSSM. This set of standards reflected the collaboration between mathematics education and university mathematics faculty, as well as industry, teachers, and other stakeholders. The goal of coherence and depth of student understanding were foundational in the development of the documents (NGA Center & CCSSO, 2010). In reviewing previous reform efforts back to the Committee of Ten, these standards may be the first concerted effort to strike a balance between application and formalization of mathematics education with a focus on student thinking and understanding, while still giving credence to the development of procedures. While the CCSSM remain controversial politically, they seem to bring into balance the essences of what reformers have been seeking for the last 124 years.

The NCTM Reform Movement in light of CCSSM

One of the major principles of the NCTM's message for the past 36 years has been the need to focus students on understanding the mathematics they are learning. Given this goal, the NCSM (2014) admits "since the 1990s, mathematics education reform has produced only marginal improvement and left many educators either searching for new and more productive solutions or unconvinced that the system is even capable of change" (p. 1). The CCSSM require students to mobilize their mathematical knowledge in new ways. They must not only calculate answers, but also communicate and model their mathematical thinking. Assessments will now measure students' abilities to evaluate the reasoning of others and assess mathematical arguments. The CCSSM "are not intended to be new names for old ways of doing business" (NGA Center & CCSSO, 2010, p. 5). For these reasons, some see the CCSSM as a catalyst for the meaningful implementation of decades of recommendations for school mathematics (Leinwand, 2012; NCSM, 2014; NCTM, 2014).

Table 1

Summary of Dimensions and Core Features of Classrooms that Promote Understanding (Hiebert et al., 1997, p. 12)

Dimensions	Core Features
Nature of Classroom Tasks	Make mathematics problematic connect with where students are Leave behind something of mathematical value
Role of the Teacher	Select task with goals in mind Share essential information Establish classroom culture
Social Culture of the Classroom	Ideas and methods are valued Students choose and share their methods Mistakes are learning sites for everyone Correctness resides in mathematical argument
Mathematical Tools as learning Supports	Meaning for tools must be constructed by each user Used with purpose – to solve problems Used for recording, communicating, and thinking
Equity and Accessibility	Tasks are accessible to all students Every student is heard Every student contributes

Hiebert et al. (1997) articulated five dimensional shifts for promoting student understanding which need to occur for successful mathematics education (see table 1). Although not specifically articulated within the CCSSM, connections can be made. These connections may most clearly be captured in the Standards for Mathematical Practice found

at every grade level within the CCSSM. Although the Standards for Mathematical Practice define the work of students and are not directly related to the actions of the teacher, creating an environment where these are possible outcomes requires shifts in classroom practice (Kanold & Larson, 2012). The five dimensions defined by Hiebert et al. (1997) categorize multiple aspects of the classroom from student roles, teacher behavior, curriculum use, instructional considerations, use of models, and the need for communication. Furthermore, these dimensions can be recognized in various bodies of research appearing in NCTM literature and have possibly influenced the authors of works such as the Principles and Standards (NCTM, 2000) and Adding it up (NRC, 2001). Through the next several sections of this paper particular consideration will be given to these dimensions.

The Role of the Student in an era of CCSSM

The back-to-basics curricula implemented during the 1970s promoted doing mathematics as a means of learning and as a result students adopted a passive role in the formation of mathematical knowledge. Although most students enter kindergarten with a desire to become mathematically competent, nurturing and growing this view has been difficult in a climate inclined to reward skills over conceptual understanding (NRC, 2001). Hiebert (1999) reports that students who experience rule-driven learning of mathematics struggle when they encounter mathematics they have not already learned. In addition, Gravemeijer and Galen (2003) claim “students misapply rules they have learned as isolated, mathematical procedures” (p. 114). Conversely, students who experience the ability to discuss mathematics in an environment where it is acceptable to make mistakes have a tendency to attribute their prowess at mathematics as innately attached to their own ability and consequently tend to have more confidence in themselves and their skills as mathematicians (Middleton & Spanias, 1999).

Table 2

Standards for Mathematical Practice (NGA Center & CCSSO, 2010, p.6-8)

Make sense of problems and preserve in solving them
Reason abstractly and quantitatively
Construct Viable arguments and critique the reasoning of others
Model with mathematics
Use appropriate tools strategically
Attend to precision
Look for and make use of structure
Look for and express regularity in repeated reasoning

The Standards for Mathematical Practice (see Table 2) were formed from materials provided by the NCTM (2000) and NRC (2001) (NGA Center & CCSSO, 2010). These are the defining characteristics of proficient mathematics students within CCSSM. The Standards for Mathematical Practice encompass a multifaceted view of mathematics focused on reason making, communication, modeling, and perseverance. The CCSSM push students to make sense of their work, continually seeking meaning in content addressed in the classroom. Students are asked to view mathematics as a tool, searching for structures and regularity of the problems they are solving; thus abstracting formal meaning in mathematics from the situations they face in both the classroom and real world. Through the act of connecting a single problem and the larger aspects of mathematics, students are required to communicate their reasoning and evaluate the reasoning of others. Whereas communication in the past had been primarily abstract equations and formulas,

CCSSM requires the creation of models, written argument, and verbal justification. Precision is not only defined as finding correct solutions, but also in how those solutions are discussed. Students are expected to build their own perseverance in solving problems; persistent problem solving involves students developing an efficacy attempting tasks and an understanding of what it means to be successful. Overall, the Standards for Mathematical Practice present lofty expectations for students, which mean teachers must engage a specific pedagogy which embeds these standards into practice.

The Role of Teachers in an era of CCSSM

Traditional mathematics teachers come to the field often believing the content is a fixed set of procedures predicated on given facts and their role as communicating these facts and providing adequate opportunities for students to practice what has been taught (Lobato, Calrke, & Ellis, 2005; Smith, 1996). Reform mathematics teaching advocates, and the CCSSM presumably necessitates, teachers embracing student thinking as a critical component of classroom learning (Ball et al., 2001; Franke et al., 2001; Gravemeijer, 2004; Hiebert et al., 1997; Jacobs et al., 2011; Loucks-Horsley, Stiles, Mundry, Love, & Hewson, 2010; NCTM, 2000; NGA Center & CCSSO, 2010; Polly, et al., 2013; Schifter, 1998; Stein & Kaufman, 2010), which may be classified as having a student-centered focus. Utilizing student thinking in meaningful ways for classroom learning requires a different conceptualization of the classroom environment and can create some discomfort for teachers transitioning to this new pedagogy (Schifter, 1998; Simon, Tzur, Heinz, Kinzel, & Smith, 2000).

When teachers move towards a more student-centered paradigm, they are forced to grapple with what constitutes good teaching. They must now struggle with understanding how their students best learn, which may conflict with their own experiences as a learner; internalized questions of a teacher's own knowledge base may arise. This is an especially

difficult time, and may lead to a decline in efficacy, for the teacher who had considered herself a successful teacher in the traditional transmitter of knowledge classroom (Smith, 1996). Lobato et al. (2005) caution this may in fact be “disempowering to teachers” (p. 105). Guskey (2002) suggests the attitudes of teachers towards such reform efforts require evidence of the impact on students’ learning to be substantial. In order to realize such impacts, a number of factors regarding teacher knowledge of both content and learning must be considered.

“Teaching necessarily begins with a teacher’s understanding of what is to be learned and how it is to be taught” (Shulman, 1987, p. 7). The advent of the term Pedagogical Content Knowledge [PCK] (Shulman, 1987) captured the need to define the interplay between the content knowledge and pedagogical capacity necessary for teaching a given topic. This knowledge is specific for the act of teaching and may not be necessary for someone in applied fields involving mathematics (Ball & Bass, 2000). Further refinement of the term yielded the term Mathematics Knowledge for Teaching [MKT] as a way to specifically capture the work done in the instruction of mathematics and the addressing of student thinking in the classroom (Hill, Rowan, & Ball, 2005). Silverman and Thompson (2008) assert “a person’s MKT [is] grounded in a personally powerful understanding of particular mathematical concepts and as being created through the transformation of those concepts from an understanding having pedagogical potential to an understanding that does have pedagogical power” (p. 502). The NMAP (2008) report indicates a direct connection between student proficiency rates within mathematics and a teacher’s MKT.

Hill, Schilling, & Ball (2004) attempted to delineate the concept of MKT further through empirical measures. Isolating various factors for testing, they developed an assessment for evaluating a person’s knowledge of mathematical content and their knowledge of student thinking. They found they could discriminate between the results of

those who taught mathematics and those who did not teach, but had a strong understanding of the content. Their results suggest the notion that the understanding a person brings to the classroom must transcend mere content knowledge. Furthermore, they conjecture that because these two distinct properties exist, it is possible that an individual may contain one without having the other. Addressing a lack of content knowledge may be simple enough as providing courses focused on mathematical topics may help to build this understanding. If teachers do not possess a specialized knowledge of content (Hill et al., 2004) developing this would be a necessity for anyone in the field of K-12 education.

Teacher learning in Idaho. In anticipation of new standards, the state of Idaho began delivering a state mandated course in 2008 to develop teacher of mathematics and administrators' MKT. The Mathematical Thinking for Instruction courses focused on supporting teachers' understanding of the number strand (NCTM, 2000) for classroom application. Three levels of the course were designed to meet the needs of teachers through the K-12 spectrum. The courses introduced teachers to the concepts of guided reinvention and mathematizing (Freudenthal, 1973; Treffers, 1987) as pedagogical constructs. Using "Hiebert et al.'s (1997) five core features and a sixth feature of classroom discourse" (Brendefur, Theide, Strother, Bunning, & Peck, 2013, p. 66) led to the development of a five dimensional framework for Teaching for Understanding.

The courses attempt to embed teachers in a culture of examining student thinking through the lens of content and pedagogy. Throughout the 45 hours of the class, teachers and administrators engage in solving mathematical tasks, analyzing those processes, and discuss various solution pathways students may take when solving similar problems with peers. The intent is to provide teachers with initial experiences in what may be a new vision for teaching while also providing a safe environment for people to learn from each other (Loucks-Horsley et al., 2010; Wilson & Berne, 1999). McLaughlin and Talbert (2006) claim

"even the highest-quality professional development resources will falter unless teachers can work together on new ideas and reflect on practice and its implications for students' learning" (p.3).

In addition to the course, teachers and administrators are provided follow-up support from a Regional Math Specialist which is the role filled by the researcher for the past six years. Teachers and administrators can contact the Regional Math Specialist to come to their school to meet with individual teachers, teacher teams, whole schools, or school districts to provide any level of mathematics support they feel is needed at any time after they complete the course. The Regional Math Specialist currently continues to provide classroom support, building-level professional development, district-level professional development, curriculum writing assistance, and general consulting to both teachers and administrators in all topics regarding the teaching of mathematics in the K-12 system. All teachers in Idaho who have completed one of the state approved courses, such as Mathematical Thinking for Instruction, can receive this support at no cost to themselves or to the school district. Often the services provided to the individual, building, or district reflect a body of literature supporting reform mathematics principles or ideas derived from the experiences of the Regional Math Specialist while enacting the work developed in the Mathematical Thinking for Instruction class.

As teachers complete the Mathematical Thinking for Instruction courses, they begin searching for resources to use in their own classrooms. As many attempt these prescribed pedagogies, they encounter an enigmatic situation of believing "teaching students algorithms that they do not understand [has] a limited potential at best, and more important, [lead] to isolated skills that do not contribute to students' general mathematical knowledge" (Gravemeijer & Galen, 2003), but being asked to use traditional, skill-based curricula. This development of critical consumership of curricular resources among these teachers pushes

them to search beyond “designated curriculum” (Remillard & Heck, 2014, p. 710) as defined by the school district in which they teach.

Mathematics Curricula

The development and use of curricular resources by teachers is a multifaceted endeavor and encompasses a wide body of research. Remillard (2005) asserts “over time, studies of teachers’ use of curriculum materials have changed considerably as ideas about the nature of teaching and the materials themselves have evolved” (p. 215). Remillard (2005) describes three categories of curriculum: (a) the formal curriculum which embodies the goals delineated by policy makers and curriculum developers, (b) intended curriculum refers the teacher’s plans for delivery, and (c) the enacted curriculum which captures what actually occurs in the classroom. Remillard and Heck (2014) further refined this list as the ideal, formal, instructional, operational, and experiential curriculum. For the purpose of this study, particular focus was given to the enacted curriculum which correlates to the operational and experiential curriculum defined by Remillard and Heck.

Curricular enactment. The concept of the teacher-proof curriculum first emphasized during the period of new math created a foundation for passivity of teachers in curriculum development (Remillard, 2005). The desire for teachers to instruct with fidelity to the materials provided by districts in order to produce proficiency in student outcomes is not a surprising (McClain, Zhao, Visnovska, & Bowen, 2009). Remillard & Heck (2014) state that, for reasons such as this, the textbook becomes elevated to an irrefutable status at the classroom level. McGee et al. (2013) discovered during their study that even after significant professional collaboration, teachers accustomed to viewing the text as the authority on what should be taught often sought the approval from the research team in their use of new materials. This matches McClain et al.’s (2009) findings that the level of

fidelity to a curriculum imposed upon a teacher may directly affect the individual's sense of professionalism.

More commonly held beliefs about curricula debunk the myth of the teacher-proof curriculum as having ever existed (Sherin & Drake, 2009). Chval, Chávez, Reys, and Tarr (2009) eschew the fallacy of fidelity as it is difficult to clearly define and therefore difficult to measure. They instead promote the term "textbook integrity" (p.72). Therefore, if the curricular resources provided by the district to the teacher are seen as tools, such as Brown (2009) proposes, their enactment can be categorized and thus measured. Brown suggests these categories of use take the forms of "offloading," "adapting," and "improvising" (p. 24). Offloading is when teachers use the materials as presented by the curriculum developer, adapting occurs when teachers make some changes to the materials when need arises, and improvising is when the materials are marginally used in the course of teaching and may only be referred to intermittently.

Curriculum developers often release curricula with the assumption that the implementation of the materials will promote new pedagogies in the classroom (Sherin & Drake, 2009). Davis and Krajcik (2005) suggest the development of educative curriculum, those curricula which have a specific goal of helping teachers to better understand both the content being taught and the rationale for how the content is sequenced within the materials, could result in teaching which better matches the intent of those who developed the curriculum (i.e. the intended curriculum). Stein and Kim (2009) claim the transparency of educative materials would help teachers to see their role in delivery of the curriculum. This also could support the teacher's ability to adapt materials, but much of this would involve what Brown (2009) terms pedagogical design capacity [PDC].

A teacher's ability to mobilize the knowledge they have for teaching, including content, pedagogy and student learning, and the resources they have available in order to

make decisions for instruction is what Brown defines as PDC. The depth of a teacher's PDC influences whether the adaptations she makes to curricula will be successful or not (Davis, Beyer, Forbes, & Stevens, 2011). A teacher's curriculum vision enables the teacher to trust the curriculum and also to recognize the larger concepts within the lesson, it leads to better decision making and the recognition of when materials need to be adapted to better meet the needs of learners (Sherin & Drake, 2009). Drake, Cirillo, and Herbel-Eisenmann (2012) cite the need for teachers to consider their district expectations, students' mathematical thinking, and the curricular materials they have available when developing individual curricular vision.

The experiential curriculum as defined by Remillard and Heck (2014) relates to student outcomes when confronted by the curriculum as enacted by the teacher. Remillard and Heck further suggest the enactment of curriculum should allow students to interact with the material on various levels. With the necessity of student communication and thinking being key aspects of the CCSSM (NGA Center & CCSSO, 2010), teachers need ways to design with these goals in mind. Because many traditional curricula still place students in a passive role, teachers need to develop tasks which elicit these responses from their students. Having a strong curriculum vision may assist teachers in selecting tasks, which meet students' needs (Drake et al., 2012).

Task-based learning. Good mathematical tasks create situations where students must engage their previous mathematical experiences in ways that lead to further understanding (Kang & Kilpatrick, 1992; NCTM, 2014; Stein, Grover, & Henningsen, 1996; Stein et al., 2009). These tasks leave behind a "residue" (Heibert et al., 1997, p.22) or trace of the mathematical structure on the learner. It is the teacher's role in selecting or creating tasks to understand the potential for the given task to address the given outcomes and understand the scope with which the task may affect current and future learning for the

student (Ball & Bass, 2000). Tasks, when developed with focused objectives in mind, may aid in uncovering what students know and their ability to apply previous knowledge in situations where a direct solution pathway is not clearly presented.

The process of teaching with tasks necessitates the teacher's ability to "unpack mathematical topics they know well and to reexamine these through the eyes of learners, as well as to be able to work with many learners simultaneously in classrooms, each with unique backgrounds, interests, and learning needs" (NCTM, 2014, p. 12). The enactment process is not always clearly delineated by the task itself, the curriculum resources the task is taken from, or by previous experiences with teaching. Jacobs et al., (2010) observe the teacher's role in deciphering "children's messy, and often incomplete, strategy explanations" (p. 194) creates further challenges as students grappling with unfamiliar content or context are often unable to fully articulate structures they discover while engaging in tasks. The teacher's goal for mathematical formalization can, at times, veil their ability to appreciate the process students navigate in approaching a particular task. This is a potential liability as the journey towards a solution may be the most important aspect of giving a task in the first place. Teachers must slow down and allow students the time required to conjecture, experiment, and reflect on the task as a learning experience.

Smith and Stein (2011) described five practices teachers should implement to foster communication between students when utilizing tasks in the classroom. They discuss, once teachers have chosen a task, the need for time to anticipate how students may approach the task. In this process the teacher should model several solution pathways for the task as well as compile a list of common misconceptions students may have. During the actual presentation of the task, teachers monitor and select examples provided by students to be presented. Using the anticipated list, teachers can seek out strategies, which present a hypothetical learning trajectory (Simon, 1995) for the discussion of the task. This is fully

recognized during the sequencing stage where teachers order the student work they selected in a meaningful way which will focus the entire class towards the intended goals of the task. Finally, as students present their work to the whole group, the teacher takes on the role of connecting the strategies together, generating curriculum coherence (Cirillo et al., 2009) from the divergent methods employed by the students.

One of the purposes of using classroom tasks is their emphasis on making explicit the thinking students use during problem solving (Franke et al., 2001; NCTM, 2014; Schifter, 1998). This is done by teachers through promoting classroom discourse surrounding the tasks presented to students (Chapin, O'Connor, & Anderson, 2003; Hufferd-Ackles, Fuson, & Sherin, 2004; Hiebert et al., 1997; Kazemi, 1998; Yackel & Cobb, 1996). Hufferd-Ackles et al. (2004) describe what they term a "math-talk learning community" (p. 82), which characterizes a classroom where teachers and students participate in an open discourse about mathematics as the premise for all learning. Through the conversational nature of the classroom, students make sense of their own reasoning as well as the thinking of others in the community. The facilitation of the discussion process requires the teacher to attend to the thinking of the students, interpret how the student conceptualized the mathematical topic, and then to respond in an appropriate manner based on how the student perceives the solution (Jacobs et al., 2010). This can be a difficult process (NCTM, 2014) and is foundational to the literature related to noticing of student thinking.

Teacher Noticing of Student Thinking

The premise of noticing student thinking assumes an active role on the part of the teacher. It is built on the interrelationship of what teachers attend to during instruction and how they internalize these events in the process of deciding how to respond. This body of literature emerged from Goodwin's (1994) description of professional vision. Although

Goodwin's original context was anthropological in nature, he generalized professional vision as a "socially organized way of seeing and understanding events that are answerable to the distinctive interests of a particular social group" (p. 606). From here it was adapted to how mathematics teachers organized their practices of instruction.

Sherin (2001) first broached the connection between professional vision and teacher interpretation of classroom events during a project focused on teachers creating video portfolios. Through the process of collecting videos of mathematics classrooms and then having teachers review these episodes later, a dichotomy of interpretation emerged. She recognized her personal lens as a researcher was not the same as those of her participants; she reflected "because teachers and researchers have set out to do different jobs, they inevitably pay attention to different things in the classroom" (Sherin, 2001, p. 89). Sherin found she was able to guide teachers in looking more deeply at the student thinking taking place, reflecting how she viewed the videos, which affected both the teachers' perceptions of the video and their subsequent, in-the-moment classroom decisions. The process was later adapted by other researchers.

Mason (2011) discusses the real purpose of teachers developing their ability to notice student thinking is to better recognize events and react to those in the future. Sherin and Star (2011) use the term "noticing events" (p. 68) to describe occurrences in the classroom which are identifiable and resonate with teachers during the course of teaching. As teachers attune their ability to recognize these events as having meaning they are able to anticipate similar situations and are therefore are able to create routines for responding.

Sherin and van Es (2009) classify two distinctive aspects of the discipline of noticing: the teacher's "selective attention" and the teacher's "knowledge-based reasoning" (p. 21). Selective attention describes the teacher's ability to isolate noticing events during the course of teaching; choosing what to respond to and what to ignore, which relates to

Miller's (2011) description of "situational awareness" (p. 51). A teacher's knowledge-based reasoning is the contextual lens a teacher uses to evaluate noticing events. This draws upon the teacher's MKT, PDC, and experiences working with particular students. Because it is often difficult to distinguish between these two aspects at real-time, classroom speeds, many researchers have adopted the use of video in capturing these events; video clubs where teachers review classroom footage have been useful in this classification process (Jacobs et al., 2010; Kazemi et al., 2011; McDuffie et al., 2014; Sherin & van Es, 2009; Sherin, Russ, Sherin & Colestock, 2008; Star, Lynch, & Perova, 2011; van Es, 2011).

Video clubs and noticing. Leinwand (2012) states "an all too infrequently used approach that teachers and administrators can use to help examine and shift instructional practices is to videotape and collegially discuss selected lessons" (p. 34). The relative ubiquity of capturing video and the benefits of being able to pause and review content presents teacher with an opportunity for meaningful reflection (van Es, 2009). The development of situational awareness takes most teachers approximately five years of teaching before being fully developed, Miller (2011) suggests that teachers, much like athletes, can actually improve this aspect of their practice through the use of video when given the opportunity to explore how they, themselves, would respond in a given situation.

The premise of a mathematics educational video club is to create an environment for a group of teachers to identify noticing events and discuss the student thinking therein. Much like the Japanese lessons studies discussed by Stigler and Hiebert (1999), video clubs present a means for teachers to engage in meaningful conversations about the development of lessons and the resulting teaching. Unlike the lesson study designs, the use of video does not require teachers to view the actual lesson as it is being taught, which is important in situations where the logistics of this is unrealistic given other constraints. In the case of research conducted by van Es and Sherin (2008), the researchers selected

specific clips from the available video which captured salient episodes for discussion by the group. These video clips were often focused on student discourse, which presented opportunities to access the students' thinking during instruction (van Es, 2011).

Jacobs et al. (2010) suggest teachers' in-the-moment decision making is multi-faceted and often appears as a "single, integrated teaching move" (p. 173). They describe these three dimensions as beginning with attending to student strategies for solving a problem, interpreting student understanding, and then deciding how to respond. From their research, they were able to show the capability of teachers to develop more focused abilities to notice specific aspects of student thinking and formulate hypothetical responses while reviewing classroom videos over time.

The *Learning to Notice* framework discussed by van Es (2011) (see Tables 3 and 4 at the end of this section) presents a progression of noticing by teachers. The two dimensions of "what teachers notice" and "how teachers notice" (van Es, 2011, p. 139) emerged as separate categories in her research. What teachers notice is further delineated as "whom" and what "topics" the video club teachers chose for their focus (van Es, 2011, p. 138). In van Es' research, how teachers notice was decided by the teacher's "analytic stance" and "depth of analysis" (p.138). The analytic stance of teachers in the video club is characterized as being either "evaluating" or "interpreting" by van Es (p.138).

The framework creates a trajectory, which van Es (2011) describes as having benefits for "scaffolding teacher learning" (p.149). Understanding how teachers progress through various levels of thinking allows the researcher to anticipate reactions to video content and thus better guide conversations regarding student thinking. A subsequent framework from van Es, Tunney, Goldsmith, and Seago (2014) describes four aspects of productive video club facilitation as: (a) orienting the group to video analysis task, (b) sustaining an inquiry stance, (c) maintaining a focus on the video and the mathematics, and

d) supporting group collaboration. These resources provide support for developing noticing of student mathematical thinking among teachers in video club-based professional development, which is particularly important for rural settings where direct observations of peers is difficult to facilitate due to teaching schedules.

Table 3

Framework for Learning to Notice Student Mathematical Thinking – How Teacher Notice (van Es, 2011, p. 139)

	Level 1 Baseline	Level 2 Mixed	Level 3 Focused	Level 4 Extended
How Teachers Notice	Form general impressions of what occurred	Form general impressions and highlight noteworthy events	Highlight noteworthy events	Highlight noteworthy events
	Provide descriptive and evaluative comments	Provide primarily evaluative with some interpretive comments	Provide interpretive comments	Provide interpretive comments
	Provide little or no evidence to support analysis	Begin to refer to specific events and interactions as evidence	Refer to specific events and interactions as evidence	Refer to specific events and interactions as evidence
			Elaborate on events and interactions	Elaborate on events and interactions
				Make connections between events and principles of teaching and learning
				On the basis of interpretations, propose alternative pedagogical solutions

Table 4

Framework for Learning to Notice Student Mathematical Thinking – What Teacher Notice (van Es, 2011, p. 139)

	Level 1 Baseline	Level 2 Mixed	Level 3 Focused	Level 4 Extended
What Teachers Noticed	Attended to whole class environment, behavior, and learning and to teacher pedagogy	Primarily attend to teacher pedagogy Begin to attend to particular students' mathematical thinking and behaviors	Attend to particular students' mathematical thinking	Attend to the relationship between particular students' mathematical thinking and between teaching strategies and student mathematical thinking

Context of the Study

Results from the 2011 – 2012 Schools and Staffing Survey conducted by the U.S. Department of Education National Center for Educational Statistics (NCES) illuminate the issue for rural schools and more specifically for schools in Idaho. Nationally, rural schools have less access to specialists or coaching available in all subject and for those schools with access, less than 20% of their coaching staff was allocated to the area of mathematics (see Table 5). Of the 380 schools in the State of Idaho reporting a specialist or coaching position, only 31.4% were filled in a mathematics capacity compared to the 69.8% in reading (see Table 6). One may assume some overlap in the roles of these specialists based on the NCES data. The reporting standard for the number of mathematics coaches in Idaho was not met by the survey and for this reason is not presented here.

Table 5

Number and Percentage of Schools (Nationally) that had Staff with Specialist or Coaching Assignments, and Among Those Schools, the Percentage that had Staff with a Particular Specialist or Coaching Assignment, by School Type and Selected School Characteristics: 2011-2012

Community Type	Percent of all Schools that had staff with specialist or coaching assignments	Percent of Math Coaches
City	70.9	34.0
Suburban	72.3	21.4
Town	59.6	20.8
Rural	56.7	16.4

Table 6

Number and Percentage of Public Schools that had Staff with Specialist or Coaching Assignments, and Among Schools Those Schools, the Percentage that had Staff with a Particular Specialist or Coaching Assignment, by State: 2011-12

State	Number of schools that had staff with specialist or coaching assignments	Percent of all Schools that had staff with specialist or coaching assignments	Percent of Reading specialist	Percent of Math specialist
Idaho	380	53.0	69.8	31.4

Most mathematics teachers in Idaho do not have a specifically assigned district support person for their development as a teacher. Isolation is an aspect of all teachers' lives (Leinwand, 2012). Bakkenes, De Brabander, & Imants (1999) define teacher isolation as "the extent to which teachers are restricted from or restrict themselves from interactions with other individuals or groups in the school" (p. 168). In rural locations, secondary teachers may belong to multiple departments or may be their own department (Howley & Howley, 2005). Isolation may be less of a choice and more a result of being the only person

who is teaching a specific class or subject area. Because of their small size, rural school districts might also be limited in supporting teachers' continuing education opportunities, choosing professional development which impacts all of the staff as opposed to content specific options. Howley and Howley (2005) state little empirical research has been done on rural professional development, so few factors regarding implications of professional isolation and teacher development are known.

Conclusion

This chapter examined the research literature relevant to this study. The research presented have constituted various aspects of mathematics education, but share common themes. The requirements for student learning suggested by the CCSSM require teachers to create opportunities for student discourse. Through the use of rich tasks, students can discuss their thinking. Teachers need to skills to build tasks and then to respond in appropriate ways which help students further develop their conceptual understanding of mathematics. The following chapter outlines the research questions and methods for studying how teachers engage in this process.

CHAPTER 3: Methodology

"Not until we consciously set out to observe learning processes can we create the means to organize, describe, and evaluate them" (Freudenthal, 1978, p. 164).

Introduction and Overview

The purpose of this chapter is to present the overall research methodology beginning with a discussion of the questions and then framing the case to be studied, the unit of analysis, and data to be collected. These methods serve the description of how teachers use noticing to better design and implement classroom tasks for instruction. More specifically, this research examined how, when engaged in a video club focused on noticing student thinking, teachers used their experiences viewing and discussing classroom episodes with peers to build instruction opportunities for their own classroom planning and practice. The researcher's interest in this area stemmed from his role as a Regional Mathematics Specialist working with districts implementing CCSSM instruction to a variety of different school districts across the state of Idaho. The research methods subsequently described in this chapter are presented to support the study of the following research questions:

1. How does teacher noticing affect decision making around selecting and implementing classroom tasks?
2. How does engaging in video club meetings focused on teacher noticing affect teachers' ability to identify and utilize pedagogical strategies which promote student thinking?

Research Design

This research employed a descriptive, single-case study approach to address the posed research problem (Stake, 1995). Based upon the focus of the study and the question

posed, using case study methods supplied the best approach to analyzing the variety of data collected (Merriam, 2009). Yin, (2009) states "'how' and 'why' questions are more explanatory and likely to lead to the use of case studies" (p. 9). Exploring decision making of teachers necessitates capturing the holistic nature of teaching through multiple sources of data. Because of the number of variables involved and the relative difficultly in controlling such variables in a teaching environment, the decision to use this method seems most appropriate.

Context and Participants

According to the Idaho State Department of Education (ISDE), of the 143 recognized public school districts in the state (including virtual and charter schools) 107 of these meet one of the two criteria for classification as an Idaho Rural District (ISDE, Idaho Code §33-319, 2015) This means roughly 75% of the state's school districts are designated rural. The National Center for Education Statistics (2015) found over 27% of all secondary and elementary schools in this nation meet similar requirements during the 2012-13 school year. The available literature on rural education topics, and more so in mathematics, is limited (Bush, 2005; Howley, 2004; Showalter, 2013) despite this representing roughly a third of schools in this country. Nyquist and Theobald's (1997) claim the issues facing rural education are often perceived as "liabilities to be overcome, rather than as potential strengths to be nurtured" (p. 2). Bush (2005) stresses the need to explore rural mathematics education as a culture, directly impacting the communities where it occurs. Williams (2005) reviewed some of the popular assumptions about rural mathematics education and cautioned more research is needed to understand the connections between being rural and student outcomes. For this reason, a rural setting was chosen for this study.

The district selected for this study, which will be referred to as Sometown School District, meets the first of the two criteria for rural schools in Idaho; its enrollment at the time

of data collection was one student per square mile according to the ISDE statistics. This school district is separated from the geographic populous of the county and is located 45 miles from the county seat. Since 2003, the number of full time, certified teachers has been reduced from 22.5 to 17.5 and full time administrators have been restructured from 2 positions to 1.6, according to the district's website. In the period from 2003 to 2013, enrollment decreased from 241 students to 219 district-wide. Many of the elementary classrooms consisted of blended grade-levels and secondary teachers were asked to teach in multiple subject areas in order to provide the necessary coverage of courses.

Participants in this study represented all secondary mathematics teachers in Sometown School District. The three teachers identified for this project instructed classes from seventh grade mathematics through advanced and applied courses and all three hold Master's Degrees in education. Teaching experience ranged from 15 ½ years – 23 years of classroom instruction and between 11 and 18 years in this particular district. Because of the small size of this setting, all the participants had responsibilities outside of teaching mathematics (see Tables 7). In addition, none of these individuals instructed the same course more than once in a given day; implying these teachers all had multiple subjects to prepare for on a daily basis.

Table 7

Daily Teaching Assignments for each Teacher by Period

Mrs. Dean	Mrs. Larson	Mrs. Wilson
HS Geometry	8th Grade Science	Algebra C/D
HS Algebra I	6th Grade Math	8th Grade Math
Personal Finance	7th Grade Math	Jr. High Rotation
HS Geometry B	7th Grade Science	Algebra II
Computer Applications	6th/7th Grade PE	Elem. Music
Advanced Math	8th Grade Health/PE	Math Lab

Mrs. Dean had taught for 15 ½ years, 15 of which had been in Sometown School District. Prior to earning her Master's degree in education, she worked a number or jobs, most notably for 16 years in the banking profession. Her background was technical preparation education and she also has a focus in mathematics. She taught exclusively at the high school level.

Mrs. Larson had taught her entire 18 year career in the Sometown School district, 13 of which had been at the secondary level. Although she held an elementary certificate, most of her work was with junior high students. From year to year her assignments had shifted, but her primary positions for the last ten years remained in both science and mathematics. As evidenced by Table 7, she was also responsible for two sections of Physical Education.

Mrs. Wilson has taught for 23 years but has been with Sometown School district for 11. For the past several years she had been teaching mathematics on an emergency certification basis and was currently working to add more permanent licensures to her credential during the study. As with the other teachers in the project, she had multiple responsibilities. She was the music director for the district, delivering elementary classes, as well as providing a home room period for junior high students. Mrs. Wilson taught math for both the high school and for the junior high, which was a unique situation in this study, but not an unfamiliar circumstance for many rural mathematics teachers (Howley, 2003).

Researcher's Role

The researcher in this study was the Regional Mathematics Specialist for Sometown School District as well as other school districts in his region of the state Idaho. In this role, levels of support spanned kindergarten through twelfth grade and varied from district to district, but could be generalized to some degree. Regionally, the researcher offered the

Mathematical Thinking for Instruction classes to both teachers and administrators, which was mandated by the Idaho State Department of Education for teacher certification. At the district level, he assisted in curriculum mapping and delivered professional development surrounding the implementation of the CCSSM. At the building level, the researcher often met with grade level teams to discuss specific mathematical content, implementation of curriculum, task selection, and assessment issues. Some of the school-based visits included team-teaching between the researcher and classroom teachers who had invited him to their school.

The researcher's role at Sometown could best be described as coordinating grade level team meetings and offering classroom support for instruction. The relatively small number of math teachers within the school created a situation where the researcher could work closely with each individual in her classroom. In addition, the video club meetings presented an opportunity where all could feel comfortable expressing their thoughts in a collaborative nature.

Given the responsibilities of both a principal investigator and as a professional developer, the researcher found himself intertwined in the research. For this reason, taking on the role of participant-observer was a logical stance for this study (Yin, 2009). This term is, at times, presented as a generic label for qualitative data gathering (Ely et al., 1991). Merriam (2009) confines this position, referring to the specific purpose of the researcher being situated as both a participant in the study and also as having external responsibilities to collecting data. Furthermore, the researcher may, at times, encounter situations where he or she must leverage responsibilities to the group over research goals. This epitomizes the shifting identity of the qualitative researcher described by Denzin and Lincoln (2003).

Being so close to the materials studied created inherent dangers of a reduced scope of vision. Stake (2010) warns that these dangers may surface as a limited ability to capture

a clear record of the situation or making presumptions about the case and participants based upon the experiences during the study. He suggests the use of audio and videotaping can create a more holistic record for later examination. In addition, periodic "reality checks" (Denzin & Lincoln, 2003, p. 125) also serve to ground the researcher and allow one to refocus on the research goals. For these reasons, the researcher periodically engaged in a process of reflecting on his field notes while confirming with video evidence from classrooms and from video club discussions during the study. When questions arose from either the initial field notes or from the review process, the researcher sought out time with the teachers to address these concerns. This process of reflection and clarification provided a means for better understanding the situation and keeping the researcher from making false assumptions about the data.

Data Collection Methods

Cohen, Manion, and Morrison (2000) state "qualitative methodologies reliability includes fidelity to real life, context and situation-specificity, authenticity, comprehensiveness, detail, honestly, depth of response, and meaningfulness to the respondents" (p. 120). Because in qualitative studies the researcher is the filter of all data analysis (Merriam, 2009), it is vital to examine issues of validity, or trustworthiness, throughout the research process (Yin, 2009). To this end, the data included an initial interview with each teacher, observations of teachers instructing students both on days of video recorded tasks and days of "normal teaching," at least one informal interview with each teacher regarding instruction or curriculum topics, collection of all electronic correspondence, the recording of video club meetings, the use of field notebooks to create a record of the researcher's days in the field, creation of a catalog of teacher task reflections and video club responses, collections of classroom artifacts from tasks when available, and a closing interview with each teacher in the study.

Because of the bounded focus of this study (Creswell, 2007; Merriam, 2009; Stake, 2010; Yin, 2009), described by the sample of teachers and setting, case study appropriately frames the research problem. Merriam (2009) implies the need for the boundedness to be intrinsic; that is, being inseparable from the context being studied. Yin (2009) poses the "rationale for a single case is the representative or typical case" (p. 48). Given the setting of this case and the roles of the teachers being selected, connections to others teaching in rural schools can be made. Yin states the use of single case designs can generate some problems concerning lack of transfer presented by examining only one case. He recommends if one is to pursue a singular case, there is a substantial need to justify the relevance for the specific case chosen. In addition, enough data must be collected from different sources to create "converging lines of inquiry" (p. 115) to corroborate claims made by the researcher.

Through the gathering of multiple sources of information, the data can then be triangulated (Yin, 2009), which adds credibility to the research and presents a full accounting for the reader. Denzin and Lincoln (2003) expand upon this with their idea of crystallization; this takes into account the point of view presented by the researcher and what is illuminated through the process of analysis. In addition, they state "crystallization provides [the field] with a deepened, complex, thoroughly partial, understanding of the topic" (Denzin and Lincoln, 2003, p. 518).

Many individuals discuss the potential subjectivity of the qualitative research because the researcher assumes the role of analyzing the data and thus makes certain decisions regarding how it is to be used (Creswell, 2007; Denzin & Lincoln, 2003; Ely et al., 1991; Merriam, 2009; Stake, 2010; Yin, 2009). In this study, the data will be transparently presented and the lens selected is clearly described for the reader to consider and judge on his or her own (Denzin & Lincoln, 2003; Ely et al., 1991; Merriam, 2009). Denzin & Lincoln

(2003) suggest the “thicker the description that can be produced, the subtler the interpretation that can be made” (p. 168). For these reasons, the data is presented in an attempt to create a trustworthy document which lends to creating a sense of validity of both method and methodology.

Table 8

Sources of Data

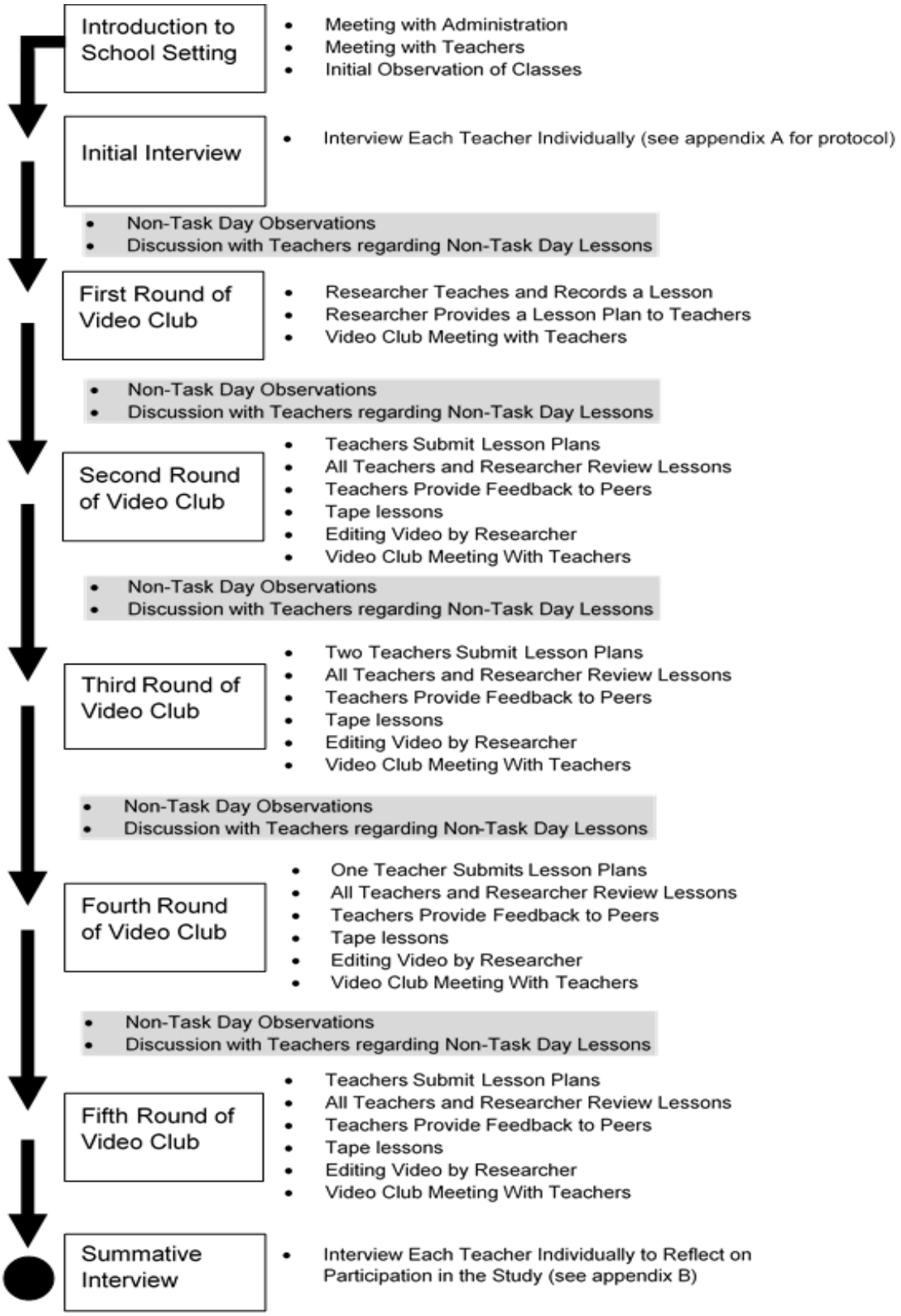
Data Collected	Description	Frequency
Observations	Task days - recorded	Three per teacher
	Non-task days - not recorded	Minimum of six per teacher
Interview	Initial Interview (semi-structured)	One per teacher
	Informal Interview (unstructured)	One per teacher
	Summative Interview (semi-structured)	One per teacher
Video Club Meetings	Recorded Group discussion	Three (whole group)
	Reflection Forms	Three per teacher
Field Notes	Observation Notes (details of events) Observation Reflections (narrative account)	Field notes were collected during each observation and one general entry was made after each day of observations and each video club
Artifacts	Task Planning Documents	Three per teacher
	Email Correspondence	Varied by teacher
	Student Work/Worksheets	Varied by teacher
	Worksheets	Varied by teacher

Data Collected

In line with creating a trustworthy study, multiple sources of data were collected throughout this project (see Table 8). Observations were made on days when teachers were conducting a task that would be filmed and later viewed during the video club (task days) and also on days when teachers are simply following their curriculum (non-task days). In addition, an initial and summative interview were conducted with each participant. These were semi-structured and served to create a deeper understanding of teacher thinking. Video club meetings represented a type of group interview where participants viewed clips of each other's teaching and then discussed aspects of instruction and task selection; these meetings were videoed and transcribed for analysis. Several impromptu interviews occurred during the course of the study as well and were also video recorded. These were individual meetings, informally structured, and mostly focused as a discussion of instruction, which had just occurred in the classroom. Finally, all observation notes, email exchanges between participants and the researcher or colleagues, teacher reflections, and classroom artifacts were also be collected. A visual representation of this can be seen in figure 1.

Observations. The researcher conducted a number of both direct and participant observations throughout the course of this project. Merriam (2009) claims "observational data represents a firsthand encounter with the phenomenon of interest rather than a secondhand account of the world obtained in an interview" (p.117). These particular observations served to better understand the setting and lived experiences of the participants, creating specific episodes which were discussed later in more formalized interviews (Yin, 2009). In addition, because of the nature of the researcher's relationship with the participants in the study, the shared understanding of classroom events made possible impromptu conversations of student thinking and future instruction.

Figure 1. Visual Representation of the Study



In order to combat observational bias, Denzin and Lincoln (2003) claim the researcher should attempt to proceed with as little abstraction in the accounting of observations as possible. Echoing this sentiment, Stake (1995) suggests field notes should provide an “incontestable description” (p. 62) of the events of the observation and thus allow the data to speak for itself when later examined by the reader. This project employed both descriptive and focused observations (Denzin & Lincoln, 2003). In the beginning it was necessary to collect general data on each teacher and their settings; during this time the primary focus of observations was classroom structure and interactions. As the project progresses, more focused observations served the purpose of addressing the research questions, and for this reason specific protocols were developed.

Moreover, it became necessary to characterize different types of observations in terms of what was actually being observed by the researcher. Because all observations represent classroom instruction in some form, days where teachers created and teach a task specifically for the project needed to be distinguished from times when the researcher attended a class session where activities were not designed with the intention of being reviewed by the group. Although it could be argued there should be little distinction between instruction from one day to the next, the researcher presupposed the possibility teachers may teach differently on task day as compared to non-task days because teachers need sustained experiences with specific pedagogies before these become fully integrated into practice (Franke et al., 2001). Any differences would create topics for discussion between the researcher and individual teachers. The different types of observations also represented the possibility for additional levels of interaction by the researcher.

On days where teachers were using one of their project tasks (task days), the researcher attempted to take a removed stance, focusing on being a complete observer opposed to a participant-observer (Merriam, 2009). This was a result of wanting to capture

authentic episodes of the teachers' in-the-moment decision making. The research focus on teacher actions dictated the adopting of this position as a means of creating video items, which could be later viewed and discussed by all teachers. If the researcher were to interfere, suggestions given in the classroom tape may be seen by the other teachers as having some level of correctness, which may hinder reflective analysis of the incident by the group. Simply stated, the researcher could be seen as the authority and discussion may be stifled as a result of not wanting to question his instruction.

Tasks days occurred three times for each participant and were videotaped for review by the researcher and then use later at the video club meetings. The task day was a singular instructional event within a larger process leading up to the day. Each participant was directed to create or find a task and then was asked to anticipate hypothetical student solutions to the problem based upon what they know about their students (Smith & Stein, 2011). The task and anticipated student solutions were then sent via email to the rest of the group (other two participants) and the researcher. This process of publicly sharing tasks and planning was considered an opportunity to provide everyone a context for what they would be watching during the video review sessions. It also created a forum for participants to discuss thinking about instruction. For each teacher's first task, the researcher chose not to respond with his thoughts on the task via email. As later tasks were presented, he did present anticipated student work and some thoughts about how teachers may address the potential issues.

The researcher's observations during the task days served to capture rich episodes of teachers either noticing a particular event or where an opportunity could arguably have been missed. The researcher used the camera as a broad tool for the observation with the understanding that later, more detailed review would take place during the video club meetings. Because the technology was preserving the more minute details, the researcher

was able to focus on specific noticing events and capture his thinking about how and why the teacher reacted in the way she did. Detailed records were still collected despite the videotaping as a way to later analyze the researcher's perception of the episodes as they happened.

Non-task days were less formalistic in nature and the researcher took on a more participatory role in the observations. Whereas the researcher made great effort to resist interacting with students on task days, the opposite was true on the non-task days. Because of the impetus for student thinking within this project, it was important for the researcher to understand what students were doing and their ability to process the lesson materials. The researcher moved around the room while students worked and he attempted to capture student thinking through taking pictures of student work and speaking with individuals. Non-task days served to compile data for later discussions with teachers and also provided a more general depiction of each classroom setting.

The non-task day observations occurred no less than six times with each teacher although the group of students chosen did fluctuate. Because of the wide variety of math courses taught by each teacher, the researcher made a point to see each class at least once. In addition, one specific class for each teacher was selected by the teachers and observed at least four times to create a deeper consistency in the data for that teacher. This also gave the researcher a better understanding of the content and context for instruction for at least one of the groups taught by the teacher.

Interviews. Although observation can create an understanding of the environment and actions of individuals, it does not capture the thoughts and beliefs held by those individuals, this is where the power of interview can add to the richness of case study research (Seidman, 2006). Sherin (2001) observed "teachers and researchers have set out to do different jobs, they inevitably pay attention to different things in the classroom" (p. 89).

For this reason, interview allows a discussion of the rationale of teachers, not just the actions perceived through the lens of the researcher. (Kvale & Brinkmann, 2009). Merriam (2009) states, “interviewing is the best technique to use when conducting intense case studies of a few selected individuals” (p. 88) because of the depth of the data one may collect.

In this project, both structured and informal interviews were used. Each teacher participated in two structured interviews, occurring at the beginning and end of the project. Video club meetings with all the participants were also conducted to examine selected classroom episode for review; these functioned as semi-structured group interviews. In addition, informal interviews occurred throughout the project as teachers wanted to discuss their thoughts about lessons, student work, chosen tasks, and other concerns they had. All of these interactions were either audio or video recorded to create transcripts of the conversations.

Initial interviews. To better understand the lives of teachers in a rural setting, it was important to create an accounting of their experiences based upon how they approached their work. The initial interview (see Appendix A) spanned topics of demographic information, instructional planning, task selection, the implementation of the CCSSM, instructional implementation, and project goals. Observations of each teacher proceeded this round of interviews. Specific themes of interest emerged from these observations.

Because the research goal of creating a mutually beneficial experience for both the researcher and teachers involved (Ely et al., 1991), these interviews allowed for a better understanding of how teachers saw themselves within their current roles and how the project may best assist them in future practice. These conversations then created an internal framework for the researcher to better understand how to proceed; this framework, which combined the perspectives of researcher and instructional coach gave meaning to

the case and created a lens for the researcher to view the development of the project. This lens informed the staging of subsequent group interviews, empowering the researcher to understand personalities and how teachers may interact when they were together. This process was the embodiment of the concept of *researcher as instrument* (Ely, et al., 1991; Merriam, 2009; Miles, Huberman, & Saladna, 2014; Stake, 2010) within this study.

Informal interviews. Less formalized interviews with individual teachers also occurred throughout the project. These were impromptu meetings often took place during the teachers' preparation times and were a natural result of the researcher conducting various, unscheduled observations. The focus of these meetings ranged from specific discussions of tasks teachers intended on having filmed to asking for the researcher's thoughts on curriculum, assessment items, or other content-based or pedagogical questions. No specific protocol was used for these meetings, but descriptions of the questioning can be found within the analysis chapter of this study.

Although these meetings were not always directly connected to the research question, they were videotaped to capture any data which would assist in the understanding of shifts in teacher behavior or thinking as a result of this project. Difficulty presented itself because the role of the researcher was to collect data, but it was also to assist teachers in improving instruction. Recording these discussions ensured a clear account of both roles. Using the framework of the study as the guide, most of these discussions could be directed towards having the teacher consider issues related to the larger topic of teacher noticing. The researcher, constantly thinking about the data collection process and the lens of the project, used the natural flow of the conversations to link back to pertinent areas (Ely et al., 1991).

Summative interview. Returning to discuss teacher noticing and task selection was an important part of concluding this study. Having teachers reflect on what they had

discovered about themselves through this process and insights gained relating to their own practice allowed the researcher to weigh the impact of the project. The interview was structured (see Appendix B) and the questions were developed for all teachers, but focused on aspects of emergent themes from the data. Some teacher-specific follow-up questions were used with certain individuals to gain further understanding of their particular situations. These interviews were also a way to bring the project to conclusion for each teacher; because of the connections made throughout the observations and interviews, it was important for teachers to feel sufficient closure at the end of the project.

Video Club Meetings. Three video club meetings were conducted during the course of this study and included the three teachers and the researcher. These meetings were structured to allow the teachers to reflect on their individual practice, view the instruction of their peers, and participate in a professional discussion of mathematics content and pedagogy. The meetings were videoed for analysis and functioned as a form of group interview, although these unstructured conversations were far less formalized than either the initial or summative interviews. The researcher attempted to focus on task selection and enacted teaching, but teachers were allowed some latitude when it came to topics of discussion. These meetings lasted between 60 and 75 minutes.

Teachers were asked to email their peers and the researcher a copy of the task and samples of anticipated student strategies prior to the video club meeting. This allowed all participants in the meeting to have an initial understanding of the mathematics involved in the lesson and to prepare for student thinking that would emerge from the lesson. Teachers were asked to respond to the emails with additional strategies they would expect students to use or comments on the specific tasks or task instruction.

When teachers arrived at the video club, they were asked to complete a short reflection found on the Video Club Observation Form (Appendix D) regarding what they

could remember about the lesson they had taught. This time was spent to allow teachers to recall pertinent information from the lesson, ponder lingering questions, and generally reenter the lesson, which was previously taped. Roughly five minutes were given for teachers to reflect.

Following the reflection period, teachers viewed the selected clips from their classroom and from the other two teacher's task day observations. The full video time was 25 to 30 minutes in length and was comprised of eight to ten minutes of episodes from each of the classrooms. The video selected from any given classroom may include one primary episode or several examples of student thinking. The purpose was to highlight *noticing events* selected by the researcher to emphasize either missed opportunities or teaching moves which elicited student thinking in order to promote discussion between the teachers. While watching, teachers were given several minutes between episodes to write notes about the episode they had just viewed using the Video Club Observation Form.

At the conclusion of watching the videos, teachers were then allowed to engage their peers in conversations about what was seen. These conversations were informal and mostly directed by the participants, but moderated. The researcher generated questions as the videos were edited to focus conversations towards the research study. These questions stemmed from using the lens of teacher noticing and reflected a progression of characteristics one may expect to see as teachers become more focused on student thinking (van Es, 2011). The discussion structure for the video club was open enough to stimulate a conversation, but formalized enough for the researcher to press the teachers in areas pertaining to the research questions (Ely et al., 1991).

The nature of group interviews can create various difficulties for a researcher (Kruger & Casey, 2000; Merriam, 2009) and this would equally apply to the video club structure used in this study. As Ely et al. (1991) suggests, being "able to swing with events

and to put them to good use" (p. 62) can be difficult during the quick-paced and unpredictable interview process. For this reason, the video club meetings were videotaped so the researcher could review and adjust for subsequent sessions with the group. As Merriam (2009) indicates, the interactions within a group interview create a socially constructed reality of the event. Because all thoughts do not always surface in a group discussion, the teacher reflection forms were collected to analyze specific items noticed by teachers in order to compare them to ideas they were willing to share with the group.

Field Notes. Field notes were collected during and after every encounter with the teachers either individually or as a group. These notes took the form of either observation notes, which attempted to capture the in the moment decisions of teachers during an observation of an individual lesson, or observation reflections, which presented the researcher's holistic thoughts following a day of observing several teachers or following a video club meeting. The field notes were written in a narrative nature and were created through the lens of teacher noticing. Through the constant reviewing of transcripts and observation notes, themes emerged from the data and fostered the development of subsequent lines of inquiry to be addressed during interviews and observations (Ely et al., 1991).

Artifacts. Documents and artifacts collected were mainly generated by the researcher for the sole purpose of gathering data specifically pertaining to this study (Merriam, 2009). Such items included email correspondence between the researcher and the teachers, writings between teachers, task-based lesson plans, formal teacher reflections, interview transcripts, video and audio tapes, samples of student work, researcher protocols, and field notes taken throughout the project. More public items included curriculum materials, worksheets, notes given in class, and other non-task lesson planning materials. Despite interview and observation being the primary sources of data in

a case study (Creswell, 2007; Denzin & Lincoln, 2003; Ely et al., 1991; Merriam, 2009; Stake, 2010; Yin, 2009), “without such multiple sources of data [like documents and artifacts], an invaluable advantage of the case study will have been lost” (Yin, 2009, p. 118). These materials created a more full understanding of the case.

Lesson plans and reflections. Tasks planned by teachers for the intent of videotaping were treated differently from regular classroom planning. All participants were asked to develop tasks and a list of anticipated student responses. These plans were then emailed to the researcher and the other teachers prior to the lesson being videoed for feedback from the group. All communication about the task was asked to take place within an email setting to preserve a record of thinking about the lesson. This process allowed for a public vetting of the task and the hope was it would focus teachers on thinking about the structure of mathematics being addressed by the lesson.

The researcher reflected on the tasks privately, but allowed teachers to respond prior to replying to the email. Because of the relationship between the researcher and the teachers, there was some concern about stifling the conversation by entering in too early. As the project progressed, the researcher posed questions to be considered by the others in hopes of stimulating more discussion prior to videotaping.

In addition to the task-based emails, all other electronic communication occurring during the project was also archived. These reflected questions about scheduling meetings, aspects of the project, and other general questions. Understanding not all of these documents directly pertained to the research questions, it was still important to keep a record of teachers’ feelings about the project, towards the researcher, and concerning their own practice.

District-adopted curriculum materials. The curricular materials used by the teachers were from a single publisher and represented a complete series from sixth through twelfth grade. The series contained a specific textbook for each level of instruction (hereafter referred to generically within this study as the district-adopted curriculum materials), which the teachers used in planning their classes. The materials were approved by the Idaho State Department of Education's 2009 curriculum adoption process (ISDE, Adoption Guide, 2015). Recommended resources could receive one of four classifications: (a) highly recommended, (b) recommended, (c) recommended with reservations, or (d) resources. This rating system was based on, and then correlated to, the former Idaho State Standards for Mathematics and the NCTM's *Curricular Focal Points for Prekindergarten through Grade 8 Mathematics* (2006) and the *NCTM's Principles and Standards for School Mathematics* (2000). A more precise explanation of this rating system is unavailable as the subsequent adoption of CCSSM led to a modified evaluation process and the removal of the former processes from the state website.

The textbooks selected by the Sometown School District were each from the *recommended* category. The range of correlation to the NCTM documents was from 56% for the geometry textbook to 94% for the algebra textbook, with an average correlation of 84%. As there was not a correlation available to the CCSSM for these materials, it is difficult to comment directly on the relevance for the teachers in preparing their students for CCSSM-based assessments. Anecdotally, it appeared the materials referenced the content standards for the CCSSM, but often failed to address the Standards for Mathematical Practice, such as through the use of tasks which required students to communicate their thinking beyond symbolic representations.

Reflection. Teachers were asked to reflect on their own lessons prior to viewing the teaching episodes with the group. In addition, they were asked to reflect on the others'

lessons just after watching the tape. This process was designed to focus teacher on their own teaching and then to collect their thoughts prior to the group interview which followed the viewing of the lessons. These documents were collected at the end of the video club and were analyzed by the researcher.

Data Analysis

The concept of researcher as instrument (Ely, et al., 1991; Merriam, 2009; Miles, Huberman, & Saladna, 2014; Stake, 2010) necessitates such a distinction in order to establish trustworthiness of the data. Simon and Tzur (1999) describe effective researchers of mathematics teacher development as needing to assume both the lens of researcher and also that of teacher, thereby defining the role of the researcher dichotomously. They suggest a strategy of developing "accounts of practice" (Simon & Tzur, 1999, p. 253) whereby the researcher attempts to create a complete and distinguishable account of the teachers' practice, including beliefs, actions, and interactions, which can then be compared to the perceptions of the researcher. For this reason, a specific case of each teacher based on emergent categories of data is presented for review in chapter four. Describing what and how teachers decide to notice and not to notice may be subjective, and for this reason the researcher presents the data as transparently as possible.

When researching teachers engaged in video club professional development focused on noticing of student thinking, van Es (2011) found several dimensions of what and how teachers notice which can be found in table 3. How teachers choose to notice can be broken in to four dimensions: (a) analytic stance, (b) evaluation, (c) interpretation, and (d) depth of analysis (van Es, 2011). Coding of these categories along with specific progressions of what teachers notice aided in answering the research questions presented in this study. Data collected determined levels of teacher awareness of events that occurred both in the classroom and during the video clips selected for review. Analysis focused on

how teachers' discussion with peers and individual reflections regarding instruction changed over time. These data were then compared to both the intended and enacted results of classroom tasks. Ongoing analysis of teacher decision making surrounding task selection and implementation illuminated how engaging in structured review of students' mathematical thinking using a noticing framework influence the choices made in the classroom.

Videos and transcripts. All interviews, both formal and informal, were videotaped to better capture details which otherwise may have been missed. All videos were then transcribed by someone other than the researcher. Transcriptions were coded through on-going analysis involving a process of creating categories, searching for patterns, refining categories, collecting additional data, and further searching and refining of categories, as described in the literature (Ely et al., 1991; Merriam, 2009; Miles, et al., 2014; Stake, 1995; Yin, 2009). Using a two-cycle coding method (Miles, et al., 2014), data were first organized in clusters, which typified categories. These data were then further refined using a system of pattern coding which sought to describe the clusters found during the initial cycle of coding and to better understand the case as a whole. The initial project codebook is provided in Appendix C with descriptions and examples of each code. These were later condensed into categories, which represented commonalities in the coding focused on the researcher questions guiding this study. The three categories were: (a) beliefs about effective teaching, (b) role of classroom tasks, and (c) development and enactment of tasks.

Task days. Data from days when teachers conducted tasks that were videotaped and later edited for use in video club meetings were analyzed in several ways. These data were reviewed through the lens of van Es' (2011) *Learning to Notice* framework (p. 139) by the researcher. The initial analysis of the transcripts was informed by observing "what"

teachers noticed and “how” the teachers noticed (van Es, p. 138). Subsequent, ongoing analysis through deductive coding (Miles, et al., 2014) of these two categories aided the researcher in deciding noteworthy episodes from the video club videos as well as in creating a structure to examine patterns of change over time. These data were notated in a way that allowed for both an examination of individual growth and as a comparison between the three teachers involved in this study. All codes were maintained in a database for future patterns analysis that could be applied to the summative analysis of the data (Merriam, 2009).

Video clubs. All video clubs were also captured on video for later review by the researcher as well. These episodes were viewed for how the participants interacted with each other and for their ability to recognize noteworthy aspects from the video they were viewing using van Es (2011) *Learning to Notice* framework (p. 139). Whereas the analysis of the task days were conducted by the researcher with respect to what teachers noticed about their own students during the process of teaching, the video club analysis targeted the teachers’ noticing of their peers and student thinking beyond their classrooms. These data assisted the researcher in understanding how general cases of noticing transfer to classroom actions. Both individual and group noticing patterns were explored and categorized through the coding process (Merriam, 2009). Both deductive and inductive coding was used to analyze these data (Miles, et al., 2014) based on the van Es framework.

Interviews. The initial, informal, and summative interviews conducted with each teacher provided information regarding teacher baseline, within project, and summative beliefs. The interviews were both compared to each other and then to other data collected during the project. The “how” teachers notice (van Es, 2011, p. 139) category was of particular use here as teachers were asked to reflect on their own perspectives of teaching

and the project at the given point. Through this process, decisions were made about the impact on the participants and modifications to individual and group direction were made. These data also allowed the teachers to voice their own perceptions as to the impact of the project on their work.

Field notes. The researcher collected data through the use of *in class notetaking* on non-task observations, because no video record was available, and through *personal reflections* on these observations which captured more general observations and theories of the teachers' utilization of practices regarding teacher noticing of student thinking. The in class notetaking was done in a two-column style where classroom times and interactions were recorded on the left and the researcher's thoughts were captured on the right. This process served to identify the transfer of project-based knowledge the teachers were using on non-task days as well as to record areas the researcher would later discuss during informal interviews with individual teachers. In addition, these data were used to aid in the interpretation of areas of growth by providing a further record of teacher actions which could be compared to both task day observation, video club, and individual interview data (informal and summative).

The personal reflections of the researcher were written in a narrative format and presented a record of the teachers' overall progress from all observations and interviews at that given time in the project. These reflections were written through the lens of both researcher and instructional coach and therefore included specific references to the research constructs as well as notes relating to suggestions the researcher could make regarding tasks and instruction. The reflections served as a reference for individual teacher progression and were therefore compared to other data to provide a deeper interpretation of events. In addition, the reflections provide an accounting of support provided to teachers

throughout the project. These reflections occurred six times during the study and encapsulated many of the notes made during non-task day observations.

Artifacts. Documents collected during the course of the study were also analyzed. Tasks submitted by teachers through their task planning documents were reviewed and categorized using Stein and Smith's task analysis guide (1998) as one of the following: (a) memorization, (b) procedures without connections, (c) procedures with connections, or (d) doing mathematics. Review of these materials in conjunction with video of the task day lesson was holistically assessed for level of both intended and enacted cognitive demand for the given task. Other artifacts such as email correspondence, student work, and classroom worksheets were reviewed as evidence to support the researcher's analysis of previously mentioned data. Brown's (2009) description of the states of curricular usage (see table 9) served for evaluating the level of autonomy each teacher displayed at various junctures of the project. It provided a measure of their comfort with developing and adapting tasks as they progressed through the project, which aided in answering the research questions.

Table 9

Types of Curriculum Use (Brown, 2009, p. 24)

Curriculum Use	Description
Offloading	Curricular materials, specifically the textbook, are the primary resources for instruction with little alteration to the designer's intentions occurring on the part of the teacher.
Adapting	Curricular materials, specifically the textbook, contribute to the teacher's planning and instruction, but the instructional decisions rest with the professional judgement of the teacher. Some modifications are made to sequencing of topics, lessons, and task selection.
Improvising	The teacher is the primary source for deciding the instructional topics, sequence, and content in a course. The textbook is used as a reference when specific lessons match the teacher's needs. The teacher often uses multiple resources or develops materials on his or her own.

Conclusion

This chapter described the research design, study participants, data collected, and provided a brief outline of the analyses methodology. In addition the chapter presented a timeline for the study and how data collection and analysis were conducted. The next chapter presents findings with additional details pertaining to the data analysis process.

CHAPTER 4: Findings

This chapter presents analysis of data collected while conducting this study. Each teacher's findings are presented as a separate case. For each individual, the same categories are examined as a means of providing an accounting for the experience of these three, diverse educators. These categories emerged from coding the various sources of data involved in this project and from reflection on the research questions guiding the study and include (a) how does teacher noticing affect decision making around selecting and implementing classroom tasks, and (b) how does engaging in video club meetings focused on teacher noticing affect teachers' ability to identify and utilize pedagogical strategies which promote student thinking. A cross-case analysis of the individuals follows to conclude this chapter. The concluding cross-case section compares the three cases and illuminates commonalities among the findings. A summary is then provided at the conclusion of this chapter.

The Case of Mrs. Dean

Mrs. Dean's primary role at Sometown High School was delivering mathematics instruction, but she also delivered courses in technology education. She taught at Sometown for 15 of her 15 ½ years in the education field. She enjoyed teaching application-based mathematics, but throughout the project she maintained a concern that the amount of time required and the content she was required to cover did not afford many opportunities for using rich contextual problems within her classes. She consistently referenced her library of textbooks as her primary planning source and lamented not having a curriculum resource directly tied to the CCSSM. Despite her reservations about participating in the project, voiced in the initial interview, she was open to attempting task-based instruction and was active throughout the year in all aspects of this study.

The following sections provide a review of the interviews, observations, and documents collected from Mrs. Dean during the study. Findings serve to describe the patterns of data and categories uncovered during the process of coding. Each category is presented in a separate section with specific data presented in support of claims. A summary of all findings for Mrs. Dean is presented at the end of this section.

Beliefs about Effective Teaching: Defining Expectations. Mrs. Dean equated good teaching to a structured environment and she felt most comfortable when she had clearly defined expectations regarding what was to be taught. In her initial interview she stated, “My lessons are structured… I like to know what I'm going to say. I don’t fly by the seat of my pants.” She continued with, “I do pretty much the same things [each year]. We’re old dogs and we’re doing old dog things here… I think that what I have done in the past years has been fairly good.” She cited results from pre-CCSSM state mandated assessments as proof, but then clarified, “I realize [the tests are] going in a different direction now.” The uncertainties of new expectations for students created the catalyst for Mrs. Dean to question practices solidified by years of experience.

Beliefs about textbooks: shifts in use. Initial interview data revealed Mrs. Dean firmly believed the best classroom materials were resources found in textbooks or lessons created by those she considered to have more expertise in the field of mathematics education than herself. This form of curriculum enactment could best be described as *offloading*, (Brown, 2009) where the teacher presents the materials as written by the developer and chooses not to make significant modifications. When asked how she decided the important content for each unit during the initial interview, Mrs. Dean stated, “You go by your standards for one thing. And hopefully your book is following your standards.” She continued by saying, “I would like more resources that somebody could just hand me… examples of this and that in the book so that I could start with that and build with that.” Her

classroom contained a single bookshelf comprising of at least three different versions of texts for every class from seventh grade math through calculus; the books spanned more than a decade's worth of district purchases. She revealed several file drawers of three-ring notebooks neatly organized with plastic document protectors holding her lesson plans for every class she taught. These mostly represented the notes she presented to students on various topics each year.

Mrs. Dean made an effort to justify her teaching by referring to the volumes of materials she accessed in the process of planning, but the demands of this method were evident in her comment regarding the amount of "time and energy to actually get in and go through all of these books and find the best tasks and know when to put them in and how to present them." She reluctantly revealed to the researcher, "I hate to say it but your little thing that you're doing is putting that much more on to (pause)… on the plate that's already overflowing." The amount of responsibility she felt towards knowing the wide range of content she needed to cover in her many classes and the changes necessitated by CCSSM caused the researcher to consider his coaching role with Mrs. Dean. It was clear she needed a process for developing tasks, which she could view as an efficient use of her time and as meaningful to student growth. Selecting tasks from her textbooks, although admittedly time consuming, had proved successful for her. This deferral of authority to district-selected materials may be considered an indicator of Mrs. Dean's initial curriculum vision and capacity at the beginning of the project.

Mrs. Dean was willing to create and instruct tasks for the days she was filmed. Of the items she chose, she developed two herself and the third resulted from observing Mrs. Wilson's lesson which addressed misunderstandings similar to those Mrs. Dean observed in her own classes. In addition, Mrs. Dean contacted the researcher on at least one

occasion regarding several tasks she taught on days he was not present. The following is an excerpt from an email she sent to the researcher:

> You gave me some good suggestions when we were talking about exponential functions in my advanced math class. One of them was the bouncing ball. I have made a project for them to do today that I thought you might be interested in. I have attached it to this email. I also did my M&M project, which went well. I like that project because it also gives them knowledge about their calculators. If you have suggestions to improve, please let me know.

This examples provides evidence of Mrs. Dean's willingness to create her own tasks and begin to diverge from the curricular materials and to supplement her textbook with new experiences. In the email she specified both tasks she had previously discussed with the researcher and those she had not. Mrs. Dean often contacted the researcher regarding her planning process, but towards the conclusion of the study she emailed more often with results she was seeing rather than to seek tasks the researcher thought she should be doing. Her ownership for selecting tasks continued to grow throughout the project.

During the summative interview, Mrs. Dean continued to view the textbook as a primary resource for instruction, but she also discussed the importance of the CCSSM in determining essential topics for her future classes. Findings suggest Mrs. Dean was in a preliminary stage of questioning her curricular enactment by the culmination of the study. In the summative interview she stated, "[the three teachers] need to sit down and go through the Algebra 1 book and we need to say, these are all in there," but followed this with "I'm unsure of what it is that's expected as far as the state of Idaho is concerned." This place of uncertainty led to a questioning of how decisions about instruction could be made in the future and resulted in her commenting that, "We need to really look at the curriculum all the way up to see, if [other teachers are] really covering this area really well, do I need to do it

again?" The diminishing rigidity of Mrs. Dean's views regarding the use of the text are further evidenced by the following:

> I want to be able to teach what they give me in the book in the right way so that it automatically aligns to whatever I'm doing. I don't know if that makes any sense but I would like to… I know what I want to teach. And I know that if I could just find a way to get this understanding or that understanding, it probably aligns to ten things.

In some ways, it appeared Mrs. Dean had more questions than answers, but was committed to developing an understanding of her own best practice. She was seeking vertical team meetings to make these determinations, which suggest the impact of engaging in the video club experience with her peers. Using Brown's (2009) categories of curricula enactment, it could be implied Mrs. Dean was beginning to transition from offloading into an adapting stage where the teacher continues to use the text as the core resource, but makes modifications based on the needs of students. Her willingness to develop some tasks on her own underscores this shift.

Mrs. Dean's questioning of the planning process indicates a change in her thinking during course of the study. Although she still sought textbooks with lessons, she saw the need for making modifications both to the topics addressed and in the presentation to students, recognizing questioning student thinking as a critical addition. Mrs. Dean's desire to have a resource which presented the materials "the right way" gave credence to a belief that the research process affected her planning process and developed a revised lens through which she now viewed her classroom materials. She continued to show reluctance in making drastic change, but the uncertainty about the resources she had been using indicates some potential for future modifications, at least relating to how she would engage in developing and implementing materials.

Effects of student thinking on instructional planning. Mrs. Dean's belief in the potential positive effects of purchasing new curricular resources appeared to mitigate her focus on student thinking in making instructional decisions for most of the study. When asked to describe how CCSSM had impacted her teaching, during the initial interview, Mrs. Dean stated, "I think the [student] thinking… I think they're making you think things through a little more, upside down, backwards maybe. Again, it's a good thing. Learning how to… think your way through problems." She immediately followed this with "I think they should make them still do their times tables. Teach the basics, the reading, writing and arithmetic… I don't think we should forget those things…. and if we can teach them to think, too, then hey." These examples encapsulate Mrs. Dean's preliminary view of what it meant to teach the new standards; the need of student thinking is quickly coupled with students having more traditional mathematical skills in place. Mrs. Dean focused on students having procedural understanding for mathematical operations as a recurring topic during conversations.

Concerns regarding new testing requirements surfaced during the initial interview. Mrs. Dean disclosed, "I like teaching with those methods that the [CCSSM-based test] is going to be talking about. I'm not sure about testing these kids so soon..." She continued, "I still think it's going to be hard, poor kids." Mrs. Dean did not believe all students would be able to meet the new demands and she presented her Advanced Mathematics class as a case where she had reduced the amount of work she gave them because she did not otherwise believe they would be successful. She commented, "I've changed actually the way I teach advanced math because of this class.... I've learned through the last few weeks, the first weeks of school, that I'm just going to have to do less this year." These findings illustrate Mrs. Dean's perception of student thinking as well as address her initial process of noticing and how this informed her instructional decision making. She was

worried that students were not necessarily capable of the new requirements in the CCSSM and this caused her to reduce the demand on students. Non-task day observations revealed this often equated to the presentation of teacher-created note taking documents.

The researcher attempted to illuminate opportunities throughout the study in order to engage Mrs. Dean in conversations about student thinking and how this could be used to plan her instruction. One instance was during her informal interview when she revealed her third task would be the one used previously by Mrs. Wilson. The following is how Mrs. Dean depicted the rationale for her choice:

> I would really like them to come out of this with is not necessarily the slope and what it means and the y-intercept and all that. But to understand that I can find the solution is where they have common ground… And so I would love them to figure out that if I can get some… I don't have to know the exact answer. All I have to know is two numbers that work…

She went on to describe how the students would procedurally complete the graphs for each of the lines. The researcher then asked Mrs. Dean, "Well, so how would you interpret those lines?" After spending nearly ten minutes discussing structural aspects of the task and what the researcher saw as significant, Mrs. Dean reasserted her desire to focus on students' understanding that they could find two possible points for either equation, plot the points, and then draw the two resulting lines in order to locate a point of intersection. In response to structural conversation she stated,

> When I'm going through my classes, you know what really gets these kids is the graphing. They hate to graph and it goes all the way up to advanced math. And understanding what's going on here, I think, is really important in a graph.

Despite the researcher wanting Mrs. Dean to address deeper mathematical understanding in her instruction, she was taking what she noticed from her students and building her instruction towards a related outcome. The researcher withdrew the suggestion for Mrs. Dean and allowed her to continue to discuss her plans for the task. He realized that Mrs. Dean conceptualized teacher noticing of student thinking as a deficiency model approach; she would observe students lacking proficiency with a concept or a skill and then her role was to plan lessons, which addressed the missing information. This episode reveals the complexity of Mrs. Dean's shift of instruction towards the use of student thinking and provides evidence addressing the research questions.

Mrs. Dean agreed with the premise of student thinking being important, but her views of student ability, at times, affected how she actualized her belief. In the summative interview she described three categories of students in the task-based classroom: "There's the thinkers and then there are the people that feed off the thinkers and then there's the people that copy off the thinkers." She later discussed the CCSSM testing which had just occurred. In conversations with students she learned there were several geometry concepts her ninth grade students saw on the test, which they had not been explicitly taught and would not be until the following year. Mrs. Dean considered, "Maybe we need to start making them memorize more things," but then lamented, "So, we're going back and that's kind of the reverse of what I believe in." These two excerpts epitomize Mrs. Dean's struggle with CCSSM. She knew she was required to promote student thinking, but she was confined by her former instructional practices and unclear expectations. She was attempting to make changes which were not comfortable for her and she did not yet have a clear purpose for regarding the needs of her students. The uncertainties of use instilled a cautiousness in her willingness to enact these methods on a larger scale.

Summary of Mrs. Dean's shifts in planning and instruction. Participation in the study caused Mrs. Dean to question her instructional decision making and to consider whether methods of planning would be adequate for teaching with the demands of CCSSM. Mrs. Dean valued her students' understanding of mathematics, but she struggled to know the best process. Project influences can be recognized in Mrs. Dean's conscious noticing of student thinking with subsequent attention given to remediation of misunderstanding. Strategies for teaching were challenged by this process and resources she was comfortable using were set aside at times as a result of expectations established by the video club format (i.e. watching classroom episodes of her teaching with peers). In addition, Mrs. Dean's comfort with her textbook remained throughout the study, but she realized the need for vertical alignment with her peers and the need to modify the materials she was currently using to better match the Standards for Mathematical Practice from the CCSSM. These data assist in understanding how participation in this study affected teacher selection of tasks and pedagogical decision making during instruction.

Role of classroom tasks: shifting perceptions. This section examines Mrs. Dean's development regarding the selection and use of tasks throughout the project. The following sections are divided into the categories pertaining to Mrs. Dean's perception of creating a culture for tasks and her instructional development in teaching students in a task-based environment. Patterns of data are presented for each category and are then connected to the research questions in order to better understand the impact of project involvement on Mrs. Dean's use of tasks.

Creating a classroom culture for tasks. Classroom dynamics represented a consistent pattern in the data from Mrs. Dean and reflected a determining factor in her choice to either use tasks or to teach through direct instruction methods. She described in her initial interview how her experiences indicated younger students tended to be more

successful with using tasks than older students. Furthermore, she maintained all of her classes were generally resistant to word problems and preferred straightforward exercise. She explained, “They won’t even look at them because that’s… it’s words. They don’t want to know the story problems. So that’s a challenge.” Mrs. Dean still instructed with word problems, but often took on a more guiding role as a result:

> And if I'm doing a story problem, I’ll draw pictures a lot. But I guess I should make them draw the pictures. It should be something... an open ended task should be maybe something that is done as an opener.

Despite stating that she valued student thinking and discussion, Mrs. Dean’s perception of the instructional potential with using tasks was limited at this stage of the project. She was unable to see how tasks could allow for both student learning and assessment of learning simultaneously. Her knowledge of teaching formed a distinction in her mind between the students who gained mathematical knowledge from tasks and those that would not. Regardless of the potential benefit, the requirements of her textbook and the CCSSM overshadowed her belief in using tasks. She had some apprehension regarding how using tasks would allow her to address the numerous topics she was responsible for teaching.

The juxtaposition of Mrs. Dean’s perspective regarding teaching CCSSM and her apprehension in taking time to use tasks was further emphasized when the researcher asked her to discuss the types of problems students preferred doing during the initial interview. She replied, “Oh, the plug and chug [problems].” The students would say, “Oh, just give me the formula. Oh, just give me the… just give me… tell me how to do it and I’ll just go through it.” This was verified during early, non-task day observations. Mrs. Dean’s classes were quiet and students spoke little unless it was to report direct answers or procedures they had learned. The enculturation of these students reflected expectations for correct answers and as little risk-taking as possible. Students worried more about numeric

solutions than the process they used, which was often reported as a verbatim recollection of the teachers steps presented in the notes. Lack of participation was another worry Mrs. Dean had shared during several meetings with the researcher between the development and implementation of tasks.

At the summative interview Mrs. Dean described how the process of using tasks pushed her to evaluate her expectations for students and her understanding of their needs. Mrs. Dean reflected that she continued to struggle with ensuring broader participation by all students. Despite this, she was encouraged by the response she saw in her students during the project and recalled one student who was asked to go to the board:

> When we pick on students to go up to the board to put their task up there… and you've seen that, pick people like [student's name] who just is mortified but she did it. She went up there and did it and I was very proud of her. So you pick on those students. And it may not necessarily be doing the way that we normally would do the math problem. But it's a way that she got the answer or was working on the answer. So I think those tasks create an atmosphere to get more participation within the whole student population of the class.

This passage suggests Mrs. Dean's transformation in perspective during the project relating to her view of using tasks and their effect on student culture. Through the development and enactment of tasks, Mrs. Dean demonstrated an attempt to experiment with her teaching. As stated in the passage, she chose students who would not otherwise have been selected because the strategy did not represent a standard procedure. Her articulation of the effect this practice had on the atmosphere of the class suggests a significant shift in how Mrs. Dean perceived her students' capabilities. She was able to observe thinking that would have otherwise gone unnoticed, which shaped her appreciation of these new pedagogies.

Instruction of tasks. During the initial interview Mrs. Dean indicated she used her textbook as the primary source for finding tasks and these items typically represented word problems from the chapter or examples at the beginning of the lesson. She remarked that she would implement tasks when she was "looking for something fun and something neat to start the lesson" or as an opportunity for students to "use [their] tools in [their] tool chest." Mrs. Dean then stated, "[I] make sure that [the students experience] a variety of problems to solve that won't take up the whole hour." She recalled that earlier in her career she presented opening tasks each day to review content from the previous lesson, but then opted to forego their use as she perceived the actual learning, which resulted did not justify the time required to implement them.

Non-task instruction remained relatively fixed throughout the project, but task-day lessons did represent shifts in Mrs. Dean's willingness to allow students to explore. During the planning for her third task, captured in her informal interview, Mrs. Dean discussed the need to utilize students' natural strategies for solving problem in a more meaningful way. She stated, "I want to take those guess and checks and I want to put meaning to them as far as graphing. Can I take those guess and checks and not beat myself up with them?" In this example Mrs. Dean recognized her usual dismissal of guess and check as a solution strategy, but pushed herself to reconcile the fact that many students would select this method to solve the problem. She wanted to plan specific questioning to address how this strategy could be coupled with the process of graphing to reduce the amount of time spent by students in selecting reasonable solutions to the problem. She believed if students could recognize approximately where an answer would occur in the graph, then they should be able to more quickly implement a method they were naturally inclined to use. This was a shift in thinking for Mrs. Dean. She consciously planned her lesson with student thinking in mind rather than towards a standard algorithm, which she ultimately wanted students to

implement. The process of using tasks with the lens of teacher noticing of student thinking affected her rationale for selecting the particular item and also for planning of its enactment.

In her summative interview, Mrs. Dean presented a different perspective on the role of tasks in her classes. She began to see tasks as transcending novel attempts at creating interest for students and instead recognized the potential of tasks to create deeper understanding for herself about student thinking and learning. She was also realized how modifications to tasks could be made through changing questioning structures.

> Now the way I do [tasks] is going to evolve. Because now that [the other teachers and myself] have been together and done tasks together, I now see where I can tweak those things and where you get more out of them. See, it's one thing to do an applicative thing. It's another thing to squeeze out all the thinking skills that you want to get out there.

The purpose of tasks took on a probing role in her classes. They were not only a means of engaging students, but could also provide understanding of how the students learned the content she was teaching. She became less concerned with student resistance to the tasks as their thinking was exposed.

> I think it pushed them to, if you make them think, they will. And all that, I think it was interesting. Some of them got really, really frustrated when you tried to make them think. And… but I think they all can. I think they can all think. … I think in trying to… and the words, trying to explain how they did it in words. I think that's an important part of that. And… I notice some kids are really, really good at that.

Whereas Mrs. Dean had consistently questioned the ability of some students to engage in tasks during the initial interview, by the summative interview she had decided tasks allowed

all students to show their thinking. Through teacher noticing experiences, Mrs. Dean came to value tasks which allowed her to know more about students.

The previously described realizations that surfaced during the summative interview were again balanced against the amount of time required to do tasks and the availability of resources for finding task items, which could be used in the classroom. When considering the new CCSSM-based assessments students would be taking, Mrs. Dean reflected on the need to spend her time teaching facts and formulas. She stated, “It really bothered me that I’m going to have to take time out to do something like that,” but she saw the work completed during the project as having possible applications. She followed by saying, “I was thinking about, how would we take a negative which is making them memorize formulas into some sort of positive? Or some... do it in a positive way.” When the researcher pressed Mrs. Dean about the connection between the tasks she had done and their connection to the CCSSM she responded that time would be one of the greatest hindrances to her success.

> Researcher: So do you feel like this year some of your tasks, you did them but not necessarily for a specific item in the Common Core?
>
> Mrs. Dean: Yeah. I know… I don't… I suppose if you ask me to align them, I could probably sift through that book. See, that's the tough part. They're saying, "Well, you need to align all of your curriculum with the Common Core." Well, that would spend… it'd take me a year just to do that, I mean, to go through.

Mrs. Dean’s previous professional development experiences focused on implementing the CCSSM stressed lesson planning and quickly connecting standards to particular lessons. The thought of creating tasks and then connecting them to specific standards rather than to mathematical concepts created some distress. This cycled back to her wanting a textbook aligned to the CCSSM where she could have evidence she was addressing the needs of

her students in the most appropriate way. She did recognize the project as a different kind of professional development and that noticing student thinking could be incorporated in any lesson, not merely in situations that required identification of a specific standard.

Summary of Mrs. Dean's perception of tasks. Involvement in the study affected Mrs. Dean's perception of tasks and their effect on student culture. She initially saw tasks as activities to make the content more enjoyable for students, which would make mathematics learning enjoyable. In her summative interview she began to view tasks as a means to evaluate student understanding and promote deeper thinking among her students. In addition, using tasks in teaching created an opportunity to promote engagement from all students, not simply the ones who had the most efficient procedural solution. She developed an appreciation for how well-developed tasks promoted student thinking and how requiring communication created opportunities for students to express their ideas. She referenced how reviewing the videos of herself and her colleagues contributed to this development. The collaborative environment provided Mrs. Dean with observable results of strategies she could then implement on her own. These findings serve to address the research question of how engaging in these activities affect how teachers begin to view the role of tasks in their classroom. From the data collected, Mrs. Dean displayed identifiable changes in her perception of the role of tasks in terms of effects on classroom culture and instruction.

Development and enactment of tasks. The third category which emerged while reviewing the data regarded the process Mrs. Dean used in developing the tasks she chose to use for the video club meetings and how her enactment of these tasks progressed through the course of the study. The following sections review the tasks, how she planned for each, and how the video club meetings affected her enactment of subsequent tasks. The data presented address the research questions regarding how tasks are implemented

and how engaging in a video club centered on teacher noticing of student thinking affected Mrs. Dean's choices during each task. The section is chronologically arranged to emphasize her sequential development. The tasks Mrs. Dean taught can be found in Table 10.

Table 10

Tasks Recorded for Video Club Discussion in Mrs. Dean's Classes

Order	Description
Task 1	At 6:00 AM, a freight train leaves a station at 40 mph, and at 7:30 AM a passenger train leaves at 70 mph, going in the same direction. At what time will the passenger train overtake the freight train?
Task 2	You are "Super Brain." The superhero that can think his way out of any problem. Today you must save your friends by placing the 400 pound boulder in the path of the water using only the things you see in the picture below and yourself. Using your super brain power, a combination of the items around you, and your 100 pound weight, create a plan to save your friends, draw your plan, and write a short paragraph explaining your plan (includes picture of situation).
Task 3	Two families go to a baseball game. The first family buys two shirts and two drinks for $44. The second family buys a shirt and three drinks for $30. How much does a single shirt cost? How much does a single drink cost?

Preparation was one of Mrs. Dean's strengths as an educator. She preferred to know what questions she would be asking, the background of the content she would be teaching, and to have an understanding of outcomes to be measured. Mrs. Dean sought out ideas from the researcher often prior to selecting tasks. Many of the conversations between the her and the researcher dealt with particular aspects of creating suitable problems to be viewed during the video club meetings. Understanding some of her hesitancies with the study, the researcher attempted to offer guidance in the form of coaching support, which was part of his role in the school district. He tried to abstain from directing the planning process when possible and instead would pose questions when Mrs.

Dean broached the subject. These actions were meant to promote Mrs. Dean seeking out the advice and feedback of her colleagues rather than the thoughts of the researcher.

Task one. The initial task Mrs. Dean selected was for her Algebra 1 class and was intended to engage students in problem solving pertaining to systems of equations. Students had some experience with exploring problems like this, but Mrs. Dean had not yet taught students more symbolic methods such as substitution or elimination. The class was given approximately five minutes to complete the task prior to the beginning of discussion.

Mrs. Dean chose four students come to the board and write their solution strategies. This process was used by the researcher, presented at the first video club meeting, and discussed by all three teachers. The students' work, chosen by Mrs. Dean, all represented mathematically correct answers and presented divergent approaches to solving the problem. It was not clear how these students were selected, nor how the sequencing of discussion occurred.

The first student asked to explain her thinking, who will be called Sue, was reluctant to go to the board. It appeared Mrs. Dean was attempting to build some confidence with Sue:

> Mrs. Dean: Sue, can you go up and explain what you did?
>
> Sue: So I made a half, and half of 40 is 20. So then I counted it by 20. Well, actually I did this one first and then I did 70 + 70 for each hour. And then I did that and I got 140.
>
> Mrs. Dean: So before you put your halves in, did you put your halves in second when you got… when you… after you did the passenger one, did you go in and put your halves in? Why'd you do that?

Sue: Because I did the wholes first and then added (inaudible).

Mrs. Dean: So you decided on one of your halves, it looks like you had… where are they meeting up at?

Sue: Right here.

Mrs. Dean: OK, at 140 miles. So did you look at that side that you had… this side that you had no 30s in? And you had 20, 60, 80 and 120 in there to start with because I was watching you. You had that and you realized that you needed to… because he had passed… by 10:00 they were not quite right. That's what I noticed.

Sue: Yeah

Mrs. Dean: And so you decided you had to do… go in in certain half hours, is that what you're saying?

Sue: Yes.

Mrs. Dean: Let's go with Jim next.

The exchange took one minute and 15 seconds to complete and was representative of the questioning posed to other students during this first task. Mrs. Dean tended to summarize all of her students' work and did not press for questions beyond short confirmations of her correct interpretation of their strategies. In the discussions, Mrs. Dean focused less on the mathematical understanding and instead the discussion was a recalling of the steps the students took to arrive at the correct answer. In the example provided, Sue's thinking became masked by the teacher's re-voicing of what she observed and speculated had occurred. The cognitive demand associated with the task was diminished as Mrs. Dean sought to assist Sue in her explanation; this trend was consistent with the other student presentations on this day.

During the video club review of this lesson Mrs. Dean was able to observe her lesson as well as those of her colleagues. Episodes in the videos of the three teachers

were specifically selected to highlight how each educator directed discussion of students when they explained their strategies to the entire class. Mrs. Dean admitted she had some anxiety that students would tend towards convergent strategies, not allowing for multiple solution pathways and therefore a less diverse conversation. She compared her video to that of a peer and remarked:

> I was afraid that [the students] … would look at me like, "I don't know what to do," if I didn't give them some prompting of something. So that's why I said, "Well, you can do pictures. You can do tables. You can do graphs. You can do…" I gave them a whole list of things that they could do. "But you have to do two different things, whatever it was." But I was afraid that I… I didn't go into it thinking, "Well, just do it like…" (turning to the researcher) think that's what you did on yours when I… the one that we watched. I think you just said, "OK, go ahead, here you guys," when we were doing a substitution in your class.

This passage provided a realization of Mrs. Dean's vulnerability in the video club and her willingness to notice the potential of teaching in new ways. She announced her own apprehensions to the group and contrasted her actions with those viewed in the previous video club meeting. Mrs. Dean could recognize a difference in the instruction between the two examples.

In addition to allowing students to use strategies they understood, Mrs. Dean also reflected on the way the other teachers questioned students. She stated, "I noticed that… you asked that question to the students, 'Well, how does this vary and how does this differ from the way the guy next to you did it?' I like that part." This aspect of the other teachers' videos at the current video club made an impact on Mrs. Dean and she made this comment later in the meeting:

> I like the idea of comparing the different methods to each other. I like that. I think I probably would do a lot of that. And I'm with [Mrs. Wilson] here. I think it's… I think this type of stuff gets you better at asking the better question. And that's the big thing -- the better question. What's going to be the question that you just say, "Oh man, that's a good question.

These observations of her colleagues had an impact on both the planning and instruction for her next task. She decided to attempt a more open task, which would require students to engage in a problem with multiple entry points.

Task two. Mrs. Dean's second task was an exploration of simple machines with her Algebra 1 class. Her objective was for students to create an equation from gathering information based on a problem represented with a visual representation. She had chosen an inquiry-based task, which would require exploration on the part of the students. Mrs. Dean was conscious of her interactions with students as she implemented this task and attempted to draw reasoning responses rather than suggesting solutions. When her students came to the board to represent their group's visual solution for moving the rock, all drew similar pictures. They had "Super Brain" using a lever to move the rock into the river. In the second student explanation Mrs. Dean probed a little deeper into the student's thinking:

> Mrs. Dean: Will somebody in that group come up? And why don't you come on up and explain what you're doing there, too. I want to know if there is any…
> Student 1: It's the exact same thing [the other group] did.
> Mrs. Dean: I want to know… yea, it's the exact same thing as [the other group's], but I have a question for you then. What if the rock is twice as big?
> Student 1: Well, then I would get the kids out of the way and tell them to come play over behind me where there's no water running. Or give them the barrel.

Mrs. Dean: Or you can move that?

Student 2: You can move the barrel closer to the rock and then… yea.

Mrs. Dean: I was waiting for someone to say that so that was OK. So everybody, it looks like and I know that you guys probably all have the same.

From this point Mrs. Dean was able to move students to explore the relationship to placement of the fulcrum and the resulting ratios of lengths to either end of the lever, which was the objective she had developed for the lesson. The task spanned multiple days and the filming only took place on the first day of the lesson. In her initial interview Mrs. Dean had stated she preferred shorter problems that allowed her to go through several in a single class period. This was an interesting progression in her instruction and may have resulted from a discussion during the previous video club where she commented on her worries about the amount of time required to truly allow students to discuss their thinking. She could possibly have planned for a two-day lesson in order to accommodate students in sharing their thinking.

At the following video club meeting Mrs. Wilson showed a clip of her Algebra 1 class working through a systems of equations problem involving the cost of drinks and t-shirts (see Table 10) and Mrs. Dean commented on the quality of the questions used by Mrs. Wilson in the video. She started by saying “I like her questions and I liked the way she mentions the good parts of each part.” When pressed by the researcher to give an example, Mrs. Dean began to focus on specific aspects of the lesson and teaching moves of Mrs. Wilson. Mrs. Dean then asked the following:

Mrs. Dean: I don’t know if I heard it right or not. But you were talking about going from 12 to 9 and that was the 9 was too much and… but then she went up more. She went up to 10. I don't know if she did those in order or…

Mrs. Wilson: I don’t remember doing that.

Mrs. Dean: And then that was one was…

Mrs. Wilson: I think she was doing just whole bunch of numbers and then she went, "Oh, I should look and see if my numbers…"

Mrs. Larson: Make connections.

Mrs. Wilson: …meet the requirements. That's my guess.

Mrs. Dean: Because there was… I thought you were discussing in there, "Well, that 10… if 9 was too much, then 10 is going to be too much especially if you're still going to use a 12." But… and I thought you said something in there on that. But then she went to the 5 and started getting less. And I don't know why she just kept going. She must not… you suggested she extend her table which I think was what she should've done in the first place is extend her table and she might have the answer.

This excerpt revealed Mrs. Dean's focus on particular student thinking from the video. In the previous video club meetings, she had made more general comments, but now, with some prompting from the researcher, she began to think about particular events of student thinking and how questioning directed student understanding. This suggests some progression in her ability to notice student thinking from the initial meetings. The evidence provided a better understanding of Mrs. Dean's growing capacity to identify and evaluate the episodes she viewed.

Mrs. Dean decided to attempt Mrs. Wilson's task with her students as her final video club task. The following example from her informal interview reveals her initial planning process for the task:

Mrs. Dean: All right, so what I wanted to talk to you about was I'm doing two equations and two unknowns with my freshmen. And I wanted to do… I was going to do this t-shirt thing with them. But then I got to thinking, well, I've already gone over this stuff. And hopefully they'll jump right into the algebra part of it and then

> I'll… if I require them to do another way, I was trying to think, well, gosh. Can I get them to do something besides guessing and checking? And I didn't know how to lead them to where I wanted them to go. I would like them to… I was looking through some of Mrs. Wilson's stuff and she went through and they were doing some guessing and checking. And they found places where the t-shirts added up to $44. On this one, added up to 44 and this one added to 30. But it really wasn't the intersection. It wasn't the answer. So in other words…
>
> Researcher: And I was there for that; for the way she did that.
>
> Mrs. Dean: But see now I would love them to figure out that they don't have to have the exact answer to get… all they have to have is an equation. Because these two answers work -- 20 and 2 add up to $44; and 15 and 7 add up to the $44. So I would like them to get to the point where they know if they have two equations, two points, they can find an equation of the line. And if they have the equation of a line, they can graph it and they can find the intersection of the two so… and I just… I don't even know if I can even go about doing any of this stuff but…

This attention to the details of student thinking seem to suggest some transitioning regarding the capabilities of using the task for a specific outcome; no longer was Mrs. Dean seeing this as merely a means of engaging students in the mathematics, but now she appeared to be seeing the potential for evaluating student understanding. In addition, the passage suggests she studied her colleague's instructional techniques and analyzed what Mrs. Wilson had done, so that Mrs. Dean could then adapt the task for her particular situation. This example reflects Mrs. Dean's progression in task modification as a result of observing the interactions between her peers and their students during the video club meetings.

Task three. Using the knowledge gained from viewing Mrs. Wilson's lesson, Mrs. Dean was able to anticipate student responses and planned several questions she would

ask if students became frustrated with their strategy, such as “What might be a reasonable cost of a shirt or a drink?” She also decided to create slides of sample student work showing visual representations of the problem being solved through graphing, substitution, and elimination methods in case students were unable to generate these models themselves. This also allowed her to focus on her own objectives for the lesson regardless if these were surfaced through student strategies, which indicated a difference in her planning for this task as compared to the other videos captured of Mrs. Dean during the project.

To ensure the best instruction for the task, Mrs. Dean chose to use the task with three of her classes. For her Algebra 1 students the task would be an opportunity to evaluate their understandings. Her Geometry and Geometry B classes should have already been proficient with methods to solve the problem, so it was a means of addressing their understanding and requiring them to analyze other student strategies. All three groups had been given direct instruction on substitution and elimination, but Mrs. Dean wondered how many would still choose to use guess and check to solve the problem. As mentioned previously, her goal with her Algebra 1 students was to highlight the importance of graphing as a strategy for solving systems of equation problems.

There was some struggle with being able to push the Geometry class to explain the algebraic processes of elimination and substitution that they used; Mrs. Dean was able to recognize the students knew the steps in each method, but she questioned if they could connect it to the context. The students were generally resistant to considering the visual representation’s connection to their own work:

Mrs. Dean: Look at this. Is this kind of what you did?

Student 1: No. I don't really know if that's what I did. I have an equation with x's and y's and there were no pictures because I'm not a good artist. I don't have pictures.

The student went on to say, "I don't work well with the pictures. My head thinks in numbers and algorithms." Mrs. Dean continued to ask questions of the students and attempted to have the entire class make connections between the student's solutions and those Mrs. Dean had created. This was visually frustrating for Mrs. Dean as this was the kind of reaction she had been worried about when she began the project. With that said, the lesson seemed to illuminate the algorithm-driven culture of students in Mrs. Dean's classes. Her struggles with pushing these students was a clear result of the expectations these students had experienced for their academic career.

The same strategies (i.e. guess and check, elimination, and substitution) were all developed by students in the Algebra 1 class later in the day. After the experience with the Geometry class earlier, Mrs. Dean seemed to be better prepared for the questions she would ask students. She appeared more confident in transitioning from the visual representations she had created to the students' equations and seen in this example:

Mrs. Dean: What does this (gesturing to her picture) have to do with what you just said?

Student 1: The two shirts and two drinks is $44.

Mrs. Dean: Which is part of ….

Student 1: (Speaking excitedly) Which has already been solved so all you have to do is figure out the price of the other four [drinks].

Mrs. Dean: Okay, so we know that this equals…

Student 2: $44

Mrs. Dean: which is what?

Student 2: The same as the first equation.

Mrs. Dean: Same as the first equation… So what have you done over here?

Mrs. Dean found a way to utilize the graphics and she pushed students to make sense of the visual prior to going to their process. This may have resulted from discovering that students in her first group struggled to think about the picture after they explained their own work; they seemed to not understand Mrs. Dean's reason for having them make a connection between the two representations. The Algebra 1 class, who had less experience with the topic, were better able to articulate how using elimination to find a solution involved scaling one equation in order to make the two equations similar in respect to one of the variables. This conceptualization by the younger students was a direct result of Mrs. Dean's modification of the instruction. By having the students discuss a visual representation of that process prior to describing the symbolic manipulations they had done, the Algebra 1 students were able to make sense of, and articulate, how the symbolic model worked. Mrs. Dean's sequencing of this discussion and her choice to not abandon using the visual representation after her experience earlier in the day showed her developing resolve with enacting tasks. She displayed a resolve to expect student thinking and to push for sense making. She used evidence to plan for her lesson and was successful when she implemented the task with the expectation that students needed to make sense of their procedures. This was a sizable shift for Mrs. Dean considering as she valued algorithms and procedural understanding.

Summary of Mrs. Dean's development and enactment of tasks. Through the course of preparing three tasks and participating in the video club meetings, Mrs. Dean

adapted her selection and delivery each time she was filmed. Her willingness to allow students to struggle and her questioning of why students proceeded in a given way also increased through the three tasks. She commented in several of the video club meetings on how the other teachers were seeking clarification from the students and how the questioning they used seemed to elicit richer conversations. She recognized her initial lessons were lacking in generating the same student thinking, and in her final task she began to attempt similar instructional strategies. In addition, she spent more time anticipating student thinking and planning for how she could use the solutions generated to aid in the conversations she wished to have with her classes.

These findings reflect a transformation in Mrs. Dean's perception of her own teaching and directly affected how she attempted to enact her final task. The patterns of data demonstrate growth in how she used the video club experience of noticing student thinking to question her pedagogical practice. Her recognition of strategies her peers were using were adopted by Mrs. Dean following each video club and these changes became more visible each time she attempted an additional task. The results suggest engaging in the video club had an effect on Mrs. Dean, at least during the project year.

Summary: the case of Mrs. Dean. Data provided in this section concerning Mrs. Dean's involvement in this project demonstrate clear shifts in her attitudes towards classroom instruction after participating in video club meetings based on teacher noticing of student thinking. Mrs. Dean's predominate teaching style prior to engaging in the study was that of direct instruction where the teacher transmitted subject content in the form of notes and homework assignments. Non-task day teaching reflected minimal change and, although Mrs. Dean recognized effects on her attitudes towards teaching mathematics, it was difficult to see sustained impact in her general classroom practice. She asked more

open questions, but often addressed these through directing the conversation when students were unable to provide an answer.

More prominent changes occurred in her view of the need for pressing student thinking and her focus on how to deliver instruction focused on the CCSSM. She recognized her current curriculum materials lacked the depth required to meet the standards and she identified ways she would need to modify lessons in the future. She also indicated the benefits of encouraging students to discuss their own interpretations of problem solving regardless if it was the most efficient way of solving a given problem. Concerns were raised during the summative interview that she needed more guidance to make this transition. She continued to believe future textbooks may alleviate this issue. In addition, she insisted that vertical alignment of topics through collaboration with her peers could provide more time for her own exploration of content without the need to review topics from previous years in her courses.

Her abilities to select and modify tasks developed throughout the study. Viewing strategies employed by her peers and the reactions of students elevated her confidence to attempt more student-driven instruction. She utilized tasks, specifically developed to promote student thinking, on her own, something she had not done previously in order to reach students who she felt needed the additional experiences. She saw the value in creating environments where students would feel comfortable expressing their thinking and recognized students who had not been given these expectations earlier in their mathematics careers often had difficulty in this area. She was also able to notice opportunities for adjusting tasks in order to create additional expectations for student communication.

Engaging in the video club pushed Mrs. Dean to reflect on her teaching and to question her practice as a teacher. She was vulnerable throughout, seeking clarification from the researcher and her peers in matters of instructional technique. Despite her

reluctance for making dramatic changes, her analysis of what she observed suggests she was progressing in her view of teaching. Her genuine concern for students and her conscientious view of her role as a teacher led to introspective conversations throughout this project. It is unknown whether these changes are sustainable without more support, but it is clear that engagement in the process created a recognizable shifts to her instructional approach in the classroom, specifically in regard to decision making and adherence to student thinking.

The Case of Mrs. Wilson

Mrs. Wilson had taught for 23 years when this study was conducted, 11 of which had been in the Sometown School District. Despite having started her career teaching elementary children, she transitioned to the secondary level with an emergency certification and had been instructing mathematics classes periodically for the previous seven years. Mrs. Wilson saw her participation in the project as a means for self-improvement, although she voiced some reluctance to being videotaped during her initial interview. Most of her lessons were developed through following the scope and sequence of her textbooks, but she reevaluated this to some degree as a result of her involvement in the video club study.

The following sections provide data collected from Mrs. Wilson regarding the two research questions. These sections serve as broader categories encompassing patterns of data that emerged in the coding process. In each of the three sections the findings are introduced, presented, interpreted, and then summarized.

Beliefs about effective teaching: defined expectations. Mrs. Wilson valued students collaborating with peers and being pushed to think “outside of the box” in her math courses, but she also valued having a structured environment where she had clear expectations for both herself and for the students. In her initial interview, Mrs. Wilson described her daily

routine by stating, “Most lessons are structured with students taking notes on the topic of the day… then we do guided practice together after doing examples in their notes and then after doing guided practice, individualize work.” She revealed in the interview that she hoped to develop strategies that would provide students with opportunities to think about the mathematical structures within the topics she was covering.

Beliefs about textbooks: shifts in use. Mrs. Wilson had strong beliefs regarding the role of her district-adopted materials in the planning process. Although her reliance on using the textbook as her primary source for materials only diminished slightly over the course of the study, the most dramatic shifts occurred concerning adherence to the publisher’s scope and sequence. Through choosing to eliminate some lessons from her textbook, she accommodated the use of tasks and other lessons focused on student thinking. This category directly relates to Mrs. Wilson’s choices in selecting instructional resources and the findings serve as evidence of the project’s impact on her development in this process. The following section will compare data from the initial and summative interviews with Mrs. Wilson on the topic of planning using a textbook.

Mrs. Wilson believed that by following her textbook she would provide adequate coverage of topics for students which would therefore prepare students for the CCSSM-based assessments. When asked how she decided what was important in a specific unit during the initial interview, Mrs. Wilson responded, “I'm following the objectives according to the state approved curriculum. And I think that they do a pretty good job being sequential in the learning.” The state approved curriculum referred to by Mrs. Wilson was the textbook her district had purchased after the previous state-wide adoption cycle in 2009. The rubric used to evaluate these materials was based on pre-CCSSM standards and allowed for several levels of approval from “Highly Recommended” through “Recommended with Reservations”; any of these curricula could be purchased by a district using state monies.

Mrs. Wilson continued, “And there are some items I have to spend more time on than the curriculum has outlined and things that I think are important that kids miss. For instance, teaching slope… I spend probably a week on that.” This realization by Mrs. Wilson suggests she was not opposed to modifying the curriculum developer’s scope and sequence, but that she does not favor large-scale change. Later in the interview she commented:

> I'm still pretty text oriented… because it gives me a solid, I know I have to get through this. I know that the state standards are covered in it. I kind of feel it gives me a little bit of structure as far as direction, where I want to go next and that kind of thing. And it’s already scope and sequenced out for me so I don’t have to… I can spend more time thinking about how to do a lesson versus, what are we doing next?

These findings suggest Mrs. Wilson initially placed much of the responsibility for curricular decision making on the developers of the materials she used in her classes. This offloading (Brown, 2009) of curricular sequencing may have been a result of her background as an elementary teacher or it could reflect the fact that she was teaching Algebra 2 for the first time the year of this project. Regardless of the reason, Mrs. Wilson clearly expressed her reliance on using the textbook as her primary planning tool during the initial interview, which created a baseline for her decision-making process in terms of instructional materials.

Mrs. Wilson’s belief in the district curriculum shifted slightly over the course of the study. During the summative interview Mrs. Wilson stated that she continued to value the structure of having a textbook but started to have some concerns. She stated, “I rely on the textbook fairly heavily and it covers… it does a pretty good job covering what the Common Core is asking us to do. But I don't get to it all.” Mrs. Wilson further described her realization when she said, “I like to go chapter by chapter, lesson by lesson. Not skip anything. [Not following the book] really messes with me. And yet, at the same time, I'm looking at it going,

"Not important." She went on to state how a conversation with the researcher caused her to begin to question her use of curriculum and her beliefs in teaching all content covered by the book. Mrs. Wilson recalled inquiring about a specific topic in her textbook and the researcher questioning the importance of content for students in her class. In the summative interview she explained, “You said, ‘Is it really that important?’ and that ruffled my… it was good. It ruffled my feathers because… then I went, ‘I don’t know. Why would it be in the book if it’s not important?’” This prompted Mrs. Wilson to study the CCSSM more deeply and to begin engaging her colleagues in discussions concerning what she should be teaching rather than deferring to the book as the ultimate authority. This suggests she was engaged in reevaluating her position as the instructional decision maker.

In the summative interview Mrs. Wilson voiced her belief in the Sometown School District’s mathematics department’s ability to make curricular decisions rather than relying on the curriculum developer’s structuring of topics. When asked to provide future ideas for professional development, she suggested:

> I think getting together and just talking through some topical ideas would be helpful.… We get together and, "Hey, let's talk through the progression of thinking for slope in linear equations. Where does it start? Where… what do we want them to have grasp by when? I mean according to the Core. But how are you doing that in your curriculum? How are you doing that in your classroom so that I know what to build on in my classroom?"

This passage illustrates Mrs. Wilson’s belief in how collaborating with her colleagues could provide a structure for all of the teachers. When asked if she noticed a difference in the interactions between the teachers during the project she stated, “Oh, yeah. We talked more, definitely. We talked more this year than we've ever in the past.… I think that's been very healthy.” Mrs. Wilson used the study as a catalyst for engaging in curricular

sequencing conversations with both Mrs. Dean and Mrs. Larson, which created a deeper understanding of the learning experience of students throughout her district. She cited a conversation she had with Mrs. Dean, “I called [her] and said, "… I'm not going to get to the last three chapters of the book. Do I need to be jumping into them? … How do you want me to prepare these guys?" Mrs. Dean gave Mrs. Wilson some suggestions of the most pertinent content and although it was admittedly difficult for Mrs. Wilson to allow herself to skip lessons in the book, she made the decision with the guidance of her colleague. Mrs. Wilson’s move from offloading to an adaptive stage of curricular implementation (Brown, 2009) was facilitated by her belief in her team’s knowledge and a trust developed through the collaborative process of engaging in the research project.

In comparing Mrs. Wilson’s initial fidelity to using her curriculum as written to her desire to collaboratively re-sequence topics voiced in the summative interview, the findings suggest participating in the study affected her view of the role of the textbook. Through examining strategies utilized by her peers and direct conversations, she was able to rethink some of the lessons and tasks she used with students. She spent more time focusing on aspects of the text that promoted student thinking and less time on topics that were not part of the CCSSM. This shift served to address the research question of how participation in the video club meetings focused on student thinking affected this teacher’s decisions around selecting coursework for her classes. The findings indicate engaging in the video club process initiated further conversations between Mrs. Wilson and her peers which in turn led to her questioning components of her textbook and her general instructional practice.

Effects of student thinking on instructional planning. Mrs. Wilson believed students needed opportunities to think through problems and communicate their reasoning. Data indicate a transition in how this belief was realized in the classroom through the

duration of the study. Mrs. Wilson developed insights into how her decision making regarding tasks and instruction affected the richness of the thinking she was able to observe. Through modifications in each of these areas she was able to accomplish differing levels of student interaction and analysis from her students.

Mrs. Wilson valued student communication and encouraged students to discuss their thinking with others. This often was achieved through allowing students to work together on homework assignments during class. In the initial interview she revealed, “I think group interactions is important. Usually I have them start on their own and then after they reach a certain point… I’ll say, ‘Oh, now you may work together.’” She estimated the frequency of this to be at least twice a week. Her own communication with students tended to entail answering questions for the class or using a “guided practice method” where she would call on a student and ask, “Okay, so tell me the first step in the equation,” and then call on other students for the subsequent procedures. This process was observed by the researcher in a number of the preliminary non-task day visits and it indicated how Mrs. Wilson viewed her role in promoting student thinking. The process was teacher directed and prompted students for a specific response. Although Mrs. Wilson saw the need to ask questions, the process she used did not encourage opportunities for authentic student thinking. It was instead focused on recitation of procedures which had been taught by the teacher in prior lessons.

After attending video club meetings and engaging with her peers and the researcher, Mrs. Wilson began to change her practices. She adapted her instruction to include more instances of asking students to explain the reasoning behind their processes rather than being limited to series of steps students used to find a solution. In later, non-task day observations, she asked pairs of students to explain why they thought a specific operation worked for a given problem; she pushed students to explain the processes of others within the group. Her selection of assignments remained similar, but her

expectations of student responsibilities became more focused on being able to communicate the mathematical structures underpinning the symbolic solutions students were choosing to use. Mrs. Wilson appeared to adopt the practices she observed her peers using during the video club meetings on a more regular basis. The shift suggests a focus on being able to evaluate the student understanding through requiring explicit communication.

At the conclusion of the study, Mrs. Wilson presented a deeper understanding of the role of student thinking in analyzing the impact of her instruction. During her summative interview she discussed changes to how she perceived questions from students while reviewing homework:

> So I'll look and I'll say, "Well, does it make sense? Does your answer make sense? We can check to see if it's right or wrong. But to me, it looks like it's estimated, ballpark, about right. Let's see. Let's see. What did you do?" And I'll have them talk me through the steps which reinforces what they did. "So I'm guessing it's right. Let's go check." And that way it's not just, "Let me get the score key. I'll tell you if it's right or wrong."
>
> I mean if they're questioning it, they're questioning it for a reason. I think it's because they need that reinforcement of knowing, did they do it correctly? Did they follow the steps? And so I think my questioning technique or my encouraging technique has changed to be more than just, "Yep. You're doing it right. Continue."

She continued to use the textbook materials to instruct, but she recognized how her normal routines could be slightly modified to encourage students to develop their own mathematical authority. She was purposeful in how she interacted with students and required more from them than she had prior to beginning the study. Teacher noticing of student thinking encourages teachers to evaluate student solutions rather than provide direct answers. This example serves as evidence of Mrs. Wilson’s growth in this regard; she recognized this shift in herself. This willingness to engage students utilizing their own

thinking supports the claim that Mrs. Wilson was affected by her involvement in the video club meetings and the overall project.

Summary of Mrs. Wilson's shifts in planning and instruction. This section provides insight into changes Mrs. Wilson made in her view of both curricular resources and the value of student thinking. She developed confidence in her ability to modify her textbook' scope and sequence, materials, and student expectation while maintaining aspects of her teaching style. As she developed and assessed pedagogical techniques in her classroom utilizing student thinking, these methods became part of her daily routines. This development of routines serves to underscore the impact that learning these new techniques had on Mrs. Wilson's view of both instruction and planning for her mathematics courses.

Role of classroom tasks: shifting perceptions. The following section examines changes in Mrs. Wilson's interpretation of both the utility of and application of tasks during the course of the study. Because she used her textbook as the primary source for instructional materials in the beginning of the study, her view of what a task was and structures for use were often dictated by the publisher's recommendations. Through engaging with her peers in the development and observation of tasks, she adopted a modified perspective on how to structure tasks and their purpose in her classes. Consequently, much of the summative interview was spent reflecting on how implementing tasks affected student outcomes. The findings in this section provide evidence for addressing the research question of how engaging in structured practice of teacher noticing of student thinking affects the selection and implementation of classroom tasks.

***Students in task-based environments*.** When first probed about the role of tasks in her classes, Mrs. Wilson presented definite beliefs regarding which students would most benefit. In the initial interview she revealed that tasks were not given daily to students. She

discussed that earlier in her career she regularly used opening activities with students, but discontinued the practice because of the time required and the amount of content she needed to teach. She stated, “I have some lower classes and I think just getting through the basics of what I'm expecting you to learn today had been challenging enough for them.” This perspective of needing to place less cognitive demand on struggling students was explained later in the interview:

> I have a lot of lower and remedial students and they don’t even want to try. So motivating them to want to try something that’s problem solving oriented when you have readers that don’t read well. Some of my remedial kids don’t read well. And so trying to set up tasks and find tasks that they can spend time on and have success at with lower skills I think is probably my bigger challenge

The motivation of students, specifically the desire to complete assignments, was one way Mrs. Wilson delineated her students into groups of higher and lower students. She was resistant to presenting work she believed would not be completed and opted instead for more condensed assignments.

To address her perspective on student work, Mrs. Wilson discussed how she gave homework assignments in which students had the opportunity to select a given number of problems from a larger set of tasks. Despite her attempt to modify her instruction, she cited that some students were still unable or unwilling to complete their work on a regular basis. While reflecting on this she stated:

> They didn’t attempt it because why? It wasn’t a task that they had to have a lot of background information on. I mean, this was a ninth grade class and they… this is a task that sixth graders could’ve done. They just didn’t want to take the time.

The lack of assessable work from the students caused Mrs. Wilson some distress. She revealed her frustration by saying, “How do I grade that? What do I do to give them… that I can put in my computer that says that, did they get a zero because they didn’t attempt it?” When asked which kinds of assignments students preferred, Mrs. Wilson claimed, “A lot of them want to do, Bam, bam, bam. I just want to get my pencil on my paper, get going and get the answer.” Understandably, Mrs. Wilson initially questioned the value of assigning work that would not be completed and therefore she would be unable to use in the evaluation of the students’ learning. She clearly stated she valued the power of student thinking in the initial interview, but was resolute in the belief that rich tasks did not benefit all students, especially those who would choose not to attempt them. Her solution instead was to provide less challenging work, which would be returned in a more consistent manner.

Data collected during Mrs. Wilson’s summative interview show a slight shift in focus from student ability and the challenges of motivation to more emphasis on how using tasks created opportunities for evaluating student understanding of topics. The topic of motivation of her students to think mathematically continued to be prevalent throughout the interview and specifically the benefits of tasks for the most remedial of her students. Despite this, Mrs. Wilson spent a significant amount of time discussing the impact of the project on students’ ability to analyze and model mathematical thinking. It appeared the pedagogical advantages of having students problem solve was powerful enough to push Mrs. Wilson to question her prior beliefs regarding collecting student work for her gradebook.

Student motivation. Mrs. Wilson continued to make distinctions between the engagement of students during the summative interview through her classification of “higher achieving students,” the “middle group,” and the “lower group”. When reflecting on her decision to provide students more choices in selecting specific problems from the homework, she stated:

> The higher achieving students will do all of [the problems] because they want the extra credit points. And so that just tells me that there are those kids out there that really like that deeper level of thinking -- that are motivated by it -- but not everybody is.

Conversely, Mrs. Wilson noticed, “The lower group… I haven't seen that benefit [from using tasks] as much. The buy-in is not there for them. So they're kind of riding the coattails of the person next to them,” which is similar to her attitudes expressed during the initial interview. Although she had hoped for more from the lower group, she did express a benefit to students in the middle, stating, “[Using tasks has] given me the opportunity to kind of see some growth, especially in the middle group when we've done those, for them to be able to benefit from it.” Mrs. Wilson’s rationale for why the lower group struggled was not because using tasks was not a worthwhile process, but rather that the cognitive demand of solving multistep problems was too challenging for students with considerable gaps in their mathematical development. She stated, “I think it's not because the rich task isn't any good. I think it's just because they have no… the foundation is so weak they can't get to the place I want them to get in the rich task.” At the time of the summative interview this aspect continued to be a difficult pedagogical issue for Mrs. Wilson to address in her courses.

Mrs. Wilson’s engagement in the project created an experience where she was pressed to reexamine her beliefs regarding student achievement. Findings suggest some shifts in attribution of student success and failures in task-based teaching. Although she continued to believe some students would not be as successful in a classroom where tasks were used, her rationale for why this would occur was less a matter of the tasks themselves and instead a result of gaps in learning which limited the students’ ability to engage in the content. This refinement of perception may indicate a modification which may affect her future instructional decision making.

Student understanding. The most significant, perceptual shift regarding the use of tasks emerged during Mrs. Wilson's summative interview and involved students' communication of mathematical thinking. With the study focusing on teacher noticing of student thinking, it logically follows that Mrs. Wilson would attempt to elicit student thinking in her classes. As she practiced skills and began to implement methods she saw modeled during the video club meetings in her own classroom, she was able to develop greater success in using the tasks. She recalled how viewing the initial video club made her aware of the amount of processing time she gave students and then seeing the other teachers using this technique solidified what she had seen the first meeting:

> I think it's when you modeled it and I went, "Oh, yeah. He waits and he makes them think." And then watching me, myself, do it and seeing that I'm pushing them. Not that you weren't pushing them. You're just a little more patient when you're pushing them than I was. And watching the other teachers do the same thing, I think we all grew in that willingness to wait.

This recognition of her own actions and subsequent adjustment of her pedagogy suggest direct connection between the video club and Mrs. Wilson's instructional practices. She attempted other strategies she noticed during conversations with her peers as well.

Teacher noticing of student thinking requires the teacher to provide opportunities for students to make their thought processes explicit. Mrs. Wilson recognized this as a weakness in herself during the initial interview and she worked throughout the project to embed situations where students needed to discuss their thinking with both the class and other individual students. This occurred first on the task-day instruction, but later because it became a part of her every-day classroom routines. She noticed that student discussions more naturally began to promote mathematical structures and practices she directly instructed in previous years. She recalled an episode that illustrated why she asked

students to show their work on assignments in her Algebra 2 course. Mrs. Wilson had made efforts to have students compare their work and critique the reasoning of others throughout the project. In the following excerpt from the summative interview, she described how this was used with her entire class.

> I did that with Algebra 2 recently and had one student who never shows his work. I mean he does so much in his head and gets things right. (laughs) I had him put up his answer and I had the girl who shows every minute step to put her answer up on the board. And it was fascinating to see as they talked it through. He had to talk way more than she did because she had all the steps there. But he couldn't. And you could see him struggling going, "Well, I got this." I'm like, "How did you get that?" He goes, "Well, you just…" And he was at a loss for words because he can do it so quickly. But it was a good challenge for him because he doesn't… I mean he gets there faster than his brain can think of the steps…. And so we talked as a class because I said, "Well, steps are important, right?... And it was a very good discussion because they're like, "Well, he's got it all." I said, "Yeah. But do I see it all?"… The one up there said, "You know he's got it all because he got the answer." I said, "How do I know he didn't get the answer from someone else?"

The discussion allowed her to explain to students that communication of mathematical understanding requires more than answers. The students had heard this for years, but this example made Mrs. Wilson's rationale for requiring symbolic representations of thinking tangible for her class. By utilizing student comparisons of thinking through explicit teacher moves, she created an opportunity to have a meaningful discussion with her class. Although this was more than likely not her intended objective at the beginning of the lesson, she noticed the potential for a more in-depth conversation and she capitalized on the situation.

Data presented in this section suggest some influence of how Mrs. Wilson's involvement in the research study promoted an increased understanding of student thinking and changes to pedagogical strategies she used with students during task-based instruction. Mrs. Wilson's initial concerns regarding the amount of time and student motivation were somewhat mitigated by her later understanding of the benefits to students in her courses. Mrs. Wilson's willingness to promote student discourse is clear despite her concerns about the amount of time required and her own ability to know how to address the situation she is noticing. Both student motivation and student understanding became factors in her willingness to adopt new pedagogical strategies.

***Beliefs regarding task implementation*.** The findings suggest shifts in Mrs. Wilson's perception of how to implement tasks from the initial interview to the summative interview. This section examines her preliminary understandings about tasks and will contrast that with her opinions at the conclusion of the study. A brief summary follows detailing the major changes in her views.

Initially, Mrs. Wilson appeared to have some anxiety regarding the task development and implementation requirements of the research study. She disclosed that most of her tasks came directly from her textbook and she searched for items she thought would "stretch" her students' thinking. She continued by saying good tasks were those "that make [students] think out of the box." She discussed how she had attempted to provide students with opportunities to engage in rich tasks, such as these, at least once a chapter, but the she felt constrained. She stated:

> I think our only negative is we're bound by time. We need to keep moving in order to cover the standards that the state suggests. So it's hard to spend as long as I would like to, as you know, as every teacher knows, as long as I'd like to dig a little deeper on those rich task problems.

This perception of having limited time undoubtedly affected Mrs. Wilson's process for selecting and implementing tasks. Later in the interview she revealed some relief when she was told she would only need to complete three tasks over the duration of the study. She had been unsure if she would be allowed to continue engaging in her "regular teaching." She revealed, "I felt a little bit of a lift of the burden… because I was like, 'Do we have to do this every day?'… I don't teach the same class twice in one day in a small school." In addition to demands of preparing for multiple courses and limited time to do so, she was exasperated by the thought of new requirements, which may account for her use of more traditional pedagogies prior to beginning the study.

Mrs. Wilson's answers to questions regarding tasks seemed vague at times during the initial interview. Much of the conversation focused on general principles for promoting student thinking, using collaboration, having students solve problems more than one way, and the importance of students modeling their thinking. From this, it may be assumed that Mrs. Wilson had an understanding of how tasks may be used, but was limited in her practical experiences with utilizing them on a consistent basis. This was further conveyed in her closing comments regarding her desired outcomes for the project, "I think that shooting for those opportunities… is the challenge that I want to approach more often with the students." Her attitude towards developing these skills led to instructional conversations throughout the study focused on current actions and the achievement of this goal.

Through enactment of pedagogies she gathered during the video club meetings, the development and teaching of her tasks, and other collaborations with peers and the researcher, Mrs. Wilson continued to develop further insights into how to implement tasks in her classes. These were observed on both task and non-task days. When asked, during the summative interview, to describe how she perceived the role of tasks in her mathematics courses Mrs. Wilson responded:

> I, again, think it is applying the skills you've learned at a deeper level in order to allow the students to probe their thinking skills, not just doing things by rote. I think that they need that opportunity to problem solve and to come full circle with the learning and how to apply it. And seeing how other students think, I think is really important for them because you can attack problems different ways.

This interpretation of the role of mathematical tasks reflected a deeper connection to the importance of eliciting student thinking during the use of tasks and was less general than her description given during the initial interview. In addition, this definition was coupled with specific methods she had used during the span of the study.

A strategy Mrs. Wilson had discussed in the video club meeting which she then implemented in her classes was the purposeful elevation of student mistakes as instructional opportunities. Through this process she began to see changes in her students. She recalled “They've come to the point where it's not so shameful anymore because, oh, it's a mistake. And other people make those mistakes, too.” This promoted student risk taking and willingness to discuss their thinking openly with others in the class. Mrs. Wilson went on to state:

> I, again, think that the students making mistakes and maybe not catching their own mistakes, but other students seeing where those mistakes were and the way that they help them without slamming them was good to see. I think it was good to see that they had kind of compassion for each other socially and that everyone makes mistakes.

Through promoting the use of student mistakes as learning opportunities she began to shift the social culture of her classroom to more open dialogue and increased equity for all students. Using tasks and valuing both the process and the answer equally allowed for

richer discussions and a middle ground for students where they were not relegated to their process being all or nothing.

Mrs. Wilson began to focus on fewer problems with higher cognitive demand when choosing the homework she gave to students. Because she still used her textbook for planning on most days, she began selecting problems she had traditionally chosen to avoid in previous years. In speaking about these tasks she stated:

> I [normally] skipped the enrichment stuff. "It's enrichment. We don't have time for it. Let's move on." So I think I look at those more with a critical eye and with an inspiration, myself, not to think they are a waste of time.

Reevaluating resources and how they can be used is a clear shift for Mrs. Wilson. Her discussion of the textbook as something to get through in her initial interview had been reexamined and at the conclusion of the study she viewed it as a resource which could provide opportunities for student thinking.

Mrs. Wilson also described her conscious decision to adjust her own routine during student work time, now with greater emphasis placed on pushing student thinking. She reflected on how previously she would say, "Redo that one. Look at it. You just set it up wrong." and now instead chose to ask questions to prompt students to see how their work did not match the question being asked. She commented that this was not reserved for students who had incorrect answers anymore either, and instead she began to ask all students to explain their work. She stated, “I think there's much more deliberate questions when I'm walking around the room checking individual… whatever they're working on.” Mrs. Wilson’s focus on student thinking and the need to evaluate student processes in more methodical ways dominated the conversation during the summative interview and suggests a shift in instructional priorities. The specificity of her comments contrasted the discussion of tasks in the initial interview.

***Summary of Mrs. Wilson's perception of tasks*.** These data show the shifts, which occurred between the summative and initial interviews in regard to how Mrs. Wilson viewed classroom culture and the enactment of tasks in her mathematical courses. Her understanding of task selection and implementation were clearly altered by the conclusion of the study. Although she continued to question the value of using tasks with all students and the amount of time required in using tasks, the byproducts of engaging in professional development based upon teacher noticing of student thinking were apparent in her perceptions recorded during the summative interview. Her observations of student engagement assisted in the shaping of this new perspective. She began employing new instructional strategies and she sought specific tasks that engaged students in problem solving and required communication of mathematical thinking. She also developed new expectations for success for her students. This was direct evidence for addressing both research questions in this study.

Development and enactment of tasks. Mrs. Wilson felt most comfortable when she was structured and had a defined plan for each lesson and unit. Although she recognized the value in alternative pedagogies, she felt constrained by time and the cognitive abilities of her students and therefore often opted for following the scope and sequence prescribed by her textbook. In preparing for the tasks initially, she was nervous of how her colleagues would view her instruction; she worried her students would not be able to perform the tasks and this would be taken as a reflection on her ability to teach. She was uncomfortable filming tasks involving content the students had not already learned. She became more comfortable with the process as she interacted with her colleagues, but her task selection (see Table 11) consistently reflected content she believed students should understand. The researcher had a number of after-task discussions with Mrs. Wilson and she supplied him with numerous samples of student work from both task and non-task

days. She did not seek out assistance on planning tasks from the researcher, but did chat with her colleagues outside of the video club meetings for ideas.

Table 11

Tasks Recorded for Video club Discussion in Mrs. Wilson's Classes

Order	Description
Task 1	Solve problems in multiple ways – come up with 5 ways to model each of the following problems: $3 \times 5 =$, $15 \times 4 =$, $26 \times 18 =$
Task 2	Two families go to a baseball game. The first family buys two shirts and two drinks for $44. The second family buys a shirt and three drinks for $30. How much does a single shirt cost? How much does a single drink cost?
Task 3	Body Math: students measure parts of their body and then create ratios which are then converted into percentages to discuss trends in the class. Comparisons to be made: femur to height, head circumference to height, wrist circumference to head circumference, ulna to height.

Task One. Mrs. Wilson's initial task was given to her eighth grade Pre-Algebra class. She had considered using the task she eventually used in her second day of filming, but chose the multiplication problems to introduce students to the process of discussing their thinking with others. The three multiplication problems were clearly content students should have mastered prior to entering middle school and Mrs. Wilson's selection of this particular task may indicate her own worries with being filmed. The task required little cognitive demand of the students, but cognitive load was maintained through the requirement of five different methods of representation. The task presented a baseline for Mrs. Wilson's implementation strategies and instructional decision making; this section highlights some of the themes which emerged.

The requirement of students' representing their work in multiple ways was likely a byproduct of Mrs. Wilson's having taken the Mathematical Thinking for Instruction course

from the researcher in previous years. In the course, teachers were asked to complete whole number operations using multiple models and algorithms. This was done primarily to stretch the teachers' understanding of viable solution pathways and to promote diversity of models for when the teachers return to the classroom setting. Mrs. Wilson's use of this strategy with her students produced diversity in thinking, but often the work was not necessarily mathematically unique, but simply a different way of representing the same thinking. This led to at least one student changing the problem to accommodate more representations. Mrs. Wilson discussed this with the class:

> So she found another answer for 60, right? She did 10 groups of 6. And then I asked her when I was looking over her shoulder, I said, "But how can you show me that 15 times 4 is in there?" And she said, "Well, just block out 4 each time." And so I thought that was an interesting way to go about that.

In this example a student reinterpreted the requirement of the problem by modifying the numbers she was representing. Knowing 60 was the product desired, the student simply changed the factors. Mrs. Wilson persevered in pushing the student to connect her model to the actual question, but in doing so the new picture was the same as another picture the student had completed. This episode revealed how pushing students to think differently does not always support actual problem solving. It appeared the student was more focused on completing the task rather than engaging in thinking about the underpinning mathematical structures.

Mrs. Wilson was attempting to develop her own questioning skills and she attempted to model the process of having students show their work and compare models with the class. Throughout the lesson she had nearly ten students come to the board and show their representations. During this time Mrs. Wilson asked students to explain their processes and she asked some probing questions. Unfortunately she often answered those

questions herself, if students were unable to give a ready answer as is demonstrated in the following episode:

> Now look at these two numbers. So [Katie], stay there. Point at your 208 and look at the 208 over here and [Kara's]. And then notice… what do you notice about the way she did it and the way [Kara] did it? (pause) They're the same, right? This means the same as what [Katie] did. She went to a lot more work to get hers. This is shorter but they're the same, right? Thank you.

Although Mrs. Wilson was attempting to generate dialogue among her students regarding the two strategies, she quickly moved on to answer her own question when no one engaged with her. This may suggest some of Mrs. Wilson's inexperience with using task-based lessons. When a culture has been established where the teacher provides answers, students understand they need only wait until the teacher dispenses the correct information and therefore they need not focus on the discussions of their peers (Hiebert et al., 1997).

While reviewing video of her first task in the video club meeting, Mrs. Wilson made comments regarding questioning strategies made by Mrs. Larson. She questioned Mrs. Larson about one episode and through doing this Mrs. Wilson was able to better understand why Mrs. Larson had prompted students in that particular way:

> Mrs. Larson: … I had said that. You're going to see a six.
>
> Mrs. Wilson: I liked that you prompted that and said, "Where does it come from?"
>
> Mrs. Larson: But I want you to know what it means.
>
> Mrs. Wilson: It's not in the question? (chuckling)
>
> Mrs. Larson: Why are you using six instead of four or 24?
>
> Researcher: Well, and did you hear where the prompt came from?
>
> Mrs. Wilson: Did someone ask her about six?

> Researcher: Yea, actually there was a student sitting right there and he says, “I don’t know where this darn 6 came from.”
>
> Mrs. Larson: Yea, it was [Jim]. He’s like, “I have a six here. I don't know what I'm supposed to do with it or it came from?” So then…

This example provides support of Mrs. Wilson beginning to notice the differences in culture between Mrs. Larson’s class and her own and strategies Mrs. Larson was implementing. The researcher focused the entire group on the fact that a student generated the question, which prompted further exploration of the class, not Mrs. Larson. This episode illustrated for Mrs. Wilson how using certain tasks and techniques elicited different forms of student engagement and how that engagement can promote further exploration.

***Task Two*.** Mrs. Wilson decided to use a more cognitively demanding task for her second day of filming, which addressed content the students had recently learned rather than material from previous grade levels. In searching for a suitable challenge, she first thought of using the following problem with her Pre-Algebra students:

> At an office supply store, a box of 60 pens contains pens of four different colors. It contains five times as many red pens as black pens, and four more black pens than green pens. The number of red, green, and black pens combined is three times the number of blue pens. How many pens of each color are in the box?

Several weeks after sending the task to the researcher, she sent an additional email stating, “The algebraic strategy would be too difficult for [students].” She then noted “They haven’t done any substitution or elimination, so other than writing the equations representing how the pens relate to each other, [Mrs. Wilson] felt that they would give up and stick with guess and check.” Furthermore, she indicated, “I don’t think it is a bad task, but not the greatest for finding multiple strategies (maybe not ‘rich’ enough?).” This provides some evidence of Mrs. Wilson’s conscious effort to select tasks, which she felt matched her

goal of generating student thinking and divergent strategies as a result of her participation in the study. It may also be indicative of her concern regarding student motivation for problem solving and her inclination for providing alternative tasks when faced with the possibility of students failing. As a result, she instead chose to use the “Two families at the baseball game” task seen in Table 11.

This task was found by Mrs. Wilson in the *Mathematical Thinking for Instruction Workbook* (Brendefur, Strother, Carney, & Hughes, 2013, p. 138), therefore it was a task she had experienced as a student when she took the course from the researcher. She cited how it better matched the content of “writing and solving equations algebraically,” which was the current topic being addressed in the class. Knowing that the researcher had experience with the task, Mrs. Wilson solicited advice regarding models she could anticipate seeing prior to instruction. The researcher provided several solution pathways he had encountered for Mrs. Wilson to consider.

Mrs. Wilson was consciously less directive on this task when she presented it to students. She spent little time explaining and suggesting strategies to the entire class and instead allowed students to struggle for themselves before providing interventions. In her preparation for the task she developed several clarifying questions and strategies she could use to prompt individuals if they needed some assistance. Students struggled to understand that the t-shirts and drinks needed to cost the same in both equations, which she had not expected. In addition, some students lacked organization of their thinking which Mrs. Wilson chose to address more explicitly. The following is an example of a suggestion she made to a student:

> So write this over here in a chart for me. So write down what you’ve already done. Put it over here. So picture number 1 and picture number 2. Picture number 1, you

> write 20, 20, 2, 2, right, because it equals 44. But using that same amount how much money did you come up with for a second one?

She allowed the mathematical structures of using a table to organize the student's thinking without imposing her own strategies on the students. When another student showed Mrs. Wilson his strategy, which had been unsuccessful for both equations, she replied, "So try something else." These two examples capture a shift in Mrs. Wilson's implementation of this task compared to other lessons viewed by the researcher. She did not provide all students with strategies for solving the problem and instead limited her role as the authority during the process, choosing her support based on her knowledge of the student. In addition, she was generally reserved in assisting students who were unable to describe their current thinking regarding the problem. Both of these indicate an increased comfort with allowing students to take responsibilities in their own work. Her unwillingness to assist students who could not articulate a process they wanted to use also reflects a valuing of using students' thinking for instruction.

During the debrief of the task with the entire class, she selected student work which captured a wide range of solutions and that she had previously planned how she would connect. In addition, she chose students with incomplete strategies who she was then able to guide using other students' complete work. In addition, her questioning was more inclusive of student thinking and she pushed the students to consider how models were similar rather than doing it herself. In this example she referenced another model while having a student discuss her solution:

> Mrs. Wilson: [Rachel's] is similar to [Bill's]. Figure out why when she talks about it.
>
> Rachel: Well, I did the (inaudible). I divided the t-shirts and bottles and the (inaudible). And this one and that (inaudible).
>
> Mrs. Wilson: So what did you start with?

Rachel: Twelve and nine.

Mrs. Wilson: Twelve and nine. And why didn't that work?

Rachel: Well, it worked for the top one but it didn't work for the bottom one.

Mrs. Wilson: So it worked for the top one. Why don't you write down what total you had for the top one was how much and then the bottom one was how much? Do you still have that information?

Rachel: Yea.

Mrs. Wilson: Great. And the bottom one was how much when you did that? We'll just do one of them. So how is she going to get how much the bottom one cost using this information here?

Student in Classroom: (Inaudible).

Mrs. Wilson: So it's 12 + 9 times 3, right, which is what? 12 + 27… no, it doesn't. 12 + 9 times 3. There you go. Under pressure. So… next to it. So her first picture here using 12 and 9 would've been $44. Her second one would've been 39. Does that match what it said? No. So then what did you do after that, Courtney?

Rachel: I did 12…

Mrs. Wilson: Turn around and tell them.

Rachel: I did 12 and 10.

Mrs. Wilson: Twelve and ten which didn't quite match it either. And so she would have numbers here and here for each of those so for those of you that need a second way to show it that did the guess-and-check. I'm curious. Why did you have 13.50 on there?

Rachel: Because I was trying to do like this, add a dollar.

Mrs. Wilson: What do you mean "add a dollar?"

Rachel: Well, 50… well, I had to do the 13.50 + 13.50. So kind of add a dollar to it.

> Mrs. Wilson: 13.50 +13.50 so you add a dollar. Oh, I see. And so because all the others were rounded to the whole dollar so I wondered why you chose that one. All right, so in the end, she… noticed she even went more, tried other ones. Interesting. Good job.

During the initial task Mrs. Wilson had been more inclined to explain these connections for students, but in this example she alerted the class to be watching for the connections. She also expected Rachel to explain her own work whereas in the prior task Mrs. Wilson summarized the thinking to the class for the student. This conversation was arguably still primarily between Mrs. Wilson and Rachel, but Mrs. Wilson does prompt Rachel to speak to the class and much of the thinking is initially discussed by Rachel rather than Mrs. Wilson. In another situation she caught herself and corrected mid-sentence: “So you… what do you mean, you… go ahead. Keep talking, you subtracted what?” These examples reflect the conscious decisions Mrs. Wilson was making during the instructional process. It is important to note though as the end of the hour approached Mrs. Wilson was more inclined to return to more traditional methods of explaining student work rather than allowing the full process to continue.

In the subsequent video club meeting Mrs. Wilson recalled how most of the students in the video, shown to the group of teachers, were not her most stellar students. She stated:

> Mrs. Wilson: Cindy is an A student, all of the rest that were up there -- pretty good strugglers.
>
> Researcher: Oh. Well, and…
>
> Mrs. Wilson: Rachel is probably the strongest. Of them, she’s a C student.
>
> Researcher: I would not have guessed that.
>
> Mrs. Wilson: Just so you know, C’s and D’s.
>
> Researcher: As far as…

> Mrs. Wilson: Two of them not passing my class right now. Just… I mean just it was interesting that they… you know what I mean? That they could show the thinking but again you're graded on the answer a lot. She didn't have the answer. Lucy didn't. Bill didn't have the answer. The answer wasn't there.

Mrs. Wilson continued to struggle with how to address students who were not able to complete tasks and how this affected her grading. It was clear to her that these students had some strategies, but were unable to follow through and this sparked a discussion with all three teachers on perseverance of students. After some discussion Mrs. Larson suggested using tasks from the textbook which presented the work of two hypothetical students with different solution strategies; these tasks required classroom students to make judgements regarding which hypothetical student was correct. Mrs. Wilson was unaware of these being in the curriculum materials. Further discussion arrived at the suggestion of spending time on specific mistakes and dissecting these as a means of engaging students. As previously discussed, these problems were referenced heavily in Mrs. Wilson's summative interview and this was probably a result of the discussion during the video club meeting.

***Video club four*.** Mrs. Wilson attended a video club meeting preceding the instruction of her third task, where only Mrs. Larson's task was featured. The task was on the topic of fraction multiplication and required students to find specific quantities given various referent wholes. Before viewing the video, the researcher presented the group with the task Mrs. Larson had done and nine sample pieces of student work. The group of teachers were asked to work together to select and sequence the student work they would use if they were teaching the lesson. Not all of the student samples were correct and this created some discussion in the selection process. Mrs. Wilson engaged her colleagues to discuss the implications:

Mrs. Wilson: I don't know that I would… I kind of would want to start with the wrong strategies just to get those out of the way or to have that solid so that they can see why those are wrong. So I don't know. What do you guys think with… I kind of… I don't know. Would you want to put the wrong strategy in their head and then have to undo it? Or do you want them to…

Mrs. Dean: Now my question are all these done? These are the students and they're done. You just collected them all and you're just going to figure out a way to…

Mrs. Larson: No, you're walking around.

Researcher: No, you're walking around and deciding who's going to go up to the board.

Mrs. Wilson: Who's going to show on the board?

Mrs. Dean: Who's going to go up to the board? But these are actually going on in your classroom and this is what's going on.

Mrs. Wilson: I wouldn't lead with the wrong strategy.

Mrs. Dean: I think I agree with her. I think I would lead with the ones that don't add up to a whole.

Mrs. Wilson: See and I changed my mind on that. I think I'd put those up at the end so that they…

Mrs. Dean: These ones?

Mrs. Wilson: …can critique the wrong ones with the knowledge of how the right one works. They can then see why it's wrong coming from their perspective rather than coming from my perspective. So at first I thought about that to put the wrong ones up. But I think it'll almost be better for them to see why they're wrong versus me trying to pull out why they're wrong. I guess it depends on how strong their fraction sense is when you are working with them.

Mrs. Dean: Or to say go do all these ones and then bring up this one. And say, "Now can you tell me…

Mrs. Wilson: Tell me or even just what were they thinking and why?

Mrs. Larson: Now start with these and see. What do you notice that doesn't make sense here? Now hold on to that thought. We'll come back to it.

Mrs. Wilson: But I think the kids that are struggling if there's a third in your class… a fourth or a third in your class that are struggling. (chuckling) If there are some in your class that are struggling, they're going to hang on to that because you put it up there. You know what I mean? I'm wondering if there's danger in putting that up there.

The discussion represented the teachers' collaborative conversations regarding pedagogy. Mrs. Wilson genuinely sought the feedback of her colleagues in the beginning of this discussion. Through interacting with the other teachers, Mrs. Wilson was pushed to consider the ramifications of either choice. Her vacillation between wanting to use incorrect strategies first and then deciding not to use them later reveals the struggle the activity caused. In addition, these data could indicate the impact of engaging in the video club in general; focused noticing and classroom shifts may have created a situation where Mrs. Wilson saw this as a significant problem to consider, where previously it would have had less consequence. The episode appears to be a meaningful debate of pedagogical strategies and emphasized Mrs. Wilson's level of reflection over the use of student thinking, even in hypothetical situations.

Task Three. The third task chosen by Mrs. Wilson was the "Body Measurement" lesson and her focus was to "solidify [students'] grasp of ratios, constant ratios, and reviewing measuring, converting units from ratios to %, averaging, etc…" as indicated on her Video Club Observation Form (Appendix C). Once again she selected her Pre-Algebra

class as the group to be filmed. The recorded selection reflected students collecting data and therefore primarily displayed Mrs. Wilson's interactions with students as they collected measurements with their partners. Because the previous task had been open to interpretations by the students, Mrs. Wilson decided to be more explicit with the directions in this task and opted to demonstrate how students should collect specific measurements of head circumference and overall height.

Much of the conversations between Mrs. Wilson and the groups of students were based on the skill of collecting measurement data. This was a planned two-day lesson and unforeseen events meant the researcher was not present on the class discussion of the results. The fact Mrs. Wilson was utilizing an inquiry lesson she developed herself with real-world data suggested some contrast to her otherwise normal adherence to the textbook. Although she had a few missed opportunities to probe students on mathematical structures, her questioning remained more student-centered than in her initial task and during non-task day instruction.

While demonstrating how to calculate the circumference of her wrist and creating a ratio to the circumference of her head, Mrs. Wilson discussed the meaning of resulting percentage with students: "29.5%. So 29.5%. I just found that that means that my wrist is 29% of my head circumference, about a third and [Gina] is about a third." This would have been an opportunity for Mrs. Wilson to have pressed students to make sense of the percentage on their own rather than taking on the role of mathematical authority. This indicates Mrs. Wilson was still developing in her ability to notice opportunities for student exploration. Her sharing of this information could have resulted from a desire to have students begin the process of collecting data, which took the majority of the hour despite the relatively large amount of time they were given.

In a later conversation between Mrs. Wilson and a group of students regarding arm length and overall height, she pushed the group to think about the reasonableness of their answer:

> Mrs. Wilson: Don't hold the tape in your hand with your fingers curved -- arm span, fingers flat. 138%. Did you average them? No, no. That's got to be between those two for the average. Add divide by 2.
>
> [Cindy[: I did -- 90.1 plus 95 equals 185. What the heck? Why didn't it do it that time? Well, that was wrong again.
>
> Mrs. Wilson: Arm span to height would be over 100%. Why would it be over 100%?
>
> Cindy: Oh, 93. No, that one was right. Number 3 is wrong.
>
> Mrs. Wilson: When would it be over 100%, Cindy?
>
> Cindy: I don't know.
>
> Mrs. Wilson: How long would your arms have to be compared to your height to be over 100%?
>
> Cindy: Taller.
>
> Mrs. Wilson: Yes, longer than you. Right? That's why I looked up there and I knew that wasn't right because I don't see anyone in the room with extra-long arms.
>
> Cindy: [Aubrey[does.
>
> Mrs. Wilson: Does she?
>
> Cindy: Aubrey has ape arms.
>
> Mrs. Wilson: And some people do. But that's why we take the average of the two. So make sure you're working out your percentages, averaging the two and putting them up.

Anticipating reasonable answers on the part of Mrs. Wilson allowed her to reason the mistake of the student. In addition, rather than telling Cindy this was impossible, Mrs.

Wilson pressed her to discuss the meaning of the percentage in terms of the context. Although Cindy cited another student who reportedly had long arms, it was probable the data Cindy collected would not support this claim. Mrs. Wilson was persistent in her questioning of Cindy regarding the answer and pressed her several times to address the specific question begin asked. Mrs. Wilson wanted Cindy to think about the question and to make sense of the result herself. In this instance, Mrs. Wilson demonstrated her beliefs in the importance of students understanding the meaning behind the numbers they found.

The continued valuation of questioning students and seeking their understanding by Mrs. Wilson represents a trend throughout the data. Although this task was less conducive for class-wide discussions, her development of the materials herself represents a shift in her thinking. It was unfortunate the researcher was unable to view the debrief of this lesson, but Mrs. Wilson reported that she used obviously incorrect data, similar to Cindy's, with the entire group the following day to launch a discussion of the interpretation of the ratios and how representing the data as a percentage presented a specific meaning. She claimed to have pushed students to analyze the data for accuracy and meaning.

Video Club Five. The fifth video club meeting had sample video from all three teachers. A discussion of Mrs. Dean's geometry class's resistance to engaging in tasks arose between all the teachers. Mrs. Wilson suggested perhaps the resistance was due to the frequency with which the students had engaged in tasks. This appeared to be an insight Mrs. Dean had not considered prior and it emerged during her conversation with Mrs. Dean:

> Mrs. Wilson: I'm trying to think through. So her geometry class, resistant. But how often have you done tasks with them? See, you've done tasks with the other group. So they're not as resistant because they have a little bit of the background of doing those rich tasks. Whereas the other group is just kind of they do the system, you do the other and done, right?

> Mrs. Dean: And that's part of it. Other than the fact that getting through proofs, that's where they have their task because I put a proof up there and say…
>
> Mrs. Wilson: I know, because that's the thing and… yeah.
>
> Mrs. Dean: …"What do we need on this?" And it's… and by the time they get through the proofs, they really feel like they've been beat up or something. But that's I think the main spot that you're right. They don't do these rich tasks other than the proofs and the things that we… and then we go on to Sketchpad and do some of those things. But not quite this and they knew how to do this. Like you said, they knew how to do this so why go… why do it?
>
> Mrs. Wilson: We haven't asked that group to think out of the box as much is what I'm saying.

Despite not being completely heard by Mrs. Dean, Mrs. Wilson retained the thought through the conversation. This discussion suggests Mrs. Wilson was beginning to think about the experiences the teachers were providing for the students and how this affected their willingness to engage in these tasks. Her conjecture to the group provided an understanding of her thinking about system-wide structures. The data may provide an insight into shifts of her perceptions of student learning.

Summary: the case of Mrs. Wilson. These findings suggest participation in the study shifted Mrs. Wilson's understanding of tasks, ability to implement tasks which promote student thinking, and her overall view of student thinking's role in her classroom. Mrs. Wilson preferred having clear direction in her teaching and this probably indicates why she appreciated the direction provided by the textbook. Traditional methodologies supported her teaching style, but as she began to notice student thinking as a means of adapting her instructional practice, she was willing to reclaim more authority for decision making in the classroom. This led to greater confidence in having discussion with her peers

about content she would be able to able to cover in her classes. Her ownership for the courses seemed to increase by the end of the study. She recognized the need for the teachers to engage in future collaboration, specifically regarding vertical alignment of both content and practice at the secondary level.

Mrs. Wilson discussed her doubts about using tasks throughout the project, but this did not diminish her willingness to develop and deliver the required elements. In addition, she adapted her classroom culture to be more aligned with the CCSSM through expecting students to discuss their thinking with peers and to articulate more than procedural knowledge for a given solution. She saw the benefit for students, but continued to feel motivation was a systemic concern for all Sometown students. She valued students explaining their thinking, but continued to search for ways to ensure all students completed their work.

In the video club meetings, Mrs. Wilson demonstrated an increase in her ability to notice student thinking. Her reflections on the work of herself and her peers progressed throughout the project. She noticed strategies for evaluating student understanding and adopted these in her own classroom. She posed questions to her peers and sought their feedback. The collaboration created a structure for further exploration of the use of tasks and general practices she could implement during non-task day instruction.

These findings indicate shifts in Mrs. Wilson's attitudes and actions during the course of the study. Data has been provided outlining her beliefs regarding effective teaching, planning strategies, student thinking, the role of tasks, and her actual development and enactment of several tasks. Patterns in these data suggest Mrs. Wilson's involvement in this research study impacted her general pedagogical strategies and her ability to select and implement tasks in her classroom. Throughout the task enactment and video club meetings she seemed to grow in her ability to notice and utilize student thinking.

The preceding sections serve to formulate this conjecture regarding the two research questions examined by this study.

The Case of Mrs. Larson

Unlike the other teachers in this study, Mrs. Larson had taught her entire career, 18 years, within the Sometown School District. She held a standard elementary certificate and this allowed her to teach through eighth grade. Mrs. Larson had been a second grade teacher in the district for her first five years and her last 13 years had been spent at the middle school level teaching various courses, including math, to sixth through eighth grade students. Her goal for the project was to develop a deeper understanding of ways to represent tasks with her students. She had been attempting to implement tasks prior to the beginning of the project and had made an effort to incorporate student discourse into her lessons. During the initial interview she acknowledged she could see the role of noticing student thinking as supporting her efforts, but she framed her involvement in the study as a means of developing a broader scope of student reasoning and problem solving methods.

The following sections provide a review of Mrs. Larson's data collected throughout the project and the connection of these findings to the research questions posed in Chapter One. The review serves to illuminate categories and the emergent themes that arose during the coding process. Each of these three section provides an introduction, a presentation of the findings, an interpretation, and a summarization.

Beliefs about effective teaching: defined expectations. Because Mrs. Larson had already begun the process of using tasks on a regular basis prior to the initial interview, she had less apprehension than her peers regarding the requirements of the project. She recognized the use of tasks as an aspect which had been previously missing from her classroom and hoped to implement items which would better prepare students for future

testing of the CCSSM. In her initial interview she stated “I’m getting the more that you work with kids, the more things you see, but [I want] to branch out more and be able to go, Okay, so how else can I teach this.” Mrs. Larson was resigned to the use of student thinking, but she was ready to improve her own understanding of practices she could implement within her own classroom.

Beliefs about textbooks: shifts in use Mrs. Larson held less defined opinions regarding the necessity of having a specific textbook in her courses compared to her colleagues. She believed the Sometown district-adopted curriculum materials did not reflect the complete requirements of the CCSSM, which had led to her question the relevance of the materials. Through the course of the project she became more comfortable with modifying the textbook and therefore began to recognize an increased utility of the resource. This section reviews data pertaining to Mrs. Larson’s attitudes towards the textbook. In addition, it examines how she reconciled the use of the materials and developed skills in adapting lessons from her book.

When asked to describe her use of curriculum during the initial interview, Mrs. Larson referenced multiple sources in her classroom and how after attending the Idaho Regional Mathematics Center’s professional development, she was planning to order several new books. She stated, “I have two book names that I can use because our textbooks have some good information and things there but to get that variety, the diversity of tasks and things.” She also interjected, “As math is changing, some of [her collection of resources] is not as fitting as it used to be.” Mrs. Larson had perceived curriculum as a resource at the beginning of the study and therefore was not tied to implementing the district purchased materials with absolute fidelity. She was reflective about what she taught and how she knew it did not necessarily align to the expectations for what she would need

to be teaching. She saw her role as evaluating the resources she currently had and finding efficient ways to make modifications despite her limited time for planning.

Mrs. Larson also discussed the topic of curricular materials during the informal interview following the completion of her first task. She had continued to use the textbook as a source for assigning student homework. In reviewing the previous night's assignment there had been a problem many of the students struggled to fully comprehend. She stated, "If I had anticipated… the lack of understanding, I would've done that as today's task." Mrs. Larson was beginning to see her textbook as containing problems that could be the focus of her instruction with some adjustments. In addition, she was using the response of the students as an indicator of what a good task could be. She began evaluating which task in the homework created discomfort for her students and how she could emphasize those problems rather than giving pages of less demanding items for homework. Her perception of what a task could be was also changing as she recognized the problem was not something that would take multiple days for the students to explore, but still created the conversations she wanted to have as a class. During a later, non-task day observation, the researcher watched her select a single question from the book as the focus task, which encompassed the entire lesson.

In the summative interview, Mrs. Larson revealed that she had been attempting to modify tasks that were in her textbook throughout the project. She stated, "You can take a problem that is already there [in the textbook] and already been done for you and just give it that extra rigor; a little bit more depth to go with it." In addition, when asked about the impact of her participation in the study and the effects it would have on the following year, she commented that she planned to "take the textbook and pull some of those problems that are in there and add to them." She also began to see how starting her instruction with

algorithms limited her ability to have discussions with students and she stated her rationale for modifications she made to instruction:

> There's a reason I skipped Chapters 3, 4 and 5 and went to them fourth quarter because it's all formulas and solving equations. And they have to have those skills from the beginning. So they built the basic skills that fall into some of those other principles at the beginning of the year.

All of these examples give credence to the claim that Mrs. Larson's participation in the project affected her view of how to best develop her curricular resources for teaching in the CCSM. She had been conscientious about what she was teaching at the beginning of the study, but the process influenced her sequencing of content. In addition, she seemed to develop a strategy for modifying the textbook to meet the needs for her students.

The aforementioned section presented data from Mrs. Larson showing some change in her view of her textbook over the course of the year. Using Brown's (2009) stages of curricular implementation, there was no actual change from the initial interview to the summative interview; Mrs. Larson was in the *adaptive* stage throughout the project. The change occurred regarding her confidence in enactment at the classroom level. She developed strategies for revising her materials to fit the needs of both students and the demands of the CCSSM. These findings contribute to understanding Mrs. Larson's process of planning for lessons and they address the research question concerning the selecting and implementation of classroom tasks. The data suggest her interactions with students, and specifically what she noticed during both task and non-task instruction, affected her overall view of the resources she was using, sparking her to question how to best implement modifications within her classroom. Although shifts were not as dramatic as those of her colleagues, it is presumable that she did move along the continuum of curricular enactment. Perhaps, because of where she began the project, she was most

ready to alter her practice and to implement more holistic changes, not simply on days the camera was present.

Effect of student thinking on instructional planning. Throughout the study, Mrs. Larson consistently referred to the planning process as needing to include students' needs and their thinking. Because this is a focal point in teacher noticing, examining Mrs. Larson's change during the project created another category for analyzing the research questions guiding this study. The following section provides examples of Mrs. Larson's views on the role of student thinking in her planning process and compares her views from the onset of data collection to the conclusion.

During the initial interview, Mrs. Larson discussed her daily routines of addressing student inquiries, providing instruction, and giving homework. She described how she would use the student work time to analyze student difficulties with particular items in the homework assignment and then how she would make plans for the following days to address those questions with the whole group. She stated most classes begin with her saying, "Okay, you guys were working on this yesterday. We're going to go through this problem because I know everybody probably either struggled with it at home or I saw half of you were on the wrong track." Although the manner in which she addressed the misconceptions on a daily basis is not known, the fact that she consciously sought out student thinking to build instruction suggests a moderate degree of teacher noticing using van Es' *Learning to Notice* framework (van Es, 2011, p. 139). Suffice it to say, Mrs. Larson had some level of understanding of teacher noticing prior to the beginning of the project.

Additionally, Mrs. Larson described, during the initial interview, how the relatively small classes allowed her to individualize her instruction to each group of students. She felt more comfortable adjusting her teaching when the students' prior knowledge was lacking. She gave the example of her current students, saying, "We're going to move through

fractions a lot faster than we did the previous year because they have a great concept of fractions. The year before, they were lost." Her flexibility with pacing based on student need was a difference from her colleagues who both discussed feeling the need to proceed with content in order to complete necessary requirements prior to the end of the year. Mrs. Larson seemed to see the completion of topics as more fluid, reflecting the needs of her students rather than the attending to her scope and sequence's recommendations. This may be a result of her comfort with her classes, having taught the same mathematics courses over the past three years.

During the informal interview she described new techniques she was implementing for the year to expand her use of student feedback and to promote discourse. She discussed how, when students were working on assignments she had a "three strikes and its out" policy. She explained, "If I have three kids ask about the same problem… I make them all stop and we kind of walk through it together and look at different strategies." These discussions were then followed by questioning students about what they knew about the problem and then she attempted to make connections to previous lessons. She also described how she was beginning to watch student thinking to anticipate common mistakes and create questions she could use with others as she walked around the room. She gave a specific example with a student; she said, "So you're going to have an advantage. I've seen it enough times. I want you to think about this before you do it." These examples could suggest some impact from participating in the video clubs resulting in an increased sense of teacher noticing of student thinking which effected changes to her instructional strategies. This interview occurred after two video club meetings, therefore she had been engaged in teacher noticing with peers on several occasions at this point.

Additionally, during the informal interview, Mrs. Larson discussed how she had modified her teaching environment to better promote student discourse. She described

taking the desks, which were previously set in rows, and creating pairings to encourage collaboration between students. Recounting her observations following the modified environment, she stated, “So yea, and I … haven’t assigned seats. They get to pick who they sit with and it changes. It’s very dynamic. It changes constantly.” Her desire had been to encourage the exchange of student ideas and to have them compare strategies in smaller groups prior to the full class discussion. She explained how this was an initial shock to the students, but the conversations have aided in the diversity of thinking during both task and non-task day instruction. Mrs. Larson’s actions were a direct result of participation in the study and demonstrate a modification to pedagogical strategy.

The topic of student success surfaced in the summative interview. Mrs. Larson disclosed how engaging in the process of having students complete tasks had revealed issues with student thinking and how traditional definitions regarding student success were not always useful. When asked about the effects of examining student thinking, she stated:

> I think it really emphasized how much kids see things differently. And whether it be the visual kids that draw the picture or the ones that just want to work out the numbers. And then being able to… some of them who might not have as strong a number sense may have a better actual understanding of the process. Or the why it works and they can justify or explain why they did what they did. Where those other kids, some of your high end kids, they just do the numbers and they get an answer. But then when you ask them what the number means or where did that come from or why did you do that here, they don't have that answer

She went on to say, “Each kid has different areas they're strong and weak in. And I think that helps see those things in kids more than just seeing their skill level and their right and wrong answers.” These data suggest Mrs. Larson was influenced by participating in teacher noticing of student thinking as a project construct. She was beginning to see mathematical

understanding as a multifaceted endeavor where the answer was more than a number resulting from calculation. She further discussed how student discourse prompted the evaluation of her own teaching to understand whether her approach to instruction had been effective. She reflected, “On my end of teaching, could I approach it different and teach something?” Is there something missing?” Although the research questions for this study specifically address task selection and implementation, Mrs. Larson’s focus concerning evaluation was triggered by her involvement in the study. Her questioning fundamental aspects of what she knew about student achievement, resulted in her modification of her definition of student success.

During the summative interview Mrs. Larson also discussed how she had to imbed the Standards for Mathematical Practice during the year, specifically perseverance in problem solving. She described how some students saw the use of a single problem as less work initially, but eventually recognized doing one problem meant increased expectations for completion. This attempt at shifting student thinking regarding mathematics resulted from her belief that “by God we're going to just get them to take on big problems.” She developed and tested strategies with students for this purpose. She ultimately found their confidence in working through problems increased with her raised expectation.

Mrs. Larson began the project with ideas regarding student thinking’s place within her own planning and described how it impacted the decision she made. The descriptions given in her initial interview suggest she engaged in noticing activities with the aim of better instruction. Mrs. Larson continually attempted to expand her knowledge through modifying her instructional practices to align with student thinking. By the conclusion of the study, her outlook on the process changed. She reflected:

> Before you just… you looked at the objectives and you looked at the standards and you kind of filled those things in. But now it looks at even in… within one problem.

> There can be so many different focuses as to what you want them to get out of that problem more than… like I said, more than just the right answer. Is it just their understanding? Is it the ability to pull apart the problem and pick out what's important, what's not important? Not just plug it in, find an answer. There's all these other pieces that go into that.

The examples in this section suggest changes to Mrs. Larson's perception regarding the role of student thinking in her planning process. It was apparent she developed a deeper understanding of her own practice and the evaluation of students. It can be assumed this would not have occurred to this extent if she had not participated in the study.

Summary of Mrs. Larson's shifts in planning and instruction. The findings suggest specific shifts in Mrs. Larson's perceptions relating to effective teaching. Her actions imply modification to her previously held beliefs. Mrs. Larson set the goal of developing strategies for implementing CCSSM-based instructional practices and through her engagement in this study she was able to evaluate various instructional methods. Her examination of student thinking both in her own classroom and in the video club setting allowed her to determine methodologies which suited her individual teaching style, but also supported student development. She created strategies for altering tasks from her textbook and she changed expectation for student success for both herself and her students.

Role of classroom tasks: shifting perceptions. The following section presents findings relating to Mrs. Larson's conception of and implementation of tasks throughout the project. Data suggest changes to her knowledge of task enactment and environments conducive to their use. Comparisons between initial and summative beliefs are provided. This section is concluded with a summary of the connections to the research questions.

Creating a classroom culture for tasks. When asked during the initial interview to provide an example of a "good task," Mrs. Larson described how the problem should encourage the use of divergent solution pathways. She stated, "I love teaching math because there's not… there might be one right answer, so to speak. But there might be 500 ways to get there or different ways to understand it and explain it." She then discussed the need to retrain students to understand tasks often required a number of steps to necessitate more time than they were used to spending on a single problem. This was difficult for her students. She stated:

> It's overwhelming for them because for us to have one problem and they're going to work on it for the whole class period that to almost retrain their thinking that you're not going to have an answer in five minutes. For them to spend five minutes on one problem, that's a big problem.

She continued to describe students as being more familiar with exercises for which they were able to find an answer in less than a minute and how problems taking longer created struggles for the students to remain focused. She felt she needed to provide more guidance on these problems. She recalled one example regarding finding perfect apples in a group of 6000. She stated "… and they finally got to 60. I kind of guided them in there. I'm like, "Okay now, take a few more minutes now and work with 60." So give them that little nudge in that direction." These examples suggest evidence of Mrs. Larson's concern with how to build perseverance in her students. She had a desire to use tasks, but she recognized how students' previous mathematical experiences created expectations for instruction.

Student perseverance in problem solving continued to surface during the informal interview. Focusing on the task which had just been recorded, Mrs. Larson noticed students were still rushing to complete their work.

> They're just pulling the numerals and they're not really… and so when we do those, to take the time and read it. And I've watched it with the pizza problem today and initially they all just started writing down the numbers. And I'm like, "You couldn't have read the whole thing yet. There's no race to get done. Take a minute. Read through the whole thing. Make sure you understand it." Because there is that… still that race to the finish.

This trend was disturbing to Mrs. Larson because she could recognize students were not really conceptualizing the problem; a belief they could have developed over years of engaging in traditional mathematics. Her intervention was to then require students to attempt to model the solution in a second way. She discussed her purpose for this:

> If I get done quick and so then of course to throw it out there and say, "Do it two ways." Because I knew that most of them won't finish the original or think they finished and have the right answer in maybe five minutes. When it says, "Find the second way to do it," was going to stretch them a little bit. And then have them in pairs and say, "Look at yours. Look at your neighbors and see if you have something different."

Pushing students to remain focused on the task appeared to be a way Mrs. Larson was able to reconcile students rushing through their work. All three of the teachers in the study employed this strategy at some point, but Mrs. Larson is the only participant to clearly articulate a rationale for using this instructional method. She implemented the procedure to address an issue she recognized rather than as a means of producing more work for the students.

During the summative interview Mrs. Larson described how students began to view the days on which they were given one task not as something to rush through, but as a day

where they would be required to engage in deeper mathematical thinking. She explained, “They get why it's one problem and so understanding one problem doesn't necessarily mean easy.” As a result of moving away from procedural knowledge-based questions, Mrs. Larson noticed “[using tasks gave] some of those other kids that might have seen themselves as not good at math a chance to kind of shine because they will often speak up,” which encouraged more voices in the mathematical discussions. In addition she recognized students taking a more metacognitive stance, questioning themselves rather than seeking the teacher as the authority. She described the transformation in the following excerpt:

> I don't know how many times I… even before doing the project, I would answer, "I don't know. Does that make sense to you? Why do you think that's right?" But now some of those kids get that chance to say it. "Well, that makes sense because… well, look at the picture. It's right here. You can see it.

Continual use of the questioning seemed to create an understanding for the students that they would be expected to provide evidence for their solutions and the affirmation of a correct answer required a logical discussion of the process they employed.

Mrs. Larson recognized early in the study that her students often struggled to focus on meaningful aspects of the problem and instead attempted to rush through to find an answer with little focus on the intended meaning. This understanding led her to address her own expectations for students and to slowly change the culture of her classroom. This evidence supports the belief that involvement in the project directly affected her decision making regarding the use of pedagogical strategies to better promote student thinking.

Instruction of tasks. Instructional decision making regarding the use of mathematical tasks is yet another theme which emerged from analysis of Mrs. Larson’s

data. Although she valued using tasks in the classroom, she had not consciously evaluated her practices prior to her involvement in the project. She developed a deeper understanding of how to adapt tasks for classroom use and how to sequence specific items within her units. This section explores Mrs. Larson's development in both of these areas.

During the initial interview Mrs. Larson discussed searching in her textbook for items to implement with students. She stated, "I try and keep them as real world as I can. Find problems or tasks -- whether it would be online or take something that's in their textbook -- and expand it." Her goal was to "to build [a task] in a unit so every couple weeks [she would have a task]." Mrs. Larson commented on how she was using tasks she received through her professional development with the Idaho Regional Mathematics Center (a regional support structure), but she found students still preferred the algorithm driven problems they were familiar with from previous experiences.

Mrs. Larson reflected on a tasks she had been doing as a result of the project during the initial interview. Specific strategies Mrs. Larson had been implementing emerged during the discussion. She described how, in the task that had been recorded for the video club, she chose a student with an unfinished model to present his work early in the discussion of the solution. She allowed the student to explain his thinking to the class and through connecting the model to other student models, the class was able to complete the work as a group and make meaning from multiple representations. Later in the interview she recalled how she was unsure about proceeding this way:

> And I knew when I put [him] up there to do his unfinished work that was a risk. Like, ah, hopefully I can walk him through it knowing that I might have to walk him through it and tell… kind of tell him, "OK, so put half there. So now what…" and he… other than telling him, "Write that there and that, what does that mean for this one? OK, write that down." But to be able to… he was able to come up with the right numbers

> and just kind of needed to know where to place them. And then from there it… and that might not have worked if that makes sense. There was a chance that that would've been, "Well, I don't know."

Mrs. Larson's willingness to try something unfamiliar underscores her desire to learn from the process of enacting tasks. She had not planned on attempting this but she recognized the reward in selecting a student who often struggles in problem solving situations. She continued, "… knowing that you want to help those struggling kids and help them in a way that's going to build their confidence.… it not just helped him, but helped others along the way." This realization of success with taking a risk in her instruction surfaced as a theme throughout other lessons she taught during the project.

When asked to describe the purpose of using tasks in the summative interview, Mrs. Larson described how they could be tailored for different learning situations. She discussed how "lead up activities" supported students making connections to real world situations and how tasks given at the end of a lesson could be applications of the skills built during the unit. In addition she mentioned how flexibility with problem solving was critical to students' ability to approach problems. She stated, "And for some kids the most efficient way isn't the best way to explain something or to demonstrate it or to be able to justify. So I think those tasks help build some of those skills." This view of adapting tasks and evaluating student solutions was an expansion of her previous understandings; she had held that many problems should be adapted, but now she was able to evaluate which tasks would be most useful at a particular time in her instruction. When asked to discuss the lasting effects of the project she commented, "Understanding the difference in the lots of problems versus depth of knowledge from a few problems and the rigor in a problem that might build the knowledge, I think that we all have probably seen the growth." These findings reflect a more

purposeful consideration of using problems with students, rather than simply choosing real-world application of mathematics.

Mrs. Larson also discussed her collection of anticipated student work and how that affected her instruction. She explained how she attempted to develop a record of student thinking in preparation for the future. She believed it may take several years before she would fully understand what a typical response would be to a given task. The process of categorizing responses was important to her so she knew what to look for as she walked around the room. She stated, “Sometimes you'd see all of them and sometimes I had to plant them,” which is important for teachers attempting to use tasks to address specific learning outcomes. This comment suggests an alteration of how Mrs. Larson conceptualized her role in facilitating learning. She allowed student responses to drive the instruction, but needed to be prepared for how she might make connection with the strategies students would provide.

Through the enactment of tasks, Mrs. Larson recognized her own need to adapt her teaching strategies and to develop instructional methods specific to her environment. She analyzed her own teaching and took personal risks to decide how to proceed. Throughout the project she demonstrated growth in the area of her own instruction.

Summary of Mrs. Larson’s perception of tasks. Findings suggest Mrs. Larson underwent noticeable shifts in perceptions regarding the use of tasks within the classroom during the project. She began the study wanting to implement more tasks and to understand practices for doing so. By the end of the project, she had attempted to adjust both the culture of her students and her own pedagogy. These data provide evidence to better understand how Mrs. Larson selected classroom tasks and how her participation in activities centered on teacher noticing of student thinking affected her instructional decision making. It could be suggested that Mrs. Larson was making these changes prior to the

study, but many of her realizations were directly connected to her interactions with peers, as described in the following section.

Table 12

Tasks Recorded for Video Club Discussion in Mrs. Larson's Classes

Order	Description
Task 1	Determine the number of teaspoons of oregano needed for twenty-four pizzas if ½ teaspoon of oregano is needed for four pizzas.
Task 2	Jim had some Fruit by the Foot (3 feet long). He gave half of his candy to Sue. Sue gave 1/3 of her candy to Mindy and 1/3 to Cindy. Cindy decided to share ¼ of her candy with you. How much did you receive? How much did everyone else receive?
Task 3	Little Red Riding Hood has a basket that holds eight eggs. Five of them are brown and three are white. 1. What are all the ratios of eggs? 2. Change all the ratios to fractions, decimals, and percentages 3. What does each percentage mean in relation to the context?

Development and enactment of tasks. Mrs. Larson had set a goal of developing tasks in each of her instructional units and therefore viewed the project as an opportunity. She felt her teaching style aligned with promoting student discourse and did not consider the requirements to be a burden on her typical planning and instruction. She cited her role in preparing students for more advanced courses and recognized that viewing the video provided insight into the content and practices of her peers. Of the three teachers, Mrs. Larson had a more impromptu approach to the project, thus many of the documents relating to planning, outlined in the study, were not received. Mrs. Larson tended to discuss task development with the researcher during observations, but did not email the other teachers

her plans. She selected tasks to be recorded from resources received from the Idaho Regional Mathematics Center professional development opportunities she attended (see Table 12). Based upon all observations of Mrs. Larson, it appeared she consistently attempted to implement strategies she developed through engaging in the project.

Task one. Mrs. Larson's initial task was presented to her sixth grade mathematics class. She described the purpose of the problem in her video club observation form as a way for students to "demonstrate understanding of fractions as parts of a whole." She continued, "by showing two ways [students] will bring meaning to the numbers seen and found, i.e. 24 divides into six groups of four and each group of four needs ½ tsp." The task was cognitively demanding for students as the content was relatively new and presented in an unfamiliar context. Mrs. Larson chose a mathematical topic from her current teaching and did not opt to review previous materials for her first lesson.

The task was given to students and they were asked to work on it individually at first, and then to compare with others within a small group. They were instructed to read carefully and to be prepared to explain their solutions. Mrs. Larson walked around attempting to assist students and select particular strategies to be shared with the class. During her monitoring Mrs. Larson stopped at a pair of students. Through the group's analysis of each other's strategies, a question regarding the number six arose. Mrs. Larson addressed the class:

> A lot of you as I walk around, I see the number six on your page. As I read the problem there is not a six anywhere in the problem. So just be able to explain where the six came from. If you don't have a six, that's OK. A lot of you got the right answer without a six. Just I want you to be able to know and explain what that means and where is it coming from?

This incident characterizes Mrs. Larson's use of conversations with students to create opportunities by anticipating the questions they may have during the debrief of the student strategies. She made her expectations clear to all; if their model contained the number six she would require them to be able to explain how the number contributed to their solution. In attempting to change the culture of the classroom, Mrs. Wilson chose to prepare all students to develop a justification preceding her asking the question. This allowed for students to understand what they would be asked and also provided continued discussion within the small groups.

Mrs. Larson began to choose students to come to the board to present their solutions to the pizza task. The first had drawn a visual representation of pizzas and explained his strategy of circling four pizzas at one time and finding there would be six groups, representing one teaspoon per group for a total of six teaspoons for the 24 pizzas. The second student, Jim, was not finished with his solution, but Mrs. Larson had him come to the projector to present regardless, because she recognized the similarities in the strategies and hoped Jim would be able to complete his strategy with the support of the class. The episode follows:

Mrs. Larson: … [Jim]. His is similar yet different.

(crosstalk)

Mrs. Larson: Oh, man. You're nervous. It just goes like this.

(crosstalk)

Mrs. Larson: That's it, this one. So he's got circles and pizzas also.

Jim: I don't know what it looked like there.

Mrs. Larson: You don't know what you did right there?

Jim: No.

Mrs. Larson: What were you trying to do right there?

Jim: See how much… I don't know. (laughter)

Mrs. Larson: We're going to help you through it. You're getting it. It's great. So here's my question for you. Why were you subtracting four from 24 up there at the top?

Jim: To see how many… how much groups of four went into 24.

Mrs. Larson: Because we knew that there were…

Jim: Six.

Mrs. Larson: Right, six groups of four. Each group of four would use what?

Student Voice 44: Half a teaspoon.

Mrs. Larson: Half a teaspoon. So this group of four, how much is it going to use?

Jim: Half a teaspoon.

Mrs. Larson: This group of four, how much is it going to use?

Jim: Half a teaspoon.

Mrs. Larson: This group of four, how much?

Jim: Half a teaspoon.

Mrs. Larson: So did you get your pictures right? Could you finish it now?

Jim: Yea.

Mrs. Larson: Go for it. I mean, write right next to the picture if you want. (pause) I got it. So back to where… what do you know about this one?

Jim: It's big.

Mrs. Larson: This row is going to do what?

Student Voice 44: Half a teaspoon.

Mrs. Larson: So write that down right next to that. There you go. What's this one going to be? What's the next row going to be? What's next on there? See that. So how many teaspoons do I need?

Jim: (Inaudible).

Mrs. Larson: How did you figure that out? You're right. Does that make sense now? What did you do to get three?

Jim: I did a whole to half a teaspoon.

Mrs. Larson: Perfect. Good.

This passage represents Mrs. Larson taking a risk, as was discussed earlier. She was unsure whether this would result in a success for either herself or the student, but she decided to attempt it regardless. The conversation between Jim and Mrs. Larson demonstrated her patience with allowing Jim to make sense of the problem and to find a solution using his own thinking. The choice marks an instructional strategy that Mrs. Larson would utilize throughout the duration of the project.

Following Jim's explanation, Mrs. Larson selected several more students to describe their thinking at the board. She attempted to continue to connect the new strategies to Jim's, but she did much of the discussion and did not allow students to make these connections for themselves. At the conclusion of the next student's explanation Mrs. Larson stated, "Wait a minute. You guys did the same thing. But you didn't, did you?... You did it two different ways with the exact same information, didn't you?" This continued with the next several students; Mrs. Larson chose to implement a more teacher-directed discussion of the tasks and did not create a situation for other students to interject. This could have been a result of having a number of students she wanted to have present and not knowing exactly how long each would take.

At the following video club meeting, Mrs. Larson indicated she wanted to discuss her sequencing of the student discussions with her peers on her Video Club Observation Form. She spoke about selecting Jim and one other student to present and how choosing these students did not reflect her typical approach. She attempted to emphasize her success by stating, "Some of my kids who are quiet… were very articulate in how they

explained it." Her desire to share this with her peers may indicate the importance of her own discovery from attempting a new strategy for selecting students in her classroom.

When discussing the other videos, Mrs. Larson focused on specific student actions, but often referenced back to what she had seen from her own students during her lesson. In one instance she contrasted Mrs. Wilson's decision not to suggest a strategy of using a graph to show all of the multiples of 15 and her own decision of showing a student who used a table.

> Researcher: How do we make that judgment call? What do you all use for… to make those decisions?
>
> Mrs. Larson: Like the graph, I wouldn't have planted it…. But on [Mrs. Wilson's], the table, I would've planted the table and I probably even would've, at the end, said, "What if most of them we would've just done it the other way? What if I only had 20 pizzas? What if…" Where [Mrs. Wilson], you saw that and we kind of got there without having to guide them.

It appears Mrs. Larson was weighing the ramifications of selecting particular models for the given mathematical situations. Viewing the choices made by her peers allowed her the freedom to consider what she may have done in the given situation. She noticed the outcome from the video and was able to contemplate how either strategy would affect the goals of the lesson.

Task two. Mrs. Larson's second task resulted from a discussion with the researcher following a miscommunication regarding filming dates. Mrs. Larson had not prepared the task, but she received it from the researcher prior to the beginning of the school day and spent her preparation period planning for the lesson. The task, which had been developed and tested by the researcher, had two possible correct interpretations of the answer (it can be solved as fractions of the whole or as linear measurements) and it aligned to the content

Mrs. Larson had addressed the prior week. As part of her preparation, she developed a number of anticipated strategies she believed students may attempt in solving the task.

Mrs. Larson took a more directive approach to framing the task than she had in the prior task-day lesson. She had a student read the task to the class once all individuals had a copy. Following the reading she stated, “I want you to think about this. Maybe draw it out, act it out. Whatever it takes, I want you to see if you can figure out how much… (audio gap) And then long, it’s really long, right? It’s 3 feet long.” The reason for her approach could either have been on account of her relative unfamiliarity with the task or as a result of experiences with the particular class when completing tasks.

Many of the students struggled with the concept of having multiple referent wholes in one problem (i.e. when finding ¼ it is actually from a piece which is 1/6 of the whole rather than from the original whole resulting in an answer of 1/24). As students were working on the task, Mrs. Larson stopped the class and suggested, “Read that carefully. A couple things I'm seeing. When we talk about this, read this. Read it one sentence at a time and go one chunk at a time. It makes it easier.” Once again she used a strategy of noticing student misconceptions and addressing these with the entire class while trying not to direct specific student thinking. She iterated the need for students to focus on smaller portions of the problem and to construct a systematic approach to finding an answer, which was an instructional method she later described in the summative interview.

Several teacher actions surfaced in the classroom discussion of the task. Following a conversation from the previous video club comparing the benefits of using the whiteboard to using the projector for presenting student work, Mrs. Larson decided to have students put all of their models on the whiteboard at one time to assess whether this made it easier to facilitate making connections between methods. In this process, she decided to once again select a student who was not completely finished with his work; he had a visual

representation of the problem, but had not yet found the values each person received in the task. Based on prior experience, Mrs. Larson applied a specific teaching move she had developed in the first day of filming. The difference in this lesson was Mrs. Larson's focus on connecting representations. Once the first student to come to the board, Jeff, completed his discussion, Mrs. Larson asked another student, Jill, to come to the board and try to use Jeff's work to complete her own work while other students in their seats attempted to compare their models to the methods being discussed.

Jeff: … And then they can simplify that.

Mrs. Larson: So Jill, you kind of got stuck, didn't you, for a minute. And you were doing all the colors. Is it starting to make sense now?

Jill: Yea.

Mrs. Larson: Come on up.

Jill: Oh, man.

Mrs. Larson: See if you can do a similar picture. Perfect. Go ahead and sit down there, Jeff.

Jill: Wait. Do you want me to draw my version?

Mrs. Larson: Uh-huh. With your fractions and your numbers, it might be a little different but still the same. [Rachel], how are you coming with numbers? Are we getting there? OK.

Rachel: I don't think I know how to do it.

Mrs. Larson: And that's good. Paying attention to theirs, looking at yours, can you maybe figure out what to do with yours?

Larry: Hers you can easily multiply the way that she broke it down.

Mrs. Larson: I agree. That one…

Larry: Even the 4 times 3 times 2 on there.

> Mrs. Larson: We'll get there in just a second, Larry. Because I think that [the rest of the class] just went, "What? Multiply?" for some. Others are like, "Wow. That's what we talked about on Friday."

This episode illustrates the concerted effort of Mrs. Larson to include the class in the process of making sense from the student's work. By knowing what strategies students were using, she was able to involve others, who were still seated, in the analysis of the work being discussed. Mrs. Larson shifted her practice from directing discussions to facilitating the thinking of her students. These findings suggest Mrs. Larson may have been becoming more comfortable with the routine of enacting classroom tasks and her conscientious decision making while teaching. Her anticipation of strategies and noticing of student thinking allowed her to consider student work which would be helpful for her objectives. This also ensured her ability to guide student discussions towards making connections between the representations rather than directly communicating this herself.

Video club three. The third video club occurred on the same day that Mrs. Larson taught the second task and consequently her video was not viewed by the group during this meeting. Instead, she reviewed video from both Mrs. Dean's and Mrs. Wilson's second tasks. Mrs. Larson seemed to use the experience to solidify what she observed in her own classroom earlier in the day.

Mrs. Larson demonstrated increased levels of noticing through the conversations with her peers. She was not only attending to specific student thinking, but also was interpreting what she saw and attempting to make connections to larger practices. The following exchange between the teachers was initiated by the researcher asking the teachers to discuss Mrs. Wilson's sequencing of student models during her lesson.

> Mrs. Larson: Like [Benjie], you start with him and you can see where… he was doing the tip of that guess and check.

Mrs. Wilson: But he wasn't done.

Mrs. Larson: No, and didn't quite know for sure how to make it an educated guess and check as much. So how can I adjust? So try to guide him through that. So you have too much money. What change would you make? There's more of these and less… so keep that in mind and move into the next. Here's another guess and check that was a little bit more thought through, not just random guess and check so that kind of guides him through the…

Mrs. Wilson: Well, and even asking him… I could've asked him, "What would your next guess be?" That would've been a good question to see if his thinking goes that far.

Mrs. Dean: See where his thinking was going.

Mrs. Wilson: Because he struggles so to see if his thinking goes that far.

Mrs. Larson: Or even to let him watch the next person and then say, "So now that you've listened to their guess and check thought, what would you…" Before they even get to their answer, before he sees that right answer. "You guys have the same method. They were picking specific numbers. Which number would you pick next? You'd spent too much money. So how can you adjust that?"

Mrs. Wilson: Right.

Mrs. Larson: "How can you make sure you're not going to keep spending more money?" because he did initially. He thought, "Well, I went down to 15. That's less money but I went up here." So that changing both variables. Let's leave this number the same and only change this one which is kind of what [Lucy] did. She kept the 12 and went… at least she's only changing one variable where he was changing both.

Mrs. Wilson: Both, right.

Mrs. Larson: So to even help him just change one number.

Mrs. Wilson: And see what happens.

Mrs. Larson: Or… and see what happens. So to build…

Mrs. Wilson: Because he wouldn't necessarily go there himself next so he would just pick another number and try it I would think.

The passage illuminates Mrs. Larson's focus on student thinking and her reflection on the process of using student work to facilitate instruction. Her choice to focus the conversation on Benjie, as student who had not fully completed his work, seems to be an indication of her own comfort with this technique. She validates Mrs. Wilson's choice and appears to offer some suggestions for how she may push students to make connections, offering Lucy's model as a means to facilitate this.

Mrs. Larson does not refer to her own class during this exchange and instead references what she noticed from Mrs. Wilson's video. This is a shift for Mrs. Larson from her discussion in the previous video club meeting where she tended to bring the conversation back to her own students. She used evidence from what she noticed in the video of Mrs. Wilson's class to formulate her comments and provide an interpretation of the episode while providing suggestions. Referring to this and other exchanges during the meeting, it could be suggested that Mrs. Larson was moving to more advanced levels of noticing based using van Es *Learning to Notice* framework (van Es, 2011, p. 139). This may also be the result of the lack of video from Mrs. Larson's classroom at this meeting.

Video club four. Only Mrs. Larson's second task was featured during the fourth video club meeting. The additional time allowed the researcher to engage the teachers in a simulation of teaching involving the task they would be reviewing. Roughly half of the meeting was spent engaging in an activity focused on Smith and Stein's (2011) steps for orchestrating productive mathematics discussions using student thinking from the fruit by

the foot task, and the other half was devoted to watching the video of Mrs. Larson's students model their thinking for the same task.

The activity the group began the meeting with was planned to engage the teachers in a discussion of sequencing student work during a lesson. They were presented with the Fruit by the Foot task and nine hypothetical pieces of student work to review. They were then asked to select four of the representations and place them into a particular sequence they felt would produce the best strategy for addressing the objectives of the lesson. Mrs. Larson had already done this in her own class and many of the hypothetical work samples were similar to methods constructed by her students. Mrs. Larson demonstrated her understanding of how to sequence in the following episode:

> Mrs. Larson: So do you want to hit on some of the… because these two I don't know if you could either… do either one or the other. I would also do [these] last because they're the simplest but they have… they show the least understanding. So be able to say…
>
> Mrs. Wilson: How does this match?
>
> Mrs. Larson: …this gives you the same information but what does it mean and where do those numbers come from? Why can you just multiply? What is this showing? So I think those would be last because they are…
>
> Mrs. Dean: I agree with that.
>
> Mrs. Larson: Hopefully that builds to the understanding why that works.

In this exchange, Mrs. Larson provided a rationale for the other teachers of why she believed specific models should be used later in the debrief with students. These findings suggest Mrs. Larson had the understanding to process the thinking of the students in each of the four samples, compare the strategies, and then decide on how the resulting discussion would impact her teaching objectives. In addition, she clarified how she may

question students regarding the specific model to create the connections to the other chosen samples. The passage suggests Mrs. Larson's conceptualization of pedagogical strategies to promote student thinking.

Later, the teachers observed the video of the task from the sixth grade classroom. Mrs. Larson was reflective of her practice and offered several suggestions for modification, such as providing students with physical representations they could use to "act out" the task. In addition, Mrs. Larson focused the conversations between the teachers on the connections she was able to facilitate for her students. The following conversation between Mrs. Larson and Mrs. Wilson serves as an illustration:

> Mrs. Larson: Where [Jill] struggled to explain why it was a sixth at first. But then when she saw [Jeff's] picture, it was crazy how they…
>
> Mrs. Wilson: …connected.
>
> Mrs. Larson: …connected their numbers with somebody else's picture to have them explain something. So…
>
> Mrs. Wilson: Good.
>
> Mrs. Larson: And then when we switched the end of it was the inches piece of it and trying out how many inches that would equate to which was fine until you get down into the end and then we're splitting wholes and parts and I'm like, "What?"
>
> Mrs. Wilson: Very nice. Good task.

Mrs. Larson was excited to share this with her peers. In the video she leaned towards Mrs. Wilson as she described her students' interaction. Mrs. Larson had decided on the goal of improving her instruction of tasks at the beginning of the project and her enthusiasm is a reflection of her realizing her development towards this objective. These findings provide further evidence of the impact the project had on Mrs. Larson.

Task three. The final task Mrs. Larson chose required seventh grade students to engage in content they were familiar with, but had not formally connected. She selected the lesson from the *Mathematical Thinking for Instruction Workbook* (Brendefur et al., 2013, p. 120) which was provided by the researcher. She adapted the task by presenting it as three distinct prompts and allowing students time to complete each section prior to giving additional requirements. This instructional method had been discussed in prior video club meetings and with the researcher, but this task was the first instance where she structured the delivery in such a way that students would not have all of the questions available from the beginning. This may suggest Mrs. Larson was continuing to experiment with how to best implement tasks to students.

The demands of the task created a situation where the students did not complete the three questions within the class period and thus the researcher was unable to capture the final discussion that occurred the next day. During the lesson, Mrs. Larson implemented many of the strategies she had developed throughout the project while she monitored her students' progress. She used guided questioning of student thinking rather than providing directed solutions. She also addressed the entire class several times, clarifying directions and soliciting insights students were developing through engaging in the task. She led students to some certain processes, but she continually pressed them to articulate the meaning of the numbers. Through these examples, Mrs. Larson demonstrated her depth of comfort with student problem solving and allowing children to take responsibility for creating conceptual understanding. These methods reflected a shift in Mrs. Larson's ability to manage a task-based classroom from her first task. The findings also suggest some evidence to address the research questions posed in Chapter One.

During the subsequent video club meeting, Mrs. Larson shared her frustrations with when she chose to use her task within the unit and therefore she made specific adaptations to this task. She commented,

> Everything else I've done… with all the tasks we've done, I had done kind of as a follow-up or kind of mid-chapter. Let's do one big problem now with what we've been learning. And I thought, "Oh, this will be a nice bridge from fractions and decimals and percents into ratios." They did not cross the bridge…. I shouldn't say that. It just was a lot more difficult than I thought it would be…. It was the seventh graders and it went well. It just I thought it would be much more natural and it didn't.

She attempted to use the task in an unfamiliar way and as a result felt less successful. Student difficulties with the task caused Mrs. Larson to reflect on the appropriateness of the task at that given time, which indicates she was struggling to make sense of how to best implement tasks.

Later, during a discussion regarding perseverance and student thinking, Mrs. Larson seemed to make connections between her students' difficulties with her task. When asked by the researcher to consider when tasks should occur within a unit, both of Mrs. Larson's colleagues contended tasks should occur following instruction. Mrs. Larson was not as sure. The following except presents her resolution to the previous contemplation:

> Researcher: And I mean also that perseverance and that justifying sometimes… and part of it is we would expect that group who had solution methodologies in place to solve that sometimes have that tendency to want to have a quick, efficient way to do it.
>
> Mrs. Wilson: And why bother with the rest.
>
> Researcher: So I'm not going to worry about…
>
> Mrs. Dean: …what it means.

Researcher: …making sense of it at this point, and…

Mrs. Larson: And that's what I find across the board with doing the tasks. I don't think it matters when you do it, before or… sometimes they just want the answer. Or they get an answer and they… when you press them for those, "Why does that work or how does that help you with where we're going next?" if we do it as a pre-teach. They don't… I don't know that they don't see the relevance but they're like, Oh, that's your job. You need to teach us that. I don't know so you can tell me, kind of thing rather than, Let me see if I can figure it out.

Mrs. Dean: Yeah. "Just tell me. Just give it to me." It's like they're…

Researcher: Do you find… so you're saying you don't find necessarily a difference if you give, say, a task that students are unfamiliar with the skill set to solve it?

Mrs. Larson: I think…

Researcher: Versus if you've taught something and then give a task?

Mrs. Larson: If either of them involve that perseverance, I think that is a… it's a… yeah, that's its own struggle whether it's at the beginning… if perseverance is part of the issue. If it's a problem you know they're not going to… it might be multi-step, the one I did. I went one question at a time trying to guide them through that and not being overwhelmed before I start. And they nailed the ratios right off the bat. They can do that. So now let's look at them in decimals. Well, right away some of them did go nicely into a decimal because the ones that were fifths, great. The ones that were eighths… and thirds they… They made those connections there and could've probably worked their way through that. The eighths was beyond some of them with that and they, right away, went, "Ugh," or…

Mrs. Wilson: What would you change, your basket total because of that?

Mrs. Larson: No, no. But I think…

Mrs. Wilson: Because it still gets them to think.

> Mrs. Larson: …that is part of… well, that goal is to give them the skillset to do the persevering that they need to.

Through this passage Mrs. Larson appears to reconcile her previous conflict of when to place tasks. She identified the issue not with when the task was used, but instead with the cognitive demand required and classroom expectation for students to persevere. She recognized the culture of the students may actually be the determining factor in success. When asked by Mrs. Wilson about adapting the task, Mrs. Larson addressed this as a reduction of expectations; she articulated her perception of tasks needing to be both mathematical and experiential. The discussion exposed Mrs. Larson's internal dialogue regarding using tasks and provided evidence of the project's effect on her decision making process.

Summary: the case of Mrs. Larson. Findings illustrate a pattern of changes in how Mrs. Larson viewed her instruction and were representational of how she engaged her students during both task and non-task observations. Mrs. Larson was open to using tasks in her classroom and she repeatedly mentioned how the project requirements complemented her teaching style. Her beliefs were initially aligned to the goals of teacher noticing of student thinking, but through her participation in the study, Mrs. Larson demonstrated instructional changes and she was able to communicate these shifts to her peers. She had always viewed her textbook as a resource, but as the project progressed, she developed strategies for adapting specific problems to better engage student thinking. Her decision making focused on eliciting student involvement in lessons and she was willing to adopt new pedagogies she noticed while watching herself and peers in the video club meetings. She was interested in sharing the experience with the elementary staff members in order to create a vertical alignment of instruction throughout the district.

Mrs. Larson examined her own practices and those of her peers to decide on generalized processes for delivering tasks-based instruction to students in her classroom. The teacher noticing of student thinking construct pushed her to evaluate classroom culture and analyze her practices for arranging students and how she selected student work for classroom discussions. Mrs. Larson attempted methodologies that were unfamiliar to her and made adjustments to her teaching because she wanted to better understand the consequences of various deliveries; she viewed the project as her own action research opportunity. Her increased comfort with anticipating and interpreting student models was demonstrated through interactions with teachers within the video clubs and with the researcher during his observations.

Findings suggest Mrs. Larson valued the structure of the video club as a form of collaboration between her peers. Although much of her planning was presented to the researcher during his visit, she engaged in the meeting and attempted to develop strategies from her observations. Her development in noticing increased over time and she often referenced specific examples in the videos while providing interpretation of the student's thinking and offering possible instructional responses to her peers. She disclosed that the project had been the most focused collaboration the group of teachers had ever engaged in and she recognized the effects it had on her perspective of her peers.

The data collected during this study suggest Mrs. Larson's knowledge of task enactment changed and therefore her willingness to modify her instructional practices to support student thinking also shifted. She sought strategies for modifying task and non-task day instruction as a result of her increased focus on student thinking both in her classroom and within the video club meetings as a result of her participation in the study. These findings serve to assist in drawing conclusions regarding the research questions guiding this study.

The Case of the Sometown School District Secondary Mathematics Teachers

This section will examine the collective case of the three secondary mathematics teachers and Sometown School District and how their involvement in the study affected their teaching of both tasks and non-task lessons. Patterns within the coding structure led to the creation of the categories identified in the individual cases for each teacher. These categories of: (a) the effects of student thinking on instructional planning, (b) beliefs regarding the role of classroom tasks, and (c) development and enactment of task, represented a heuristic for explaining emergent themes relating to the research questions. This section examines each of these themes and will offer interpretations of the data.

Development of teacher noticing of student thinking. The three teachers all demonstrated growth in their ability to notice student thinking as demonstrated through their individual communication, enactment of tasks, and video club interactions. The following delineates this theme by what the teachers were able to notice and how they noticed as defined by van Es' *Learning to Notice* framework (van Es, 2011, p. 139). Furthermore, examples are provided to illustrate this development at various stages of project.

Table 13 provides typical examples of each teacher's ability to notice student thinking from the second and fifth video club meetings. These two meetings were chosen because each represented occasions where all three teachers contributed videos for analysis. In addition, the second video club occurred after each teacher had taught a task and the fifth was the final meeting and signified the culmination of the group interactions for the project. These examples were chosen as representative samples of each teacher's noticing during these meetings.

Table 13

Sometown Teachers' Ability to Notice Student Thinking

Teacher	Second Video Club	Fifth Video Club
Dean	I noticed that about both of you that you asked that question to students, "Well how does this vary and how does this differ from the way the guy next to you did it?" I like that part	That's what I should've done. I should've said, "Okay [Jen], go ahead and sit down. That was wonderful…." Get [Fred] up there or somebody up there that would just jump at the chance to get up there and do something. That's what I should've done.
Wilson	I liked that you prompted that with them. [Jim], having him stretch past what he drew, stretched past it because obviously he knew.	[Jen] couldn't see it. She didn't see the mistake. Even after she erased the wrong one. I mean that was interesting because I thought she still didn't see the mistake even though you talked her very gently through the mistake but she had it wrong.
Larson	And [Jake] had that same thing. He has that picture and well, because [he] knew [he] needed 140. So to be able to explain, why… They see it and know it but they don't necessarily understudy why. So to help them bridge that… which for my kids, that's where we're at.	[Jen is] insecure with herself. She's very insecure with her abilities… getting our kids to persevere through those and to be able to explain and justify it. You don't just get an answer and be done. What does it mean or how did you justify the change of it?

In the second video club, the three teachers were at various levels of noticing (see Table 14) when compared to each other. Mrs. Dean mostly focused on the questioning strategies of her peers, offering her approval of the technique. Mrs. Wilson focused on a specific teaching move used with a particular student and provided an interpretation of why this was employed, but did not suggest much analysis beyond this being something she observed. In the case of Mrs. Larson, she attended to one student's strategy and situated the thinking into the broader landscape of teaching mathematics, but she did not elaborate further action to address what she had noticed. Collectively no two teachers were at the same level of noticing during the second video club meeting, with Mrs. Dean and Mrs. Wilson displaying more similar responses than Mrs. Larson.

Table 14

Sometown Teachers' Level of Noticing based on Learning to Notice Framework (van Es, 2011, p. 139)

Teacher	Second Video Club		Fifth Video Club	
	What Teacher Notices	How Teacher Noticed	What Teacher Notices	How Teacher Noticed
Dean	Level 1 - Baseline Primarily focused on teacher moves of colleagues	Level 1 – Baseline Provided description of what others did in their classrooms	Level 2 – Mixed Attended to student thinking and mathematical impact	Level 2 – Mixed Beginning to interpret impact on her own teaching using observed student thinking
Wilson	Level 2 – Mixed Focused on student thinking, but no evidence for claims	Level 2 – Mixed Provided a general impression of what occurred	Level 3 – Focused Attended to a particular student's mathematical thinking	Level 3 – Focused Referred to a specific example and used evidence to support her view
Larson	Level 3 – Focused Attended to one student's thinking and then extrapolated to the whole class	Level 3– Mixed Referred to student thinking and offered an interpretation	Level 4 – Extended Focused on student's issue and then extended to propose a way to build support for insecure students	Level 4 – Extended Used student thinking to focus on larger issues facing most students at Sometown Secondary Schools

The levels of teacher noticing of student thinking recorded during the fifth video club meeting indicate more developed strategies for recognizing and interpreting student thinking for all three teachers. Mrs. Dean focused her discussion on one particular student and the instructional decisions she had made during the task. She reflected on how she could have modified her teaching by recognizing the episode as an opportunity to allow another student to draw connections from Jen's model (see Table 13). Mrs. Wilson

identified Jen's struggle to conceptualize a mistake even after Mrs. Dean discussed the error with her. Mrs. Wilson pondered why the student was unable to conceptualize the mistake given the support. This evidence suggests Mrs. Wilson was beginning to evaluate individual thinking as a means of eventually creating connections to her own practice. Finally, Mrs. Larson, who displayed the highest level of teacher noticing of the three teachers in the fifth video club, posited that Jen's issues may stem from deeper insecurities, based on the video evidence. Mrs. Larson then generalized this to an issue of all Sometown secondary students and referenced the need to instill greater perseverance in all students in order for them to meet the needs of problem solving. These findings suggest Mrs. Larson's ability to notice increased from attending to student thinking to identifying specific examples of student thinking and then making connections to teacher actions which could mitigate issues she noticed. The three samples from the fifth video club represent a collective growth of the teachers in the area of teacher noticing of student thinking.

These findings inform the conclusion that involvement in video club meetings, focused on teacher noticing of student thinking, can positively impact a teacher's ability to notice student thinking. Using van Es' framework for analyzing the teachers' development, each individual displayed advancement in both what they noticed and how they noticed during the course of the study. For this reason, teacher noticing of student thinking appears to be a theme of this project.

Teacher noticing's effect on task development and implementation. Findings suggest all teachers in the study exhibited shifts in their ability to develop and implement tasks. Categories of data supporting this claim include changes in the teachers' perception of the role of tasks, collective beliefs surrounding classroom culture, selection of items, and the use of student thinking in task enactment over the duration of the project. The following provides evidence of the teacher's growth in each of these areas and address the first

research question of how does teacher noticing affects decision making around selecting and implementing classroom tasks.

Table 15

Sometown Teachers' Perceptions of Tasks

Teacher	Initial Perceptions	Perceptions at the Conclusion
Dean	Mrs. Dean viewed tasks as providing a "fun" way to engage students in mathematics and considered science applications to be the best example. She believed they most benefited younger students and she worried they could take time from important content she needed to cover.	Mrs. Dean identified the role of tasks in increasing student confidence and how allowing students to discuss their strategies provided opportunities to hear from all students. She implemented strategies she viewed her peers using in the video clubs and was pleased with the results. She continued to wonder how she would adjust her courses to facilitate the use of tasks in the future.
Wilson	Mrs. Wilson saw tasks as problems she gave students from the textbook. She worried that most students would not benefit because they would be unable to attempt to complete them.	Mrs. Wilson recognized that tasks benefited students in creating increased expectations for communication of mathematical ideas. She recognized adding questioning to the use of tasks allowed her to evaluate student work beyond correct answers. She articulated the benefit for the majority of her students.
Larson	Mrs. Larson valued the use of tasks, yet wanted to understand strategies for implementing tasks in meaningful ways. She had attempted to begin using them on a more regular basis, but recognized she needed support to increase her effectiveness.	Mrs. Larson developed instructional strategies for using tasks and adapting problems from her textbook. She valued how they provided opportunities to notice student thinking. At the conclusion of the study she was questioning how to best balance their use with more direct teaching.

Perception of the role of tasks. The teachers' views of the role of tasks transformed as they enacted their tasks and shared experiences with their peers. Summative reflections on the role of tasks indicated all teachers recognized the potential for tasks to create situated learning that supported efforts to implement the CCSSM. Table 15

presents a comparison between each teacher's initial perception of the role of tasks and those held at the conclusion of the study.

Although the teachers had differing views about tasks at the onset of the study, all indicated positive views during their summative interviews. Whereas the comments tended to be more general when initially questioned, by the end they were able to provide specific responses regarding their experiences with their use. In particular, all discussed the impact of participating in the video club as aiding their appreciation of the use of tasks. In addition, they shared a common belief that tasks needed to be part of their curriculum if they hoped to address the CCSSM expectations. These shifting perceptions of the role of tasks propagated the use of instructional techniques focused on eliciting student thinking by all three teachers. Their modified mindsets allowed the teachers to become more adept at implementing tasks with greater confidence and thus they saw benefit to their students' exposure to this environment.

Beliefs surrounding classroom culture. A byproduct of the video club meetings and task enactment was a general questioning of the expectations and classroom culture within Sometown School District (they wondered about both the elementary and secondary schools). This topic was not directly addressed in the initial interviews with teachers, but both Mrs. Wilson and Mrs. Dean expressed how some students would be successful with tasks and others would not and then implied the need to reduce the cognitive demand of tasks in order to accommodate these individuals. As the teachers used tasks more frequently, they collectively began to believe in the need to increase expectations for students to discuss their thinking and to clarify their understanding. During the fifth video club meeting Mrs. Wilson suggested that students who were not given the expectations to discuss their thinking would be less successful in situations where they were asked to communicate their mathematical understanding, such as in future testing of the CCSSM.

Each teacher was able to identify benefit for at least one of her students during the study and this prompted all to express the need for continued focus on providing opportunities for students to take responsibility for their mathematical thinking. Mrs. Larson's reflection on Jen from table 13 provides an example for the teachers' belief in increasing the confidence of their students so they would be better prepared for task-based instruction.

Selection of Tasks. The nature of the tasks selected by teachers changed as they became more comfortable in understanding how students would react to the expectations of completing non-routine tasks. Initially all three teachers selected tasks which addressed topics that had been previously taught, or should have been taught, to students. Mrs. Wilson's first tasks represented content students should have understood from their elementary experiences and she simply increased the cognitive load by requiring students to solve the problem in five different ways. Mrs. Dean's task presented a higher level of cognitive demand to students, but through discussion, Mrs. Dean decreased the rigor by explaining students' strategies to the class. Mrs. Larson's task reflected content the students had been studying in a new context. Of the three teachers, hers was cognitively appropriate, but she was unable to connect student models in meaningful ways. The tasks she implemented following this presented higher expectations for all students. Mrs. Dean's second task was inquiry-based and required students to generate meaning from data they collected through exploration. She used her third task to press student's conceptual understanding about how graphing could be connected to their natural inclination towards guess and check strategies. Mrs. Wilson's second task was given prior to the formalization of algorithms and her third task was an exploration of gathering data and interpreting ratios. Mrs. Larson utilized tasks which promoted numerous models and she consciously anticipated how she would better facilitate students to connect the representations through questioning strategies. These findings suggest increased understanding of the impact of

selecting tasks with multiple solution pathways. The teachers recognized that certain tasks would allow students the ability to produce more divergent solutions, which would therefore enable the teacher more opportunities to select and discuss mathematical structures. As they progressed in the study, the teachers' conceptualization of potential student thinking increased and as a result they selected items that allowed them to address issues in their classes.

The use of student thinking in task enactment. Teacher practices shifted as they communicated with their peers about tasks presented at the video club meetings. The emphasis on student thinking during task implementation increased following observation of video club meeting. Mrs. Dean's recognition of the questioning of her peers was emulated in her teaching. Furthermore, after viewing Mrs. Wilson's second task, Mrs. Dean opted to replicate it with her students, making adjustments, which were discussed at the third video club meeting. Mrs. Wilson spent time anticipating models her students would use to solve the tasks. She implemented the use of a recording sheet to track the students she wanted to present and questions she would ask, in order to connect strategies. Mrs. Larson experimented with various ways to present student work during the debriefing of tasks to assist student analysis and reflection on the work of others. Overall, the teachers instituted practices for questioning students and took on less directive behaviors while using tasks. They allowed students to present strategies that were not always the most efficient means of finding answers, but nonetheless represented authentic solutions. The teachers debated the ramifications of using a specific technique in situations presented during video club and made suggestions for other ways the task could have been presented. Cooperatively they grew to understand that teaching with tasks required them to allow student thinking to surface and then use that thinking to reach their lesson objectives. This did not always go

as planned, but the teachers reflected individually and as a group on how to better implement the task in the future.

Teacher noticing's effect on task development and implementation: conclusions. The four areas presented describing teacher noticing's effect on task development and implementation suggest teachers grew in their ability to select and implement tasks because of their increased attention to student thinking. The identified shifts in each of these areas collectively indicate the teachers made decisions based on what they observed in their classrooms and the classrooms of their peers. The construct of teacher noticing permeated each of these changes in teacher attitude and behavior. Teacher noticing therefore provided a structure for teachers to develop strategies for selecting and implementing classroom tasks. Furthermore, noticing enabled teachers to increase their ability to anticipate strategies students may implement while engaging in tasks-based problem solving.

Influences of video club participation on teachers' ability to identify and utilize pedagogical strategies which promote student thinking. Engagement in the video club meetings resulted in noticeable changes in the attitudes and actions of the teachers. These specifically related to views of instructional planning and practice. Each of these topics is explored to create a foundation for understanding how the video club experience influenced the teachers in this project.

Video club's effect on instructional planning. Participation in the video club shifted all teachers' views of their district-purchased curriculum as an effective means of addressing student thinking. Using Brown's (2009) curricular use descriptions (Table 9) at the onset of the data collection, Mrs. Dean and Mrs. Wilson would best be categorized as being in the *offloading* stage, while Mrs. Larson was in the *adapting* stage. Mrs. Dean and Mrs. Wilson used the curriculum as presented to plan the topics they would address in their

units, mostly following a prescribed scope and sequence presented by the developers of their textbook. Mrs. Larson also used her purchased materials, but exhibited more flexibility in how she interpreted the progression of topics and the order of lessons. Mrs. Dean and Mrs. Wilson described the need for structure while Mrs. Larson appeared more flexible regarding the need for a textbook. Through the process of developing tasks and engaging in observing student thinking, all three teachers recognized the materials they were using did not provide focused instruction relating to the Standards for Mathematical Practice found within the CCSSM, and therefore did not address all aspects of their standards. This realization prompted reflection. At the summative interview Mrs. Dean reflected on her need for further direction in how to realign her materials to match the needs of her students, understanding tasks would be a part of her future instruction. She hoped to receive new materials that would cover these aspects, but was resolute in doing what she could to adapt what she had. Mrs. Wilson modified her scope and sequence, eliminating materials that no longer were reflected in the standards for her grade level. This was uncomfortable at first, but she recognized the value of freeing time to incorporate more discussion of student thinking and therefore viewed her decision as the correct one. Mrs. Larson disclosed that she hoped the district would not purchase new materials being that she felt what she was using could address student thinking with the strategies she developed throughout the project. At the conclusion of the study, all three teachers appeared to be in the *adapting* state with Mrs. Dean remaining inclined to return to *offloading* if a better resource was adopted. Regardless, each teacher became a more comfortable with adapting materials by the conclusion of the study.

Related to this, each teacher mentioned the need for more collaborative meetings with their peers focused on topics related to teaching mathematics. Mrs. Dean felt the team should spend time evaluating their textbooks and aligning materials to the CCSSM in order

for her to better understand what she needed to cover in the future. Like Mrs. Wilson, Mrs. Dean was seeking to know what she could discontinue teaching so she could spend more time addressing student thinking. Mrs. Wilson wanted collaborative meetings where the three teachers could discuss content and instructional practices with each other. It seemed that she valued the discussion that had occurred and hoped for continued interactions based on mathematical content. Mrs. Larson recognized the video clubs as strengthening the relationships between all three teachers and she valued seeing content at all grade levels. She viewed this as helpful in her preparation of students for future courses. The video club acted as a focused discussion of mathematics and student thinking for three teachers who were bounded by other responsibilities, being from a small school. They all valued being able to engage their peers in these discussions and expressed interest in continuing the process.

Video club's influence on instructional practice. The three teachers' practice, both on task and non-task days, was influenced by their involvement in the video club discussions. Concerted efforts regarding questioning of student thinking, expectations for discussions, and items presented shifted to more student-centered models, at least in some respects. Mrs. Dean implemented tasks when she believed her students would benefit from more exploratory experiences on days the researcher was not present. In addition, her lectures were also modified to include more participation from students, although this often reflected a discussion between herself and one other student. Mrs. Wilson modified her monitoring practices to include holding students accountable for explaining their reasoning and to ask student questions rather than suggesting solutions. During her direct instruction of new content she encouraged students to question items and even to come to the board and describe their thinking to the class for group discussion. Mrs. Larson solidified practices through experimentation during task-day lessons and video club analysis. She discovered

that students with unfinished work created useful models to discuss with the whole class. In addition, she worked to change wording of tasks in her textbook to encourage students to have to communicate their thinking. These examples suggest the impact engaging in the video club meetings had on the participants. They observed the impact valuing student thinking had on students and found ways to replicate this in their classrooms on a more regular basis. In addition, their focus during the video club meetings shifted as they began identifying the results of practices enacted by their colleagues on student thinking; data suggest this may have led to shifts in their ability to engage in subsequent noticing of student thinking as they seemed to offer more interpretive comments as the meetings progressed. Through participation, they became more comfortable with accepting student thinking as integral part of instruction and also in identifying opportunities within instruction for fostering higher level engagement from students. The cycle of noticing leading to new practices leading to deeper noticing was apparent in the actions and interviews with all three teachers.

Influences of video club participation on teachers' ability to identify and utilize pedagogical strategies which promote student thinking: conclusions. The preceding two areas of: (a) video club's influence on instructional planning and (b) video club's influence on instructional practice, contribute to understanding the larger impact participating in the video club meeting had on the teachers in this study. Each individual demonstrated residual effects from the video club meetings. Perspectives and actions shifted as the teachers developed a deeper understanding of teacher noticing. Rigidly held beliefs regarding textbook usage and pedagogy were adapted. The teachers' sense of community increased and all requested future collaboration time to continue addressing various topics of need unearthed by the project. This provides evidence to conclude that the

video club structure enabled the teachers to better understanding of the beliefs and actions of their peers as well as the students they each taught.

Conclusion

This chapter explored the pertinent findings of this study which were: (a) all teachers demonstrated increased levels of teacher noticing of student thinking using van Es' *Teacher Noticing* framework (van Es, 2011, p. 139), (b) the effects of teacher noticing on task development and implementation, and (c) the influences of video club participation on teachers' ability to identify and utilize pedagogical strategies which promote student thinking. Evidence presented reflected patterns of data which related to addressing the researcher questions of this study that focused on (a) how does teacher noticing affect decision making around selecting and implementing classroom tasks, and (b) how does engaging in video club meetings focused on teacher noticing affect teachers' ability to identify and utilize pedagogical strategies which promote student thinking. This analysis suggests the teachers involved in this study were affected by their participation and demonstrated pedagogical shifts resulting from engaging in video club meetings focused on teacher noticing of student thinking and the requirement to enact tasks. Chapter five describes the implications of these findings and suggests how these relate to field of mathematics education research as a whole.

CHAPTER 5: Conclusions

The purpose of this single-case study was to investigate how participating in video club meetings based in teacher noticing of student thinking would affect secondary mathematics teachers' subsequent decision making in the classroom. Specifically, the project focused on the beliefs and actions of the teachers regarding their selection of materials, use of pedagogical strategies, and general understandings for the promotion of student thinking. The conclusions from this study serve to examine the areas of (a) influence of video club meeting's on developing teacher noticing of student thinking, (b) influence of teacher noticing on task development and implementation strategies, and (c) how video club participation focused on teacher noticing shaped teacher beliefs and practices. The review of these conclusions illustrates the significance within this particular study and suggests connections to the larger field of mathematics education research. Recommendations are provided for future research and are then followed by the researcher's final reflection on the study.

Involvement in Video Club Meetings Increases Teacher Noticing of Student Thinking

The first major research finding of this study revealed that participation in video club meetings and the related requirements increased the teachers' abilities to notice student thinking as measured by the van Es' Learning to Notice framework (van Es, 2011, p. 139). This supports the assertion that teacher noticing is a skill which can be learned, as described in the literature (Jacobs et al., 2010; Mason, 2011; McDuffie et al., 2014; Sherin & Star, 2011). Confirmation of this justifies the use of teacher noticing as an analytic lens by teacher educators during professional development and within teacher preparation programs. This knowledge is useful specifically because if teacher noticing was an innate skill, which some teachers possessed and other did not, time spent engaging in-service and pre-service teachers in building understanding of its use could be better spent in other

areas. It is likely that without the video component of the collaboration process, given the preliminary level of noticing, at least two of these teachers would not have made the degree of growth they were able to accomplish. The focus of all aspects of this study on teacher noticing of student thinking created a structure where teachers developed skills in recognizing student thinking for instructional purposes.

Furthermore, this finding provides evidence for video clubs being a primary component in the development of teacher noticing. The teachers were able to reflect on the in-the-moment decision making of themselves and their peers, which allowed them to evaluate the actions and speculate on the effect of different practices. Miller (2011) likens teachers gaining situational awareness (e.g. teacher noticing of student thinking) in the classroom through watching video to professional athletes reviewing film prior to a game. This process of reflection and discussion during video club produced shifts in the teachers' focus from general classroom events and teacher actions to student thinking and interpretations of how to improve student thinking. Through the acts of receiving and providing feedback on student thinking, teachers were able to conceptualize this understanding in deeper ways as evidenced by shifts in their focus during the video club meetings. This conclusion serves to confirm the findings of others (McDuffie et al., 2014; Schifter, 2011; Sherin, 2001) who have used video club frameworks to understand teacher noticing of student thinking as they engaged with peers while analyzing video of classroom episodes.

In addition, the conclusion serves to further inform the understanding of individuals who provide professional development regarding the benefits of using video clubs in their practice. Because teaching occurs in a fast-paced environment and recognition of aspects within the classroom may go unnoticed (Erickson, 2011), the use of video presents an opportunity to pause the episodes and discuss in the moment actions and examine the

thinking which is occurring (van Es et al., 2014). Santagata (2011) suggests video also allows teachers to focus on specific features of the lesson and the classroom, thereby producing knowledge which can be utilized in future instruction.

The Effects of Teacher Noticing on Task Development and Implementation Strategies

The second major research finding was the identification of several influences the project had on the teachers' shifting understating of task development and implementation strategies. These included: (a) recognition of qualities in a task which lead to increased student thinking, (b) increased ability to develop and adapt tasks, (c) demonstrated improvements in facilitation of task-based lesson, and (d) ability to anticipate strategies and sequence student discussions of problem solving. The following sections address each of these influences separately to better illustrate the relevance to this study and the larger field of mathematics education.

Recognition of qualities within task which lead to increased student thinking. The teachers' participation in this study led to increased ability to discern qualities of tasks which promote student thinking during lessons. According to Ball and Bass (2000), teachers should possess the ability to understand both short-term and long-term impacts of their tasks on student conceptual development. The findings of this project demonstrate that these teachers, who were provided experiences examining tasks through the lens of teacher noticing of student thinking, showed increased ability to provide a descriptive rationale for the use for the use of specific tasks. In particular, they were able to reason about the impact on student thinking of using certain tasks and could make these decisions prior to implementation. Boston and Smith (2009) found teachers who could evaluate tasks for impact on student thinking became more comfortable engaging in the use of tasks with students, which was also found during analysis of the findings in the current study. Additionally, Boston and Smith (2009) found that teachers engaged in developing tasks

specifically to increase student thinking were better at maintaining the cognitive demand of the task throughout instruction than teachers who used tasks from a textbook, even when that curriculum was reform oriented. The understanding that a focus on student thinking needs to be an integral part of both planning and instruction would be crucial for groups of teachers evaluating curricular resources for district adoption; understanding a source is standards-based does not ensure instruction which promotes student thinking. Mathematics coaches attempting to support the transition to using these materials would also be impacted by this information as professional development such as the use of video clubs focused on teacher noticing of student thinking may assist coaches in facilitating discussions with teachers regarding the enactment of tasks.

Increased ability to develop and adapt tasks. Based on the findings of this study, it appears that one specific outcome for teachers was an increased understanding of how to develop and adapt tasks in ways that promote student thinking. Sherin and Drake (2009) found teachers who attended to student thinking during instruction tended to address mathematical "concepts and procedures more substantively" (p. 491) as they were attempting to adapt content to match their student's needs. Based on the findings from the present study, it is presumed that as the teachers shifted their practice to align with student thinking, they found themselves needing to adjust their tasks in order to reflect student needs, just as the teachers in Sherin and Drake's study had done. The ability for a teacher to do this becomes vital as the CCSSM requires students to engage in increasingly more rigorous analysis of mathematical structures, which many current curricula fail to address (NCTM, 2014; NMAP, 2008) and therefore becomes the responsibility of classroom teachers. Teachers trained in noticing techniques, such as analysis of how or what they are noticing, could serve as a group worth further study as they would presumably be using tasks in their classrooms and therefore would be exposing students to this type of

instruction on a more regular basis. Educational researchers may wish to consider this area for further examination as teachers will require greater proficiency in developing tasks relating to the Standards for Mathematical Practice in the CCSSM. Understanding this outcome of the study presents a mechanism for anyone working with teachers in the area of task development and adaptation and therefore warrants further study.

Demonstrated improvement in facilitation of discourse during task-based lessons. Findings demonstrate increases in the teachers' abilities to use tasks which foster student mathematical discussions as a result of engaging in tasks development and implementation based on teacher noticing of student thinking. When students discuss their mathematical thinking, misconceptions are surfaced and therefore may lead to teachers addressing these errors earlier in the learning process (Burns, 2015; Chapin et al., 2003; Fosnot & Dolk, 2002; Humphreys & Parker, 2015). Similar to the work of Smith and Stein (2011), this means teachers who have knowledge of techniques for orchestrating such discussions would have an advantage in their ability to utilize classroom tasks. The ability to access students' thinking allows the teacher to make actionable decisions regarding instruction and content. The outcome of increased ability to foster discussions during this study suggests benefits of using teacher noticing with both pre-service and in-service teachers as these are populations that would be served by having better strategies to guide student mathematical discussions (Chapin et al., 2003; NCTM, 2014; Smith & Stein, 2011). Those who train teachers may consider imbedding teacher noticing of student thinking in their course content as a means of bolstering future K-12 instruction on the topic of using task-based lessons in the classroom.

Ability to anticipate and sequence student strategies to promote discourse. The findings suggest that teachers displayed increased abilities to anticipate and sequence student strategies for classroom discussions as a result of their participation. Smith and

Stein (2011) recognize the acts of anticipating and sequencing as a significant factors in promoting meaningful discussion of classroom tasks. Development of these skills requires an ability to conceptualize the purpose of the task and to abstractly reason through multiple possible instructional results. Through anticipation of these possible outcomes, the teachers in this study were pressed to conceptualize hypothetical learning trajectories (Simon, 1995) for the given lesson based on predicted student strategies. The teachers demonstrated this ability to select and order samples of student work during the fourth video club meeting when they were asked to engage in the fruit by the foot exercise. The conversation established evidence for their increased ability in this area when compared to their initial planning of tasks. Ball and Bass (2000) caution, “although pedagogical content knowledge (PCK) provides a certain anticipatory resource for teachers, it sometimes falls short in the dynamic interplay of content with pedagogy in teachers’ real-time problem solving” (p. 88). Teacher noticing of student thinking can therefore act as a mechanism for shifting pedagogical content knowledge towards this area and thereby assisting teachers in the creating hypothetical learning trajectories which allow for wider scopes of potential student thinking. Understanding that teacher noticing of student thinking provides a lens to predict and monitor progress towards task objectives assist educational researchers in better understand the preparation mathematics teacher need for teaching. Smith and Stein (2011) present steps for task delivery and teacher noticing of student thinking may be a means of providing a framework for utilizing this structure by those unfamiliar with the use of tasks. This project presents useful information for those beginning to use classroom tasks and for researchers seeking to identify best practices for task delivery. Connecting the processes described by Smith and Stein to professional development based on teacher noticing of student thinking may be a logical next step for those who work with both pre-service and in-service teachers.

Conclusion summary. These effects, which characterize how teachers in this study increased their shifting understanding of task development and implementation strategies, provides examples of the impact engaging in a project on teacher noticing of student thinking has on teachers. This conclusion addressed the research question of "How does teacher noticing affect decision making around selecting and implementing classroom tasks?" by providing specific instances of this change. Furthermore, through the connection made between teacher noticing of student thinking and the body of literature surrounding the use of classroom discourse, deeper understanding of these topics becomes clearer for both practical application in classroom settings and for future researcher in these areas.

Video Club Participation Focused on Teacher Noticing Affects Teachers Beliefs and Practices

This project provided an understanding of specific influences video club participation had on the teachers' beliefs and practices over the course of this study. These influences were: (a) shifts in teachers' curricular vision, (b) evolving understandings of the need for a classroom culture which fostered student thinking, (c) changes in teacher PDC, and d) teachers' view of collaboration. Elaboration on these four influences are provided in the following sections. A summary of this conclusion is provided after each has been discussed.

Shifts in teacher's curricular vision. The video club experiences of the project teachers led to increases in their ability to modify their curriculum vision to enable the encouragement of practices focused on student thinking. Remillard (2005) suggests that shifts in school context can trigger changes in teacher-curriculum interactions. Through the discussions occurring during video club, all teachers ended the project at the adapting state of curriculum use (Brown, 2009). Participation in video club meetings may have influenced the development of this more uniform view of resources, or curriculum vision. The changes

the project teachers displayed regarding their curricular vision suggest a rationale for the developments they exhibited in the use of tasks with students; this broader influence affected more specific shifts previously described, which was also found by Drake et al. (2012). Video clubs focused on teacher noticing of student thinking created a forum for discussing the current district resources. This process exposed the teachers' views on the materials they had available, which therefore illuminated each individual's views on how to best incorporate teaching tasks into their current paradigm. The teachers were able to then collectively construct a vision of how to develop student thinking, which could explain why they shared a more unified vision by the end of the study. Their new trajectory for teaching mathematics (Cirillo et al., 2009) now included the role of student thinking, which also supported their increased vision of how they should be preparing students for CCSSM-based assessments. Engagement in this particular video club process assisted the shifting of the teachers' curriculum visions.

Evolving beliefs regarding classroom culture. The video club format influenced the teachers' beliefs regarding Sometown School District's mathematics classroom culture and what it should reflect. The project teachers had all experienced professional development stressing the need for shifting expectations in the classroom towards environments which foster conversation, but it was not until they viewed and discussed the thinking of their own students that they were able to understand how their instruction impacted student culture. Each teacher discussed this realization during both video club meetings and the summative interview. Examining student thinking in a familiar context produced shifts not realized in previous professional development experiences delivered by researcher. This information is critical those who deliver professional development for teachers because the way teachers conceptualize their own learning from these experiences influences how they subsequently conceptualize possibilities for student

learning, which confirms the findings of others (Franke, et al., 2001; Mason, 2011; Stein & Kim, 2009). The video club experience coupled with the situated noticing underpinning the project, clarified aspects of student culture which did not align with implementing the CCSSM and more specifically the Standards for Mathematical Practice. Consequently, this shared understanding led to alignment of specific practices for eliciting student thinking. These findings provide professional developers with a framework for assisting groups of teachers who are analyzing whether their classroom culture supports student thinking.

Changes in pedagogical design capacity (PDC). The video club experience influenced shifts in the project teachers' PDC and subsequent instruction. Teacher noticing of student thinking imbedded within video club meetings provided a lens for interpreting curricula materials and instructional decision making. More specifically, the teachers were able to evaluate and assimilate knowledge they noticed from their peers into their own pedagogical framework, thereby building on their individual practice, which Brown (2009) states is the definition of increased levels of PDC. In addition, the teachers became increasingly adept at generating comparative analysis of what they observed and alternative, hypothetical pedagogies which could have been applied in the situation. Involvement in these focused discussions influenced teacher agency for developing adequate instructional materials, which was facilitated by the personal context video club created for each teacher (Drake & Sherin, 2006). This influence suggests a connection between a teacher's level of PDC and the impact of engaging in video club meetings based on teacher noticing of student thinking, but further study would be needed to better understand the factors within the video club structure which most contributed to the teachers adapting their practices.

View of collaboration. The video club experience influenced how the teachers began to view the role of collaboration in their development as teachers. Because the

nature of Sometown School District necessitated the division of labor among the teachers, all operated in separate spheres and therefore collaborative activities were primarily focused on selecting curricular materials to purchase as a district. The video club experience increased the frequency of meetings between the teachers and therefore began to erode professional isolation within the group (Leinwand, 2012; NCTM, 2014). In addition, teacher noticing of student thinking provided a construct which each teacher was then able to recognize as being directly applicable to their individual classrooms. Teachers described the process as beneficial and all wished to continue the use similar collaborative activities into the future, which may suggest movement in the group's stage of development as a team (NCSM, 2014). The comprehensive nature of teacher noticing of student thinking coupled with the localized context created through video club produced a situation where teachers at different grade levels were able to create a shared experience. This was particularly useful in Sometown School District where no teachers instructed the same classes, which Howley and Howley (2005) depict as a regular occurrence in rural settings.

Conclusion summary. These influences characterize noticeable shifts teachers made to both beliefs and practices as a result of participation in video club meetings focused on teacher noticing of student thinking. This conclusion addresses the research question of "How does engaging in video club meetings focused on teacher noticing affect teachers' ability to identify and utilize pedagogical strategies which promote student thinking?" by recognizing patterns of change witnessed during the study. These outcomes collectively represent how the project teachers were impacted by their participation. In addition, these influences draw connections between teacher noticing of student thinking and curricular enactment research areas, suggesting the prior impacts the later. This conclusion requires further study to first confirm this conjecture and if so, in what whys this occurs.

Suggestions for Future Research

This section presents topics revealed in the findings that could benefit from further exploration. Because the duration of this project only encompassed one academic year, a longitudinal examination using the same conceptual framework and data collection would be useful to see if the results found were sustainable over time, or if teachers reverted to previous attitudes and pedagogies when the researcher requirements were removed. In addition, this study was conducted with secondary mathematics teachers, it would be valuable to conduct a similar study with elementary teachers to examine whether results of this study generalize beyond this population of secondary teacher. Sherin and Drake (2009) focused on elementary teachers' use of curriculum and found student thinking to be a factor in addressing the depth at which the teachers taught, but they did not examine using a construct such as teacher noticing for developing the teachers' attention on particular classroom events. Likewise, McDuffie et al. (2014) studied the impact of video club analysis on task-based instruction in K-8 classrooms, but she and her colleagues did not use teacher noticing to guide teachers in their analysis of those episodes. Therefore, it would be beneficial to further examine the impact of teacher noticing with elementary teachers in both task enactment and curricular design.

Additionally, further research could assist in forming a better understanding of the relationship between teacher noticing of student thinking and other topics such as PDC, curricular vision, and task implementation. Findings presented in this study indicate a teacher's ability to notice student thinking may be related to these areas, but this is as of yet unsubstantiated. Current research on this area is limited to curricular enactment and instructional planning, but additional studies should focus specifically on understanding factors within teacher noticing and the video club structure which most contributed to this increase. Further researcher directed at the connection between teacher noticing and

these areas would be recommended as a means of better understanding the benefits of engaging in professional development such as that described by this study.

Summary

Chapter five presented the conclusions based on the findings of this study. These conclusions addressed the researcher questions of a) how does teacher noticing affect decisions making around selecting and implementing classroom tasks and b) how does engaging in video club meetings focused on teacher noticing affect teachers' ability to identify and utilize pedagogical strategies which promote student thinking? The conclusions presented evidence of specific influence teacher noticing of student thinking had in each of these areas and added to existing research literature by presenting an examination of the construct's effects on task enactment, curricular adaptation, instructional change, and beliefs regarding student thinking all within the model of video club meetings. Finally, the chapter offered recommendations for further study based on the findings of this project.

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Appendix A

Initial Interview Protocol – Rural Schools Project

- Could you give a little background on your career as a teacher and how long you have been in this school district?
- Please describe working in a small rural school
    - How do you see your role here?
    - What classes do you teach here?
    - Are there advantages/disadvantages to teaching in this type of school?
- Please describe your teaching style and how you structure your classroom
- How much time do you typically take in preparing for your various math classes?
- What resources do you use to plan your lessons or units?
- What impact has Idaho Core had on your planning and teaching?
    - Have you felt prepared to begin teaching the Idaho Core?
    - Were there any major changes to your standards with the adoption of Idaho Core?
        - What was the most significant change?
        - How have you addressed these?
- What do you look for to know a lesson is going well or you are successful after a class?
- Do you ever have department meetings with your fellow math teachers?
    - If so, what is the typical focus of those meetings?
        - How much time is spent on instructional practice?
        - How much time is spent on vertical alignment?
        - How much time is spent on content of specific courses?
- In this project we will be watching videos of instruction; how do you feel receiving feedback from your colleagues?
    - What do you think the positive outcomes could be?
    - Do you have any worries?
- How well do you understand the content your colleagues teach or the content of their classes?
- How comfortable do you feel watching videos from your colleagues' classrooms and discussing what you see?
    - How comfortable are you with giving feedback about:
        - Content
        - Instructional Practice
        - Student Engagement
        - Student Thinking
- What would your goals be for participating in this project?

Appendix B

Summative Interview Protocol for SAHE 2013-2014

Can you describe your year and how your involvement in this research study has gone for you?

1. Describe the experience of watching video of you or your colleagues teaching.

1.1 To what extent did this change your understanding or knowledge of teaching mathematics?

2. What did you learn about students' mathematical thinking as result of the video study?

3. What are the Standards for Mathematical Practice and describe their role in the teaching and learning of mathematics

3. Describe the extent your understandings of the Standards for Mathematical Practice changed over time as a result of participating in this video study.

4. Do you feel that participation in this video study will have a long-term impact on your teaching?

4.1 Why or why not and in what way?

5. Based on your experiences in this project this year, what will you do differently next year?

Appendix C

Initial Project Codebook

Codes		Definitions	Examples from Transcripts
Student Engagement	Thinking	References to and/or descriptions of student thinking provided by the teacher	"… Because things didn't turn out and their concepts weren't the same. They thought very differently…"
	Discourse	Examples provided by the teacher of students communication with instructor, other students, or the entire class	"And when you say, 'Well, let's try to solve it another way,' students respond 'I want to be done. I'm done. I got the answer. Why do I have to do it another way?'"
	Actions	An Accounting of various actions taken by students	"So they'll go through all the problems and they'll get to the story problems. And some of them will just…"
Role of the Teacher	Planning	Teacher description of planning process, considerations made in planning, Classroom routines, reflections on teaching, and expectations for students.	"I have a copy of each textbook at home. Again, I'm still pretty text oriented, textbook oriented, because it gives me a solid, I know I have to get through this. I know that the state standards are covered in it. I know… so I kind of feel it gives me a little bit of structure as far as direction, where I want to go next…. It's already scope and sequenced out for me…"
	Questioning	Discussion of questions posed to students or to be presented to students during the course	"Why did this one give you a different number than this one because they both make sense?... So whose is right?"
	Knowledge of Student Needs	Encompasses teacher's Mathematics Knowledge for Teaching (MKT) as a construct for evaluating students' current level of need at any given time.	"So motivating them to want to try something that's problem solving oriented when you have readers that don't read well. Some of my remedial kids don't read well. And so trying to set up tasks and find task that they can spend time on and have success at with lower skills…"
	Beliefs about Instruction	Ideal understanding of how mathematics teaching "should be" based on teacher perceptions of current situation.	"If I'm doing a story problem, I'll draw pictures a lot. But I guess I should make them draw the pictures. It should be something… an open ended task should be maybe something that is done as an opener."
	Observations	Description of events noticed by the teacher either during classroom instruction, course planning, or collaboration experiences.	"Things I noticed as they were completing an assignment before they walked out the door that I'm like… I saw half of you were on the wrong track…"
	Teacher Actions	Instructional moves described by teachers during the process of teaching	"And so there are a few that I'll call on more than others but not necessarily."
Teaching Environment	Opportunities	Events or situation experienced by the teacher which either afford favorable results or limiting ramifications.	"I think also the small class size…. I mean, my largest class is 20. And I think that having small class sizes is an incredible benefit to me as a teacher in order to check in with each student."
	Structures of Instruction	Aspects of mathematical instruction which guide teacher practice such as: curricular resources, educational standards, instructional protocol, assessment and evaluation requirements, etc.	"I think our only negative is we're bound by time. We need to keep moving in order to cover the standards that the state suggests. So it's hard to spend, as long as I would like to, as you know, as every teacher knows, as long as I'd like to dig a little deeper on those rich task problems."
	Collaboration	Opportunity to meet with colleagues to discuss practice and plan for future teaching in order to improve classroom instruction	"… and I have talked with Mrs. Wilson quite a bit because, OK, this is what I would like to see. When they walk into Albegra1, this is what I would like them to know how to do this really well."

Video Club Observation Form

Name: _____ Date: _____

Write a short reflection on your task. What were the important ideas you hoped students would leave understanding?

Are there things you want to discuss about your task with the group?

Task 1:

Please describe the task that you are observing in the box below:

While watching the video episodes, write what you notice the teacher doing. How is student thinking used for instruction? How does the task lend itself to instruction?

Task 2:

Please describe the task that you are observing in the box below:

While watching the video episodes, write what you notice the teacher doing. How is student thinking used for instruction? How does the task lend itself to instruction?

Task 3:

Please describe the task that you are observing in the box below:

While watching the video episodes, write what you notice the teacher doing. How is student thinking used for instruction? How does the task lend itself to instruction?

Appendix E

University of Idaho

May 16, 2013

Office of Research Assurances
Institutional Review Board
PO Box 443010
Moscow ID 83844-3010

Phone: 208-885-6162
Fax: 208-885-5752
irb@uidaho.edu

To: Julie Amador
Cc: Abraham Wallin

From: Traci Craig, PhD
Chair, University of Idaho Institutional Review Board
University Research Office
Moscow, ID 83844-3010

Title: 'Teacher Curriculum Design within the Common Core Project'

Project: 13-100
Approved: 05/15/13
Expires: 05/14/14

On behalf of the Institutional Review Board at the University of Idaho, I am pleased to inform you that the protocol for the above-named research project is approved as offering no significant risk to human subjects.

This approval is valid for one year from the date of this memo. Should there be significant changes in the protocol for this project, it will be necessary for you to resubmit the protocol for review by the Committee.

Traci Craig

Traci Craig

Appendix F

Wallin, Abraham (wallin@uidaho.edu)

From:	Ely, Robert (ely@uidaho.edu)
Sent:	Friday, November 13, 2015 6:40 AM
To:	Cole, Cheri (cheric@uidaho.edu)
Cc:	Amador, Julie (jamador@uidaho.edu); Wallin, Abraham (wallin@uidaho.edu)
Subject:	Re: Dissertation Paperwork - Next Step
Follow Up Flag:	FollowUp
Flag Status:	Flagged

Dear Cheri,

This email is to authorize my signature for approval of Abe Wallin's dissertation and defense. I am away on sabbatical this semester, so I cannot physically sign the appropriate paperwork. Because of this, I authorize Julie Amador to sign for me on all the necessary forms. In particular: I confirm that I accept Abe Wallin's dissertation and vote "yes" that he passed his defense. I give Julie Amador permission to sign my name for my on the "Authorization to Submit Dissertation" pages.

I am attaching an image file of my signature, which I authorize you to paste into documents if that would help in any way.

Thanks Cheri — all the best!

-Rob Ely

Robert Ely, PhD.
Associate Professor
Department of Mathematics
University of Idaho
P.O. Box 441103
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208-885-6740
ely@uidaho.edu