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The Role Of Reflection In Expert Teacher Instruction

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THE ROLE OF REFLECTION IN EXPERT TEACHER INSTRUCTION

by

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DEDICATION

To my late mother, Elsa V. Takacs, an educator with over forty years' experience in the field. She began her career as an elementary school teacher and became a junior high school math teacher and counselor, and exhibited the traits of an exemplar. She set the standard by which I judge teacher-student interactions. She also supported my dream to attain my doctoral degree. I wish she could be here to see my dream become a reality.

To my aunt, Beatrice Lawhorn, a teacher with over forty years' experience in elementary education and art education. She is a wealth of information and her story needs to be told.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Chapter 1

Introduction

All k-12 classroom teachers, both novices and those with many years of experience, have the same number of students and classes, and the same expected content delivery and success. However, experts have an advantage in that they have complex schemata that help them understand classroom situations. Expert teachers' methods differ from novices' in that their decision-making differs (Westerman, 1991, p. 3). Both novice and expert teachers are given the same types and numbers of students to teach, so the overall teaching load for the two different levels of expertise is the same. Novices do not have the experience or teaching acumen to link classroom activities with successful instruction. It is a trial by fire of sorts. If novices could understand what expert teachers know and do, and be able to implement these practices, their work life might become more efficacious more quickly than the sink or swim approach currently seen in some US classrooms. What factors influence expert teacher decision-making in the classroom?

It is common sense that practitioners in any field are versed in their profession on a level that is in line with their experience. It has been shown that experts in any field have spent ten years or 10,000 or more hours in practice (Ericsson, 2006, p.690). In the field of k-12 education, expert practitioners are consistent in their ability to teach successfully no matter what the conditions for teaching and learning are. These professionals are able to solve instructional problems, utilize their experiences, and interact with their students to successfully deliver course content. By using their expertise in lesson design, the students of these experts continually increase achievement on standardized tests year after year, even though the conditions for learning are not optimum (Jozefiak, 2011). While every one of these teachers was a novice at one

point, how they became expert is not clear. “How to develop such changes from novice to expert remains rather obscure” (Cross, 2011, p. 144). Since all k-12 teachers are given the same class load, novices struggle while more experienced teachers may not (Gu & Day, 2006, p.7). The rate of attrition in novice teachers has been documented (Deangelis and Presley, 2011, p. 599). Between 40%-50% of new teachers leave the profession within the first five years of practice (Ingersoll & Smith, 2003). Although there may be numerous causes for attrition, teachers who never advance to expert may give up in part because they do not employ strategies as experts do, but spend “a huge amount of time attempting ‘problem-structuring’ and small amounts of time on ‘preliminary design’ and ‘refinement'” (Cross, 2011, p. 138).

K-12 teachers are prepared for their positions in the classroom by course work, an internship, and student teaching. However, many new teachers spend many more hours of preparation for their teaching than seasoned professionals do. They must learn how to apply theory and pedagogy in their first years in the profession. This is true even of those who have had the most extensive preparation (Feiman-Nemser, 2003, p. 2).

Teachers’ ability to effectively provide students with the situation that will best support their learning is acquired over time (Dahlgren & Chiriac, 2009, p. 998). Each class brings a new set of students; therefore one formulaic set of actions may not work for every group. Teachers’ experiences, in tandem with content knowledge, build a knowledge base that informs the teachers’ practice. This study investigated how teachers in k-12 education make lesson design decisions based upon their prior experiences including interactions with students, their understanding of content, previous success with lesson design, and their own beliefs about themselves as professionals.

Research Questions

This research study attempted to address the following questions:

1. How do expert teachers describe their performance?
2. What expert teacher constructs are held in common?
3. In what ways do expert teacher performance and constructs inform instruction?
4. How does expert teachers' thinking during acts of instruction in conjunction with self-identity and constructs modify in-the-moment learning activities with which they choose to engage their students?

Statement of the Problem

In most traditional k-12 institutions in the United States, both new teachers and experienced teachers have the same caseload of classes and students. In order to understand how to help novice teachers become expert in a more facile manner, the goal is to understand how expert teachers use tacit knowledge about the underlying structure of instruction in conjunction with student needs, classroom culture and their own personal view of themselves as teachers in their approaches to the design of lessons. It is also informative to determine what parameters experts use to guide their work as teachers. How expert designers in general go about the task of designing is quite different from the ways novices do (Schön, 1983, Cross, 2011).

Another context with which to contend is the teacher's own view of self-as-teacher in the world. This belief involves the individual's ideas of what it is to be a teacher. Novices have only their own experiences as a student to which to refer, while expert teachers have had first-hand experience with teaching. This difference seems to be important. Education students have had over thirteen years' experience observing teachers. Because of this experience, these students believe they know what it is to be a teacher. However, experts have assumed teaching as part of their self-description, and this difference—between thinking you know what it is to be a teacher

and the real thing—does indeed separate novices from experts (Luehmann, 2007, Davis, 2006). The notion of the use of participant narrative to help discuss and understand others' reality makes sense here as well (Bruner, 1991).

Purpose of the Study

This study attempted to provide a theoretical framework to understand how expert teachers accomplish their work. The evolution of these professionals from novices to experts is still not well understood (Schön, 1983, Cross, 2011, Davis, 2006, Luehmann, 2007). Teacher beliefs have been studied (Kennedy, 2004, Pendlebury, 1993, Schoenfeld, 1998), but how do teacher beliefs interact with teacher goals in the classroom? How do the minute-by-minute adjustments and decision-making that occurs interact with content knowledge and beliefs? The ultimate aim of the study was to grasp more fully the relationship between beliefs, goals in teaching, and reflection-in-action.

Theoretical Context

The theoretical constructs that drive this research involve the idea that human beings make sense of their world and their surroundings based on what they believe both about themselves and that world. Constructionism "claims that meanings are constructed by human beings as they engage with the world they are interpreting" (Crotty, 2011, p. 43). In order to get at these meanings, I used a qualitative approach to the research in which the researcher gathers data that will help tease out the meanings the participants place on experience. The researcher must look at the world as lived through the eyes of the participant in order to be able to make sense of another's experience. The theoretical focus of this study was experiential in terms of the participants' experiences, thoughts, judgments, and motivations. Qualitative data gathering is the examination in detail of a few cases, rather than a small amount of data from many cases, as is

the case with quantitative data gathering. The ultimate aim is to understand the meanings the participants give to the phenomena, as opposed to a universal meaning. Because of this aim, mindfulness in terms of the context is also important in understanding the phenomena.

The data collection process was phenomenological in nature. Phenomenology is a method of study as well as a philosophical belief by which the researcher aims to understand the participant's worldview (Cresswell, 2007). Phenomenology allows a researcher to gather data in order to formulate an understanding of another individual's unique worldview and experience. It is a very different stance than the philosophy of realism, which holds that there is only one truth that can be gleaned by research and this truth is empirical and apart from participants' experiences or worldview Crotty, 1998). Phenomenology as a research method studies, describes, and comes to understand individuals' experiences of a specific phenomenon. This understanding of the essence of each individual's experience of the phenomenon is then examined and analyzed to find commonalities within these individuals' experiences. Essence is the basic underlying quality of an experience that is the same for all of the individuals within the study group (Cilesiz, 2010). Each individual's experience cannot be completely known, but phenomenology is a lens through which the essence can be glimpsed.

Definitions

The following list of terms is defined for clarity in their use in this study. I have developed all of the definitions in this list not accompanied by a citation.

Reflection is defined as "consideration of some subject matter, idea, or purpose" (reflection. 2013. In *Merriam-Webster.com*. Retrieved January 24, 2013, from http://www.merriam-webster.com/dictionary/reflection).

Reflection-on-action is to analyze later the characteristics and the process of our action (Perieira,

2011, p. 3).

Reflection-in-action is practitioners' thinking about what they are doing while they are doing it (Weiringa, 2011, p.2).

Novice adheres rigidly to taught rules or plans, and does not exercise discretionary judgment (Dreyfus & Dreyfus, 1986).

Advanced beginner has limited amount of the perception of the situation in which she finds herself. All aspects of the work are treated separately and with equal importance. (Dreyfus & Dreyfus, 1986).

Competent workers can juggle multiple activities and continue to build knowledge base. They have some perception of their actions in relation to their goals, and engage in deliberate planning and the formulation of routines (Dreyfus & Dreyfus, 1986).

Proficient professionals are experienced and take a holistic view of the situation, and are able to prioritize the importance of some aspects of the work involved. They still rely on heuristics for guidance rather than their own views of the situation. (Dreyfus & Dreyfus, 1986).

Experts no longer rely on rules or guidelines to create their work. They utilize extensive experience and the ability to recognize patterns as well as feedback to gauge success (Dreyfus & Dreyfus, 1986).

Constructs are subjective views of an individual's reality. Constructs can be widely held or particular to an individual's view of his or her world (Kelly, 1955).

Summary

A teacher attrition rate of 40-50% in the first five years of a career is a serious problem within the educational community. Since expertise is not achieved until after many hours of practice, the individuals who leave teaching may never experience satisfaction and success. An

experienced practitioner is one who has had time to form routines and practices that can be replicated and reused. Expert teachers are distinctly different from their colleagues who have experience but do not achieve expert level performance. How they differ depends on their views of themselves and their beliefs, as well as the dynamic aspect of their instruction. This difference has implications for the education and training of both pre-service and in-service teachers. Pre-service and new teachers would benefit from supports that help them begin to practice seeing the profession, students, content, and themselves as professionals as expert teachers do. The time needed to learn to think like a master teacher can be shortened if these new professionals had guidance to know what practices and aims are helpful in shaping expert behavior. The next chapter is a review of the literature regarding expertise in teaching. It begins with expertise characteristics in professionals and other master performers. Next, research on expert teachers is reviewed. Domain knowledge, reflection, and beliefs are keys to understanding expert thinking and behavior. These areas are also expanded and reviewed. Teacher beliefs will also be studied. The role of reflection will be explored within the literature as it has been shown to be vital to expert behavior.

Chapter 2

Literature Review

Introduction. In the curriculum of major professions such as medicine and law, theory is separated from practical experience. For example, a doctor will learn medical theories and sciences before experiencing rotations within the profession. The education of teaching professionals has followed the same format. The education student learns theory and pedagogy first, followed by practical experience. This separation of theory and practice makes for difficult applications during the first years in the profession, and may contribute to attrition rates among novice teachers, as they cannot make the conversion from student to teacher reliably and confidently enough to elect to continue in the profession. Attrition rates for novice teachers is of great concern to the supply of professionals who will stay in the field long enough to become competent. Of those, an even smaller number has the chance to become expert (Feiman-Nemser, 2003).

Effective teachers benefit the economic outlook of their students. "The implications of effective teaching on the income of students has been estimated as follows: a one standard deviation (SD) increase in teacher effectiveness (that is, one that leads to an increase of about 0.15 standard deviations of student achievement for 20 students) has a value of around $330,000 to $760,000" (Staiger and Rockoff 2010, p. 4).

Teaching is an ill-structured problem (Choi & Lee, 2009, Clark, 1988, p. 10). The best solution is not obvious, which partially defines an ill-structured problem. Teachers must know and choose what facilitates learning without the luxury of time and silence. Novice teachers believe they know what it takes to be a good teacher. Before they walk into a classroom as educators, most novice teachers have had at least twelve years of informal observation of the profession. They may believe that they know what it takes to be a good teacher, even when they

have never actually experienced the practice for themselves. Part of the education curriculum for prospective teachers involves a restructuring of expectations regarding both pedagogy and professionalism (Davis, 2006). Novice teachers think that transition to becoming a teacher only happens once they are in the classroom (Dahlgren & Chiriac, 2009). This may be due in part to the structure of teacher education. "Decontextualized domain knowledge isolated from authentic situations and experience has always been questioned for facilitating ill-structured problems skills" (Choi & Lee, 2009, p. 104).

Veteran teachers, not considered expert but with many years' experience, may block or try to change the newer teachers by not allowing them to implement ideas and processes that have been taught in education classes (Davis, 2006). These older, more experienced teachers have habituated to a specific way of interaction with students and may not want to change what they see as good practice. This makes it difficult for novices to put into practice newer, more productive teaching strategies. It is hard for these new teachers to buck the system and create new practices that better support student learning. In the profession of teaching, achievement of the level of expertise in the field allows people to feel fulfilled and remain in education.

The study of expertise in many professions has been an area of research for most of the last century. From the efficiency studies of Frederick Winslow Taylor (1911) to the operating room checklists of Atul Gawande in surgery (2005), expertise has been studied in order to improve performance in many areas. The study of expertise is valuable because it can inform instruction for those interested in becoming professionals in many areas. Experts emerge from the experiences and skills they learn in the course of their professions.

This section is a review of the literature regarding expertise in teaching. It begins with expertise characteristics in professionals and other master performers. Next, research on expert

teachers is reviewed. Domain knowledge, reflection, and beliefs are keys to understanding expert thinking and behavior. These areas are also expanded and reviewed. Teacher beliefs are also studied. The role of reflection is explored within the literature as it has been shown to be vital to expert behavior.

Expertise

A continuum of developing expertise. The development of expertise is a continuum with incremental and sequential change. These stages include novice, advanced beginner, competent, proficient, and expert (Dreyfus & Dreyfus, 1986).

Novices tend to follow rules regardless of the demands of the situation in which they find themselves, while experts are driven more by the demands of the situation and their extensive domain and background knowledge. As practitioners become more expert, they rely less and less on rules and are able to solve ill-structured problems because of their extensive experience coupled with an understanding of the structure of the problem (Dreyfus & Dreyfus, 1986). The ways that experts and novices attempt to solve problems in their domains of practice shows that thinking has changed from when the expert was a novice. Experts and novices approach the same problems differently (Chi, Feltovich, and Glaser, 1981). For novices, more time is spent in how problems should be represented than seeking and executing a problem-solving strategy. Experts represent problem frameworks with much more sophistication—they look more for structural rather than surface similarities (Sternberg, 1998). Novices solve ill-structured problems focusing on an immediate search for a solution. They use a trial-and-error method that results in many partial solutions. These are hard to work well into a synthesized whole. Experts look for the structure of the problem and seek a more broad understanding of the issue before they create solutions. Solution threads to complex problems are worked at the same time to create a

synthesized whole. Their foresight, acquired through their experience, allowed them to know what might solve the problem and was worth pursuing (Cross, 2010, p. 145). Experts take the known information regarding a complex problem, and generate a strategy to solve for the unknown. They then work forward to find a solution. Novices focus on the solution and try to figure out strategies that will help them use the givens to find the unknown. In addition, experts consistently choose appropriate solutions (Sternberg, 2006, p. 421).

How expertise develops. Expertise is developed according to the number of hours of dedicated, deliberate practice. The accepted time frame is ten years or ten thousand hours (Ericsson, 2006, p.7, Bryan & Harter, 1899). However, the time spent must be used in acquisition of understanding the practice. Expertise development "…is not simply a matter of experience or exposure to the field of endeavor, but of dedicated application. One of the key factors of expertise is believed to be sustained, deliberate, guided practice" (Cross, 2010, p. 141). It is reported that expertise development demands "thousands of hours of reflective practice" (Berliner, 1993, p. 171), and a "tremendous number of hours of deliberate practice" Sternberg, 2006, p. 428). Experts develop through deliberate, intentional, mindful rehearsal. Intentional means that the individual focuses on self-identified goals to meet. Mindful refers to the conscious awareness of one's actions (Ericsson, 2006). Traditionally, ability is seen as being fixed early in life. People who meet expectations are viewed as competent. Competence suggests that an individual has the skill and ability to adequately perform the work. The development of competence can be viewed as "the ongoing process of the acquisition and consolidation of a set of skills needed for performance" (Sternberg, 2006, p. 15). Expert performance passes beyond this level and may not be inherent as much as motivated (Chi, Glaser, & Farr, 1988, DeGroot, 1965, Anderson, 1981).

Expertise characteristics. Expertise is defined as "skill or knowledge in a particular area" (American Heritage Dictionary, 2006). However, a review of the literature in the research gives a much more robust definition. For example, in talking about design expertise, Cross defines an expert designer as someone who possesses "designerly ways of knowing" (Cross, 2006), which implies that expert designers think differently than others do about how to solve problems in their areas of expertise. Experts see themselves and their professions differently than novices do. Experts tend to intuit the path to take to solve problems (Dreyfus & Dreyfus, 1986). Experts' ability to problem-solve involves the ability to identify and use relevant knowledge to find the solution (Ericsson & Staszewski, 1989). Through practice in applying strategies, experts may automatize various operations. In fact, two important processes happen: automatization—consolidation of steps into unified routines that require little or no conscious control, and the action of schematization—developing highly organized schemata (Sternberg, 2006, p. 425). Experts can easily, quickly, and flexibly recall necessary aspects of their knowledge for problem-solving because their content or domain knowledge is strategically organized (Bransford, Brown, & Cocking, 1999). For experts, the problem-solving burden shifts from limited capacity short-term memory to infinite capacity long-term memory. Knowledge is firmly tied to context. Added to this is rich experience that guides the application of knowledge (Hardre, Ge, & Thomas, 2006). Problem representation is different for experts as compared to novices (Berliner, 1993, p. 175). Experts see uncertainty as a good thing, stimulating, challenging, and exciting (Atkinson, 2012, p. 187).

Experts call upon their experiences to guide them in their decision-making. Given that the board with which they are presented is a real game, chess grand masters can predict how the game will turn out many moves in advance (deGroot, 1965). It is the same with experts in other

fields such as architecture and medicine (Schön, 1983). Because experts can call upon not only experience, but successful moves in past situations, they seem to effortlessly problem-solve with imagination and ease. It is of interest to note that the mental models experts use to guide their decision-making are constrained by the task demands and the social situation in which they work, coupled with their beliefs. They are also more sensitive to the physical environment in which they must conduct their work (Shanteau, 1992).

Domain Knowledge

Domain knowledge acquisition is critical to the development of expertise. The depth of an individual's domain knowledge is an indicator of the level of expertise that individual has achieved. As well, ill-structured problems are context-dependent (Choi & Lee, 2009). Experts have large, rich schemata, which contain a great deal of declarative knowledge. Units of knowledge in schemata are well organized and interconnected (Sternberg, 1998). It is thought that "[c]onnections created among external stimuli then form connections inside the brain and external connections are thus incorporated into internal ones" (Vygotsky, 1960, p. 41). Because of their extensive domain knowledge and the connections within their schemata, experts bring knowledge to bear more effectively than novices when solving problems. In their domains of experience, experts do more in less time than novices do. Using insightful thought, experts are more likely to arrive at novel situations to problems (again within domain) than novices (Sternberg, 1998, p. 14). Experts are able to see patterns because of their lengthy experience within a domain (deGroot, 1965, Chi, Glaser, & Farr, 1988, Berliner, 1993, Bransford, Brown, & Cocking, 1999). Expert computer-aided systems, such as those being developed to diagnose disease or play chess use the notion of pattern recognition to perform their work. In order to implement such systems, computer programmers must study the ways that human expert

physicians or chess players organize the relevant information in order to successfully treat disease or win tournaments (Berliner, 1993). In order to know what information is relevant, expert domain knowledge is deep and broad within the area of their expertise. Experts are able to see more features within information than novices do (Bransford, Brown, & Cocking, 1999). They see connections among features and the underlying principles needed to solve problems, rather than just surface details (Chi & Van Lehn, 2012, p. 7, Chi, Glaser, & Farr, 1988). Experts identify meaningful patterns better than others in domains in which they are experienced (Berliner, 1993). They also have superior pattern recognition skills and organize information better (Berliner, 1993, Cross, 2010). Experts developed rich schemata for solving problems in their own domains of expertise (Glaser & Chi, 1988). "Experts excel mainly in their own domain and in particular contexts" (Berliner, 1993, p.167). "Expertise is specific to a domain developed over hundreds and thousands of hours and continues to develop" (Berliner, 1993, p. 163).

The Role of the Domain in Developing Expertise

The ways that experts think about problems and the ways that they go about solving them are different than those of novices within their domains of expertise. This is not because experts have innate talent for the work. The way that people experience their work and allow it to inform their actions is more fundamental to their competence than their attributes (Schön, 1983) so experts have changed not only because of their vast domain experience and practice, but also because they have allowed the experience of the work to inform how they do it. The attributes people use for work are context-specific (Sandberg, 2000, p.12). Individuals build a body of knowledge that is directly tied to the environment in which it is being built. Workplace learning is the way to become a practitioner, not learning about the practice. There is a tacit dimension or tacit knowledge at work here as well (Brown & Duguid, 1991, p. 43). While it may seem

obvious that a person who has mastered a particular field may not be an expert in other areas, this type of domain specificity is actually been proven to be intrinsic to expertise. The domain itself has demands upon the individual and works in tandem with the individual's characteristics to produce superior performances (Stoof, Martens, van Merriënboer, & Bastiaens 2002, p. 355). Expert house painters and master portrait painters may share some of the same skills; however, the application of these skills in each context is very different. In order for these individuals to be considered expert in their respective fields, they must excel in their work, and different measures of excellence hold for each individual. All the aspects of an expert individual's level of professional service are encompassed in the phrase "highly competent expert performance" (Chi, Glaser, & Farr, 1988, p. xv). "[D]econtextualized domain knowledge is isolated from authentic situations and experience has always been questioned for facilitating ill-structured problems skills" (Choi & Lee, 2009, p. 104). Findings suggest that attributes acquire their context-dependent nature through workers' experience of their work (Sandberg, 2000).

Characteristics of Expert Teachers

Expert teaching overview. Teaching is "inherently difficult, emotionally draining, and requires repeated public performances" (Berliner, 1993, p. 184). Expert teachers are exemplars. They have had many years' experience in the classroom. Typically they teach one subject, or, in the case of elementary teachers a few subjects, to a more or less homogenous age and abilities range, although this is certainly not always the case. They are able to learn techniques in the classroom and modify their teaching performance when necessary. Experts have superior predictive skills. They use more systematic approach to solve difficult problems than novices (Vollmeyer, Burns, & Holyoak, 1996). This is the case in the classroom as well. They automatize and routinize repetitive operations (Berliner, 1993, p. 169). In fact, experts have a need for

"routinization" (Berliner, 1993, p. 170). Expert teachers attend to "naturally occurring multiple and simultaneous visual and auditory events" (Carter, Cushing, Sabers, Stein, & Berliner, 1988, p. 31). Routines and the act of chunking activities together allow expert teachers to attend to novel situations within the course of the day. Research on teacher thinking shows the uncertainty of the practice (Clark, 1988). Expert teachers are more sensitive to social situations than novices are (Berliner, 1993). They constantly monitor and evaluate their teaching and student understanding. They use prior experience with a teaching technique or past performance of students to choose a particular method. An expert teacher can be seen as a "Bayesian sheepdog" (Berliner, 1993, p. 174), constantly weighing the probability of success of a particular instructional strategy on a particular group of students and constantly monitoring the effect of instruction on student learning. "If a teacher reacts [to classroom demands] without much reflection, … reaction is based on unconsciously and momentarily triggered images, feelings, notions, values, needs, or behavioral inclinations and often in combinations of these factors" (Schoenfeld, 2010, p. 101).

The use of social context. Expert teachers are also aware of the effect the classroom experience has on their students. Expert teachers use social cues to gauge their instruction and its success (Housner & Griffey, 1983). Expert teachers are more flexible than novices (Berliner, 1993). In research that sought explanation for the different ways that expert and novice teachers gained information about student learning, each group was asked to comment on what they thought was going on in slides of classes in the midst of a class period. Experts assess or infer about instruction when evaluating classroom scenes rather than giving a description of the scene in general, as novices do. Novices describe the scene without offering any explanation of what the students were doing. Expert interpretations were richer (Carter, Cushing, Sabers, and Berliner

1988). Expert teachers recognize that environments are learner-, knowledge-, and assessment-centered. They are situated within communities (Davis, 2006). It has been shown that successful teaching also involves the teacher's ability to think about the conditions for learning and to actively promote them. This is not only in the cognitive realm, but also the physical characteristics of the classroom. A study that matched gains scores to particular teaching performance within a school found that teachers whose students had low-gains scores were not cognizant of their students' physical arrangements for comfort and learning. The teachers of the low-gains students thought more in generalities of the curriculum and did not attend to the cognitive aspects of the particular lesson or the students they were teaching (Morine-Dershimer, 1977).

Teachers' implicit theories. Teachers make decisions based upon the feedback they get from their students and what they hold to be their mission. Professional vision makes instruction more effective (Sherin, 2001). Teachers choose instructional strategies based upon their beliefs about themselves, their students, and the content. Teachers "think, make decisions, and construct their practice" (Atkinson, 2012). What influences teacher thinking are the implicit theories they hold about how people learn and what student behavior can be seen to represent in terms of student learning. "Implicit theories are preconceptions that affect perception, interpretation, and judgment and have potentially important consequences in what teachers and students do and say" (Clark, 1988, p. 4).

A Gestalt view of teacher practice. Teachers' practice follows theories they hold. Teachers may not be overtly cognizant of the methods they employ while teaching. Practices teachers employed were "[n]ot conscious to the actor" (Korthagen, 2010, p. 101). These are the types of classroom management practices or teaching methods that are gained through deliberate

practice. These are the "[i]mplicit practices required for doing work that management knows nothing about or pays no attention to" (Brown & Duguid, 1991). Expert teachers have a high ability for improvisation (Borko & Livingston, 1989). Korthagen holds the view that in order to understand teaching, the whole person must be taken into account—the goals of teachers coupled with beliefs about their students and themselves, and the resources these teachers have available to them. He uses the term Gestalt to describe this microcosm. "The Gestalt view of teachers' behaviors is more complex than just practical knowledge" (Korthagen, 2010, p.101).

Experts' view of themselves. Expert teachers take more time than novices do to represent the problem in the classroom (Berliner, 1993). An expert can be seen to hold a certain belief about him- or herself regarding ability which tends to shape the work that individual does (Dewey, 1910). Teachers who have "academic optimism—a self-referent, positive belief about the capacity to teach all students, to form trusting relationships with parents and students, and to emphasize academic tasks" tend to persist even in a difficult teaching milieu (Duffy, 1993, p. 21). Self-efficacy beliefs refer to individuals' beliefs about their capabilities to successfully carry out a particular course of action (Duffy, 1993, p. 2). Expert teachers believe they have control over student achievement to some extent. Teachers who feel that they exhibit efficacy are more willing to try innovative practices (Berliner, 1993).

Pedagogy. In terms of problem-solving, hypothesis-making is more prevalent in experts than novices. Experts are more interested in instructional aspects than novices are. Teachers tailor new knowledge to particular kinds of personalities and beliefs to adopt actions to the particular characteristics of the school and classroom (Duffy, 1993, p. 17) but these may change on a daily basis Teachers need content knowledge, but also pedagogy. They need to know

- How to explain concepts so students understand them which involves a grasp of student ability and interest.
- How to demonstrate and rationalize (make understandable or give validation to) procedures and methods (Leinhardt & Greeno, 1986).
- How to correct students' "naïve theories and misconceptions about subject matter" (Sternberg & Horvath, 1995, p. 11).

Expert teachers see, attend to, and analyze relationships in the classroom (Cohen & Ball, 1999). Teachers use more complex teaching behaviors than they perceive (Wray, Medwell, Fox, & Poulson, 2000). The ability of teachers to attend to their students' cognitive abilities also provides for observation and interpretations of student "intellectual reactions" (Dewey, 1933, Korthagen, 2010, p. 9). There is a constant interchange of knowledge and information between the teacher, the classroom, and content to be taught. The worker is "informed by the work" (Sandberg, 2000, p. 186).

Mindfulness. Expert teachers exhibit mindfulness. Mindful teachers are "…powerful thinkers who are interpretive, analytical synthesizers of various types of knowledge, solvers of complex cognitive problems, and creators of principled, generative, affective and even ethical ideas" (Duffy, 1993, p. 9). Research into expert teachers' daily work with students shed light on the "dignity, quality, and sophistication of teachers' practical knowledge and judgments" (Duffy, 1993, p. 17).

The Role of Reflection

Reflection in professional practice allows space for a practitioner to become expert. Reflection involves thinking about and evaluating the outcome of practice, so a professional is able to increase knowledge of successful strategies for future use. Reflection also involves

deconstructing what did not go as well as expected to understand why and reveal underlying structure to help make sense of it. This is a form of implicit knowledge, a type that can only be arrived at through critical reflection (Schön, 1983). Dewey defined reflective thought as "[a]ctive, persistent, and careful consideration of any belief or supposed form of knowledge in the light of the grounds that support it, and the further conclusions to which it tends…It is a conscious and voluntary effort to establish belief upon a firm basis of reasons" (Dewey, 1910, p. 6). Reflection is a key attribute for professionals (Schön, 1983, Pereira, 2011). Reflection helps pre-service teachers realize teaching is an "intellectual or moral pursuit characterized by creative and idiosyncratic responses to students" (Duffy, 1993, p. 21). According to Pereira (2011), reflection

> aims not only at integrating the self and its forces into teaching, but also at considering the requirements of teaching specific conditions. Such perspective implies considering the teacher's self – with its main qualities – and the environment as interconnected dimensions in the construction of educational practices. By knowing the qualities of the self and understanding the classroom conditions, namely students' characteristics, the teacher becomes more able to carry out his/her work successfully. The assumption of core reflection is that professional behavior becomes more effective and complete if it is involved with the various dimensions of the teacher: environment, behavior, skills, beliefs, identity and personal mission (regarding spirituality) (Pereira 2011, pp. 35-36).

A second type of reflection, also called reflection-in-action, involves decisions made when it is clear that the original course of action is not having the desired effect. If a pilot knows her plane will crash if the controls are left as they are, she makes an immediate and decision to change them for a more positive outcome. Feedback from the environment and the ability to implement corrections or new strategies are examples of reflection-in-action (Schön, 1983).

Reflection-in-action happened repeatedly when confronted with unforeseen events that potentially related to student learning (Jung 2010, p. 172). Similarly, if a teacher begins a lesson and realizes that key pieces of the content are incomprehensible to students, she must quickly adjust the instruction to accommodate the students' need.

A third type of reflection, "knowing-in-action" (Schön, 1995) involves the intuitive, implicit understanding of how to get the job done. Schön contends that this type of thought is how professionals do their jobs. Reflection as intuition deserves respectful consideration. The notion of knowing-in-action instead of reflection-in-action, which is more deliberate, identifies this third type of knowledge base (Atkinson, 2012).

Reflection in educational practice is critical to professional development. Core reflection aims to

- "Integrate the self and its forces into teaching
- Consider the requirements of the conditions under which teaching is undertaken" (Pereira, 2011, p. 35).

Reflection-in-action may be too much for novices who are trying to integrate the many tasks of teaching (Davis, 2006). Reflection in educational practice is critical to professional growth (Pereira, 2011). Reflection changes both beliefs and practices in many ways (Jung, 2010).

Reflection must be contextual, not autonomous (Atkinson, 2012). Reflection is always situated in a social context. A situated practice enables attention to focus on the relationship between participants and context (Ovens & Tinning, 2009). Reflection is seen as empowering teachers to act as individual agents of transformation of practice to

- Enhance professional growth
- Refine and nurture purposes for teaching

- Improve student learning (Atkinson, 2012).

Reflection has to take into account the context levels that provide the conditions for learning, namely

- Classroom practices
- Professional group in which models of professional behavior are designed
- Socio-cultural context provides values and content considered important (Pereira, 2011).

Teachers become expert by "doing teaching in the messiness of classrooms and then reflecting on what happened and why…and bring professional knowledge to bear in principled ways to increase effectiveness" (Duffy, 1993, p.21). Reflection "relies on exemplars, knowledge bases, and past experiences" (Jung, 2009, p. 172) and allows us to "change the eyes through which we see the world" (Korthagen, 2010, p. 101). Reflective practice helps those

- Who want to change (improve)
- Explore the meaning of their work
- Seek out choices available to them (Cochran-Smith & Lytle, 2009).

Reflection also provides a way to verbalize a framework for their beliefs and educational practices (Pereira, 2011). There is disagreement among researchers on what should inform reflective thinking and how to best study and represent it (Atkinson, 2012).

Teacher knowledge of practice develops from and with ongoing reflection. This is key to fostering and developing good teaching (Atkinson, 2012).

Summary

Expert behavior has been analyzed and researched from many perspectives. Expertise is developed on a continuum from novice, a person who follows the rules regarding process in practice, to expert, who relies exclusively on their extensive experience, coupled with deliberate

practice and constant adjustments to increase effectiveness. Individuals become expert in a specific domain. This means that they develop their expertise based on interactions with the environment and content within which they practice. Domain is intrinsically tied to expertise.

Expert teachers are exemplars of experts in other fields. They use their knowledge not only of the content, but create pedagogy that supports student learning while constantly evaluating their practice to improve performance. They are more able to gauge the effectiveness of instructional strategies based on cues their students exhibit than novices are. They are more interested in how students interact with instruction than are novices, and they are ready to change instructional strategies to achieve success in student learning.

The greatest support to the development of expertise is reflection. There are three types of reflection that support expertise. Reflection-in-action is the adjustments professionals make in their practice when they need to refocus or change their activities to reach their intended goals. For expert teachers, this means they read cues shown by students to assess whether the concepts they intend to teach are being understood. If the content is difficult for the students, the expert teacher does not push ahead, heedless of the needs of the students. She changes her strategy based upon her knowledge of student cognitive abilities, interests, and comfort.

Reflection-on-action is an after-the-event practice. Experts look to see what was successful and what was not. This type of post-game analysis helps solidify the use of actions and practices that will help experts understand what they need to do differently and what actions they should keep.

Knowing-in-action, a term used by Donald Schön to distinguish this type of reflection from the others, is the at times unconscious choices experts make in the course of the work. He likens it to riding a bike: one may be able to do a thing expertly without being able to explain

how it is done. This type of innate choosing of activities to complete work is also a part of expert repertoire.

Reflection is intrinsic to expertise. In the next chapter, I describe my study in depth and focus on the role of reflection in the in-the-moment decisions expert teachers make to identify the decisions and beliefs that predicated them.

Chapter 3

Methodology

In this chapter I describe the methodology that was used in this study. This includes the research design, setting, population sample, data sources, data collection methods, and data analysis methods.

Purpose of the Study

The purpose of this study was two-fold. First, it identified constructs, or ways of understanding what it means to be a teacher, which individual expert teachers hold regarding their practice. These constructs were elicited from each individual teacher and compared to the constructs of the other participants. Reflection-in-action was also explored in terms of the framework that expert teachers use to create their work, and the differences and commonalities between and within these teachers' behavior. This ethnographic multiple case study observed the behavior of expert teachers in the act of teaching to understand how they utilize reflection-in-action to inform their instructional strategies. It explored the data to uncover whether there are common constructs that all expert teachers share regarding their practice. Although work has been done in this area (Tsui, 2003), this study extended the research. Instructional components have been seen to be influenced by interaction of accurate interpretation of student needs, context, and teacher constructs about what students know and can do.

The research questions that guided this study are:

1. How do expert teachers describe their performance?
2. What expert teacher constructs are held in common?
3. In what ways do expert teacher performance and constructs inform instruction?

4. How does expert teachers' thinking during acts of instruction in conjunction with self-identity and constructs modify in-the-moment learning activities with which they choose to engage their students?

Research Design

This research, grounded in a constructionist epistemology and phenomenological methodology, was based on the view that people interact with their surroundings and others and create meaning from these interactions with the world (Crotty, 1998). Phenomenology originated in the social sciences and was intended as an attempt to understand the meaning participants made from their interactions with the world. Typically, ethnographic research includes observations, interviews of the participant and others, and the examination of documents and other artifacts (Genzuk, 1999). Symbolic interactionism as a theoretical perspective weaves these artifacts together to gain an understanding of an individual's experience in the world with the aim to understand the world as that individual perceives it (Crotty, 1998). This theoretical perspective is instructive here because my research focus is to understand and be able to describe how teachers perceive and think about instruction as it is happening, and to focus specifically on how reflection-in-action is used in conjunction with experience, knowledge of student ability, and the goals of the course content as well as the goals of the particular lesson. Ethnographic inquiry is scientific, systematic, and supports understanding of how people view their worlds and make sense of it (Atkinson, A., Coffey, A., Delamont, S., Lofland, J., & Lofland, L., 2001).

Because thinking is not observable directly, other methods need to be employed to analyze the actual thinking that occurs during an instructional session. For this reason the research employed a number of data collection methods and a triangulation of this collected data was used to validate findings (Morine-Dershimer, 1983). Data was collected through a variety of

activities. Direct observation of classroom activities was conducted. After observations, the teacher was interviewed to bring to light the thoughts and reflection-in-action that the teacher experienced. I made notes to help guide the questions to ask regarding particular aspects of the lesson. This interview was a conversation about how the teacher made decisions in the moment to help students learn the content of the lesson. Triangulation was employed to help validate findings within this research project. The aim was to employ grounded theory to formulate an understanding of teacher reflective behavior and its effects on their ability to craft superior performance.

This research used a multiple case study research design. Case studies are typically employed to understand an "issue with a case (individual, multiple individuals, program or activity) selected to provide insight into the issue" (Creswell, Hanson, Plano, & Morales, 2007, p. 246). The issue of interest here is the influence of the teachers' beliefs and prior knowledge on action, coupled with their decisions made using reflection within the moment in the delivery of appropriate instruction. The emphasis of the research is how the individual teacher's constructs about how students learn coupled with knowledge about these particular students and understanding of the content interact to create expert instructional skill. Since the topic of interest is teachers' own rationale behind the activities expert teachers employ while teaching, the case study data collection methodology and cross-case analysis is a systematic and replicable way to examine and find similarities as well as differences within each case.

Participants

NCLB and AYP are primarily of concern to public schools, as private and charter schools are not bounded by Federal law. The participants were six high school mathematics teachers who have been in the field for at least ten years and have demonstrated success in working with

underserved populations. The definition of underserved in this research is based upon ESEA Title I (http://www2.ed.gov/programs/titleiparta/index.html). The teachers in this study were identified as expert by members of an organization within the local university's college of education with twenty years' experience in the field of mathematics teaching instruction. This organization works with math teachers within the district and offers materials to any teacher interested in increasing teaching skill in mathematics. The head of the department is an acclaimed former math teacher with twenty-six years' experience in the high school classroom. Mathematics was the subject of choice for this study because of the diverse nature of the content. Math has been broken into areas such as algebra, pre-calculus, calculus, geometry, and trigonometry. These areas have distinct and discrete challenges to understanding as well as teaching content. The type of math matters in learning and teaching. Once potential participants were identified, the recruitment process followed the protocols outlined by the school district. Because of the small sample size, it was important to retain participants in order to gather as much data as possible. Consideration of teachers' time was also important. Every attempt was made to make efficient use of participants' time and effort.

Setting

The setting where the research took place included high schools in a large city, population 2.16 million as of 2012, in the Southwestern United States (United States Census Bureau, 2012). The school district is a low socio-economic status district as outlined by the Elementary and Secondary Schools Act (ESEA). The classes examined varied as these experts do not all teach the same classes. The classes these participants taught at the time of the study were geared to the general population and not specifically toward special needs students, either gifted or developmentally challenged.

Instruments

Qualitative in-depth interviews have been shown to help understand people's thoughts, experiences, decisions, and understanding of the world around them (Glaser & Strauss, 1967, Baxter & Jack, 2008, Turner, 2010). Direct observation of classroom procedures is necessary to provide space to form pertinent questions useful to understanding each particular teacher's thinking and behavior. The template I used can be found in Appendix B. The direct observation of the classroom allowed the students and teacher to become acclimated to my presence in the classroom.

Data Collection Procedures and Timeline

Procedures. The six teachers who participated were identified by a panel of expert teacher-educators who have worked with teachers in this school district for over twenty years in mathematics teacher professional development. Initially, I contacted the six identified teachers via email to describe the research and gain buy-in. I explained procedures and timeline. A period of approximately one week of visits to the classes of the participants acclimated students and teacher to an observer in the room and I gained a familiarization of the particular classroom and teacher-students relationship. A week was more than sufficient for this, as the students and teacher took very little overt notice of me. A week has been shown to be sufficient (Connors, 1978).

In depth interview. Because of the time of year, much of what the teachers were doing was review. I took notes on a lesson that the teacher presented and that I observed. Afterward, my notes helped my identify questions that might help discover where the teacher may have insight as to why particular methods were used to teach a lesson, what content and/or prior understanding of student learning may have influenced the lesson design, and the like. I

conducted an in depth interview with each teacher. This interview took the form of a conversation because I wanted the teacher to describe what motivated his/her behavior in the classroom. The goal was to compare interviews to find commonalities, if any, within the multiple cases.

The in depth interviews took place in the teachers' classrooms. It was hoped that the familiar surroundings would add to the teacher's ability to recall just what he/she was thinking, feeling, and noticing during the lesson. This interview was recorded and transcribed. Patterns that emerged from the text helped shape understanding about how reflection-in-action takes place. The data was coded line-by-line in the transcript. These codes were organized into categories and individual themes emerged. The data was analyzed for overarching commonalities among participants (Stough, 2001, p.2). Concerns about the use of in depth interviews as the sole source of information was ameliorated by the use of other data such as field notes to corroborate or refute findings from this interview technique (Yinger, 1986).

The use of in depth interview offered an abundance of information. The reliability of the information was supported by the use of the quantitative data—length of experience, student achievement data, and the alignment of curriculum with instruction.

Repertory grid interview. The Repertory Grid Technique, developed by George Kelly in 1955, allows the participant to share their constructs of the world. I conducted repertory grid interviews to elicit constructs. These constructs were important in understanding teachers' worldview. Constructs are views of reality or beliefs about the world, and can be widely held or particular to an individual (Kelly, 1955). The template can be found in Appendix E. Repertory grid interviews are widely used in marketing, counseling, and medicine to get a grasp of others' constructs about a particular set of things. The use of the repertory grid helped illuminate how

teachers in this study think about their profession, their beliefs about themselves as teachers, and their understanding of their role as teachers in their classrooms and in the wider world. The Repertory Grid was developed to understand how individuals' constructs with little to no influence from the researcher. The rationale for the use of Repertory Grid interviews is that "[g]rids provide a way of understanding other people; precisely; in their own terms" (Jankowicz, 2004, p. 20.) Repertory grid interviews are a way to understand other people's worldviews. This is done through the elicitation of personal beliefs, or constructs. Constructs are the beliefs that teachers use to shape how they view their classroom and the students in it, how much influence they have on student achievement, and the like.

Quantitative data. The number of years a teacher has been teaching the particular content, lesson plans, and curriculum goals was included in the data collection process. This information was obtained in the in depth interview or from the district's website. Curriculum goals, the overarching driver of lessons throughout the year, are published on the website of the school district. These were used in addition to interview data to gain a better understanding of teachers' use of reflection-in-action.

Field observations. Teachers were observed in their classrooms for a minimum of five class periods to become accustomed to that particular participant's routines and teaching style. I was able to observe participants' relationships and demeanor with students. Specifically, after the initial observation sessions I paid special attention to specific interactions between teacher and students that involved how teachers explained content with which students were having particular difficulty. I used the adapted teacher observation checklist found in Appendix B.

Researcher journal. I kept a journal to record thoughts, questions, observations within my own reactions to the teacher's lessons, the classroom and school environment, and any other

relevant topics that arise during and after observation of the participant. The rationale for the journal was twofold. First, I wanted to write down any interesting or surprising details I found in the observation process. This is known as memoing and is suggested through the work of Glaser (1967) to help capture information that might otherwise be overlooked. Secondly, because of my experience in classroom teaching I wanted to identify my own assumptions and prejudices regarding the act of instruction. A journal helped me to understand what my own biases are regarding teaching, known as epoche. I continually checked for my biases while writing field notes, and bracketed these. I observed each participant in the classroom for the same class or group of students for a total of one week, after which an interview period was scheduled with each participant. In addition to the teacher observation checklist, a daily journal entry after each observation allowed me to record my thoughts, impressions, and feelings to be addressed in the in depth interview. Notes on classroom observations and other relevant information were used to help guide the in depth interview to answer any questions or check for my understanding of the teachers goals, actions, and attitudes.

Timeline. Data collection occurred in four phases. The target population was identified initially by identification of a Title I school district. Notice was given to all principals per the request of the school district. Consent was obtained from the individual teacher. The introductory phase was followed by classroom participant observation and examination of artifacts and student records. Next, a schedule for lesson observation for in depth interview and finally the repertory grid interview was conducted.

Phase one. Participants and I met for an individual explanatory session so that teachers could ask questions and become acquainted with me. The script that was used can be found in Appendix A. A script was used so that all the teachers heard the same message.

Phase two. I observed the classroom environment at the invitation of the teacher to gain a sense of the atmosphere, visual presentation of the classroom itself, and to gain an understanding of the rapport that the teacher has with students. As this environment is somewhat a creation of the teacher, I took notes about the presentation of the classroom environment. I observed classes for approximately one week for each teacher. The checklist used for classroom observation is in Appendix B.

Phase three. The participant scheduled a time for the in depth interview that allowed us to meet shortly after observation. The directions for conducting the in depth interview are included in Appendix C. In order for me to understand the lesson to be delivered, I asked the teacher to tell me about it. The list of questions for this orientation is in Appendix D. The interview was conducted shortly after observations were completed.

Phase four. In this final phase I conducted the repertory grid interview. This interview took approximately 60 minutes for each participant to complete. A sample Repertory Grid interview chart can be found in Appendix E. In the interviews conducted for this research, the participants addressed their conception of expert teaching. The participants generated the elements from their own experience and view of teaching. The object of these interviews was to elicit beliefs and perceptions of professional practice as experienced by the expert teacher. Each teacher participated in a repertory grid interview. I emphasized that this was a way for me to be able to understand participant points-of-view about their practice. The objective of this interview was to uncover the constructs used by teachers in their daily work.

Data Analysis Procedures

Rigor. Rigor is an essential quality of good research. Random sampling and before-and-after treatments to individuals, useful in rationalistic inquiry, are not always available or even

ethically acceptable in educational research. In qualitative studies there has been debate regarding these concepts because the results are not usually generalizable to a larger population as is the case in medical treatments, for example. However, the study of human experience is useful to help understand, explain, and make clear the ways that people approach their work and lives in order to help others understand these individuals' experiences, especially in the area of education. The rationalistic benchmarks for trustworthy research are "internal validity, external validity, reliability, and objectivity" (Guba & Lincoln 1982, p. 246). In naturalistic inquiry, a parallel set of parameters for rigor in qualitative studies are "credibility, transferability, dependability, and confirmability" (Guba & Lincoln, 1982, p. 246). It is interesting to note that Guba & Lincoln's work on rigor in qualitative studies is based on the notion of trustworthiness of the study and their work remains essential in developing a rigorous study. Rigor can be achieved in both types of inquiry, rationalistic as well as naturalistic. I address the issue of rigor in my phenomenological study using these four concepts.

Credibility. "Phenomenology relies on the interpretive legitimacy of the researcher" (Bednall, 2006, Preference for Phenomenology section, para. 1). I used epoche and bracketing. Epoche makes plain any latent assumptions I might have regarding participants' experiences and descriptions of them based on my prior experiences as a classroom teacher. Bracketing is the way to keep these in mind as I analyze data so that my assumptions do not override what my participants tell me (Christensen & Brumfield, 2010). Member checks, a process of inviting participants to check that I am correctly interpreting their ideas, was done to help ensure credibility of findings. Peer debriefing was used within the analysis process to ensure that interpretations closely represent participants' experiences. This involves written notes and record of discussion (Rudestam & Newton, 2007).

Transferability. Data collection was deep and thorough. Enough data needed to be collected to ensure that the descriptions and interpretations at which I arrived were validated by the data. This is also known as the criteria of adequacy and appropriateness of data (Morse, 1998). Many different sources of data ensured transferability. I kept an audit trail, a detailed and precise record of the process by which others can replicate the study.

Dependability. In order to show dependability, the results of the research must be a coherent outcome of the data collected. Guba & Lincoln warn that, although two different researchers might diverge in their paths regarding the same data, "the naturalist defines dependability to mean stability after discounting such conscious and unpredictable (but rational and logical) changes" (Guba & Lincoln 1982, p. 247). The constant comparative method in data analysis was used to ensure as much as possible that results reflect the data.

Confirmability. Triangulation of the data by means of many sources including interviews, field notes, member checks, and revisiting epoche regularly allow the results to be traced back through analysis to the original collected data. By using these strategies, the data clusters are also confirmable in that they represent an accurate picture of the participants' responses (Guba & Lincoln, 1982).

Data Analysis

The aim of qualitative research is to uncover many data points in order to allow patterns to emerge, and they must be gathered through many data, both empirical, such as student achievement scores, and anecdotal, such as interview transcripts. Qualitative data analysis involves inductive analysis of the raw data to discover patterns and themes within them. The reliability, credibility, and dependability of interpretations is at stake. As well, other researchers interested in the same area of research must be able to conduct similar experimentation and

obtain similar findings. The research must be transferrable. Finally, the research to be done must somehow be confirmable (Rudestam & Newton, 2007, p. 112).

Analysis of in depth interview data. The interviews were listened to and read several times to glean themes and patterns. It was not possible due to the data collection timeline and the end of the school year to transcribe and analyze each interview before taking the next interview. However, each interview was coded before moving on to code the next interview. Line-by-line coding of the interviews was conducted first to get an idea of the concepts the participants related in the interview. Next, recurring concepts were arranged into categories. Themes and patterns emerged from the interview data, repertory grid data, and field notes (Charmaz, 2006). Table One gives an example of the process of in depth interview analysis. Moving from left to right in this chart, I distilled the segmented information into categories of responses. Categories were made based on the most frequent information sets. After I completed my analysis, a second researcher also analyzed and coded the data using the same method. This researcher has experience in qualitative analysis through both study and practice. She was also a classroom teacher for a number of years. After coding and comparing notes, we looked together at our categories and came to a consensus via discussion and comparison with field notes and journals. This is common practice in qualitative studies to validate the categories obtained from the data analysis. Themes were identified from the category analysis.

Table 1

Inductive analysis—coding

Read through and become familiarized with text data	Identify significant segments of information	Label the segments as to content—category creation	Compile categories into discrete content	Using the most important categories, create a model for the data
Start with many pages of text	Reduce to many segments of text	30+ categories	15+ categories	Narrow to 3+ categories

Table 1. Adapted from Creswell, 2002, Fig. 9.4, p. 266

Repertory Grid. The repertory grid elicited participant ratings of elements which make up the topic in question. The topic in this study, which was told to the participants, was expert math teaching. The participants generated their own elements except for the first one. Since all the participants mentioned reflection in the in depth interview, I asked that it also be included as an element because of my interest in their conception of the element of reflection in math teaching practice. The interview was conducted by having each participant generate elements that were listed at the top of the grid. The participant rated the elements he/she generated by comparing and contrasting the elements in groups of three. The remaining elements are ranked between these generated construct and contrast poles (Kelly, 1955) These data are numerically assigned, much as in a Likert Scale. This allowed the participant to tell how he/she views aspects of teaching, generated by the individual, from his/her point of view. Again, the elements and constructs were completely generated by the participant. I guided the completion of the grid, but the object was for the participant to generate the ideas, thoughts, and perceptions. Analysis of the data involved cluster analysis and percent similarity for both the elements and constructs. Since it is entirely possible that the responses generated by the individual teachers might be different and significant, this was also a check of the themes generated in the in depth interviews.

Student achievement data. Familiarization with the students' backgrounds was an environmental factor that influenced decisions and gave rationale for particular instructional strategies. No individual student records were viewed; rather, AP scores of students of these participants were viewed to glean a general overview of the success of students' mathematics achievement.

Lesson plans. These expert teachers who had them provided me with a general overview of their lessons. They did not, as a rule, use lesson detailed planning. Some of them used no formal lesson planning at all. Rather, they used a calendar that was broken down into no less than six-week blocks with specific topics and student deliverables. No detailed lesson plans of the sort that new teachers are required to complete, with objectives, aims, and goals of each lesson, were used by any of the participants.

Table two presents the organization of data source, data collection, and analysis for the research questions and provided a methodology overview for the research.

Table 2

Methodology Overview

Research Questions	Data Source	Data Collection Method	Data Analysis Method
Question One: How do expert teachers describe their performance?	Observation In depth Interview	Repertory Grid In depth Interview	Repertory Grid: examine and list teacher responses, compare with other teacher responses, inductive analysis
Question Two: What expert teacher constructs are held in common?	Repertory Grid	Repertory Grid	Constant comparative analysis, inductive analysis
Question Three: How do expert teacher performance and constructs inform instruction?	Participant Observation Interview	Participant Observation Teacher Observation Checklist In depth Interview Repertory Grid	Repertory Grid arrangement Compare observations arrived at by the checklist In depth Interview coding
Question Four: How does expert teachers' thinking in conjunction with self-identity and constructs modify in-the-moment learning activities in which they choose to engage their students?	Participant Observation Interview Repertory Grid Researcher Journal	In depth Interview Repertory Grid Teacher observation Checklist	Inductive analysis Peer review and debriefing Compilation of teacher checklist data

Table 2

Microsoft Word software was used to code and categorize interviews, as well as memoing the interviews. R (2014), an open source platform for statistical computing, and OpenRepGrid software (2011) which uses R as a repository of statistical operations was used to create cluster analyses of the repertory grid data. Microsoft Excel was used in calculating the percent similarity scores, aided by tables in Jankowitcz (2002).

Summary

The methodology chapter describes the research, the setting and participants, the instruments used, the data collection procedures, and timeline. This multiple case study utilized the participation of six expert mathematics teachers. Participants are experienced teachers with at least seven years' experience. They work within a Title I school. Data collection included at least a week of participant observation with the same class of students, an in depth interview with each participant based on a class session of the teacher's choosing, and repertory grid elicitation. The repertory grid was completed in another hour-long session at a time that is convenient to the teacher, but not longer than two weeks after the in depth interview. Analysis of the data implemented triangulation of field notes, member checks, interview data, and repertory grid data. I analyzed the data and had another researcher do the same. The aim of the study was to identify specific constructs as the lens through which expert teachers revise instruction in-the-moment in order to solve the ill-structured problem of classroom teaching.

Chapter 4

Results

Purpose. The purpose of the study was to look at how expert teachers describe their practice, find out how they construe their work, and see what role if any reflection plays in their ability to achieve such an outstanding result—namely, successful students who excel in a difficult subject in high school. Significant to this study are the constructs teachers have created to understand their practice. Because these teachers have been in the field a number of years, their experience has given them ways of explaining their world to themselves. Expertise has been studied in the area of classroom teaching. Implicit, or tacit knowledge in teaching has been explored (Torff, 1999). Constructs are the concepts about how the world works that arise from personal experience. A construct is personal and may be held by only that person. Constructs are a person's way of looking at things and of making sense of the world, and can change with new information or experiences (Kelly, 1955). Constructs of expert teachers, then, are lenses through which they view their world and which they use to choose actions that produce superior performance. Constructs formed by the same experiences can be different for different people. Constructive alternativism as a philosophy states that, although we all live in the world together, our understanding of our experiences may differ widely (Kelly, 1955, Jankowitcz, 2002). This study is a first step in understanding how expert teachers view the world.

Participants

As is the case with the smorgasbord that is high school mathematics, the participants in this study teach a variety of levels and students. They have been teaching a minimum of twelve years in various positions in the United States. Currently they work in the same large Title I school district in the southwest US. Only two of the teachers work at the same school. None teach exactly the same classes. All have varied backgrounds. One began his career as a chemical

engineer. Two others were honored as the district's Teacher of the Year and one of these also holds an undergraduate degree in electrical engineering. In order to help me identify which individuals to include, I contacted the Rice University School Math Project (RUSMP). The RUSMP offers guidance and support to math teachers in the district in question and has done so for over twenty years. In their work within the district, they are able to identify expert exemplars, and I was given the names of six math all-stars (in the vocabulary of RUSMP) with whom to connect. I was able to interview every teacher on the list. The results of my study follow.

Background

I got permission from and was able to observe the six participants while they were teaching. Table 3 shows teacher demographics and classes taught at the time of the research study.

Table 3

Demographic and course information.

Teacher	Gender	Age	Years in the Profession	Classes Taught
P1	Female	35-45	15	Geometry, AP Calculus AB, Pre-Calculus
P2	Female	45-55	28	AP Statistics, Geometry, Pre-Calculus, Calculus AB, math models, Algebra I
P3	Female	35-45	14	Geometry, dual enroll college level algebra and trigonometry (with a local community college), math models, Algebra II, Algebra III
P4	Female	45-55	18	AQR, Geometry, Algebra I and Algebra II
P5	Male	35-45	19	AP Calculus BC, Geometry, Pre-calculus
P6	Male	45-55	13	AP Calculus AB, AP Calculus BC, AP statistics, Summer Algebra II pre-AP

Table 3

I interviewed the participants in depth regarding their practice. These questions turned to the ways they know whether or not students comprehend the content, and what they do when students do not understand the lesson or need help in forming an understanding of the lesson and how to apply the concepts they need to learn. As I suspected that reflection was an important part of this process, I also asked specifically on the role of reflection in their practice. As well, since one of my research questions—and to me, the most important—was regarding the techniques teachers use to monitor student understanding while delivering instruction and also what they do when they see the students may not be following the lesson, I asked each of the teachers what told them specifically that students were lost and what they did about it. I transcribed the interviews and used the constant comparative method to categorize statements and generate themes. I used the repertory grid technique to elicit constructs regarding their teaching. Although there are many different methods to analyze the grid results, I was interested primarily in similarities of each individual's elements of teaching that they chose to use. Also I wanted to see which of the constructs, again provided by the participants, were similar to each other. I used cluster analysis to do this. Next, I took the repertory grid responses of the participants and compared them to each other. I looked for both similarities in the elements that were elicited from each participant, as well as how these elements reflected instructional design and how they viewed their work. Lastly, I looked for similarities across the responses for the constructs to compare these experts' views of practice.

Individual Cases

Teacher 1. Teacher 1 (P1) has been teaching for fifteen years. She teaches at a school where she says she is spoiled and gets along well with administration. She does not have to turn in lesson plans, and feels that the way she is treated allows her to do her best. She teaches a

variety of skill levels, and I was able to observe that she changes delivery depending on the audience, even class to class of the same course material. She exhibited all the skills on the teacher checklist that I used to help me observe the participants in the study, as did all the participants. In this sense the checklist was not of very much use. P1 has been teaching the topic of geometry the longest, and has had experience teaching calculus BC. She currently teaches geometry, algebra pre-calculus (a class designed to prepare students for AP calculus) and AP calculus AB.

P1's description of performance. P1 makes her time and here expertise available not only to the students, but to other teachers as well. She teaches a summer course for novice math teachers to help them achieve their goals of better math teaching.

In order to best understand how she goes about design and delivery of lessons, I asked her questions both about her views of teaching and how she uses reflection in her practice. She gives the students a routine on which to rely from the very first day of classes for all of the courses she teaches. She believes the routine gives potentially nervous students something on which to focus, something to *do,* that helps them to become acclimated to math that may be difficult for them.

> The most important thing to me is that table in the back with the materials. So there are already—first day I put it back there. And I put on the board *Get your materials from the back.* Well most of them, are you know, new, and a little nervous the first day and they don't read the board but I make them physically, Day One, go back and get it. They're really nervous, at the beginning of the year because it just sounds like a very challenging course—which it is—and you know I have a wide range of students. I have those that ace everything, and those that barely made it though regular pre-cal, but they want to be an

> engineer, or they want to be in a field that requires this. So I think just letting them know and trying to give them the attitude like this is a work in progress. (Participant 1 interview, lines 7-15)

She makes herself available for tutoring and help before, throughout, and after the school day. Motivation is important for herself as teacher, but for the students as well. She uses a variety of techniques to keep them interested in the material, and stated that students have told her that they will do her work first, or maybe hers will be the only homework they complete.

> It's a motivation partly on the teacher too. Do they have the internal drive to succeed or for their students to succeed? Do they have the inner motivation to succeed or for their students to succeed? (Participant 1 interview 2014, lines 345-347).

She also had the students move around the room and into the hallway to do work, just so that they experienced variety.

P1 cites a quality she calls *with-it-ness* (Participant 1 interview 2014, line 46) as one of the most helpful ways to make sure students understand the material and are on task in the classroom. She defines with-it-ness as the ability of a teacher to be aware of what's going on in the class between students and while students are learning, an awareness of whether the lesson is being received, and whether students are on task. It's partly classroom management and partly awareness of what students are attending to at any particular time in the class. With the advent of handheld devices, she has come to rely on with-it-ness to keep students on task so that they will attend to the lesson and help themselves succeed.

> I just remember early on in professional development, them talking about with-it-ness, and I just really think that's the most important aspect a teacher needs to have. So I do a lot of management with my eyes or proximity or things like that, where I'm not

> interrupting the flow of the lesson, but I can just say *so and so are you with me?* and it kind of jumps them back to attention or I can just mouth to someone *put your phone away* and I just found that most effective if they know I'm seeing what's going on. (Participant 1 interview 2014, lines 45-51).

She uses homework, board problems, and in class work to constantly assess student understanding, creating formative assessments for her benefit and the benefit of the students to gauge learning. She is constantly available for student help with understanding the content. This last aspect of P1's teaching is exceptional. She offers tutorials twice a week at lunch, offers test preparation and corrections the other two days, has a tutoring session every seventh hour for seniors needing help, and is available both before and after school for student help. On Fridays at lunch, she opens her classroom to colleagues for discussion and support.

Repertory grid. The repertory grid analysis starts with a list of elements, which can be elicited from the participant or supplied by the researcher. In this case, they were elicited from the participants because the aim of the research was to generate some type of list to compare to the other participants' lists, as the final goal is to ascertain whether the participants share common views of practice and if so, what they are. Because of my research interest in reflection, I asked that each participant allow me to choose this as the first element. Interview responses indicated that all participants thought reflection was an integral part of teaching practice. The constructs, which are poles of a continuum, were created from the responses the participants gave to the questions *if we take three of the elements you've identified as elements of your practice, which two are more alike? How would you categorize them? Then, what would you say about the other element? What does it represent for you?* I have indexed the responses by the number of the participant, 1-6. P1's responses are denoted by the number 1 in both the elements

and the constructs. The elements are denoted by a letter and the constructs are denoted by a number.

P1's responses. P1's elements and constructs that were elicited from the repertory grid interview follow. Items of high similarity percentage are bolded:

Table 4

P1 Repertory grid data

Elements and Constructs

Elements
1.A Reflection and feedback for following year
1.B With-it-ness (ability to constantly monitor level of student engagement)
1.C Lesson planning/searching for new materials/ideas
1.D Professional development—Conferences, NCTM
1.E Efficiency/Organization
1.F Revamped lessons
1.G Constant learning
1.H Enrich/try new things for greater effect
1.I Never satisfied
1.J Share responsibility with students/ownership

Constructs
1.1 Process—Feeling/innate
1.2 Task you do in order to better your practice—Key trait to being a successful teacher
1.3 Make instruction better—[Teacher initiated] climate/interaction
1.4 Teacher traits—Task you do
1.5 Key component of instruction—Approach you take in the classroom
1.6 Traits of an educator—Outcome of those traits
1.7 Outside the classroom—during instruction

Table 4

In order to arrive at the construct list, the elements were then ranked across the construct poles in a 5-point scale, with 1 on the scale being closer to the construct and 5 being closer to its contrast. The participant assigned the construct and contrast names/descriptions. This routine was repeated with three new elements until it seemed that the constructs became repetitive. The percent similarity scores are shown below for the elements that P1 said are elements of math teaching.

Table 5

P1's Percent similarity scores: Elements

Elements	Similar	Elements	Similar	Elements	Similar
1.A&1.B	64.29 %	1.B&1.C	21.42%	**1.C&1.D**	96.43%
1.A&1.B	64.29 %	1.B&1.D	25.00%	1.C&1.E	39.29%
1.A&1.D	60.71%	**1.B&1.E**	71.43%	**1.C&1.F**	89.29%
1.A&1.E	75%	1.B&1.F	53.57%	1.C&1.G	60.71%
1.A&1.E	75%	1.B&1.G	60.71%	1.C&1.H	60.71%
1.A&1.E	75%	1.B&1.H	60.71%	1.C&1.I	25.00%
1.A&1.H	82.14%	1.B&1.I	67.86%	1.C&1.J	32.14%
1.A&1.I	67.86%	**1.B&1.J**	78.57%		
1.A&1.J	57.14%				
Elements	Similar	Elements	Similar	Elements	Similar
1.D&1.E	42.86%	1.E&1.F	42.86%	1.F &1.G	71.43%
1.D&1.F	89.29%	**1.E&1.G**	71.43%	1.F &1.H	71.43%
1.D&1.G	64.29%	**1.E&1.H**	75.00%	1.F &1.I	28.57%
1.D&1.H	64.29%	**1.E&1.I**	78.57%	1.F &1.J	39.29%
1.D&1.I	28.57%	1.E&1.J	67.86%		
1.D&1.J	32.14%				
Elements	Similar	Elements	Similar	Elements	Similar
1.G &1.H	85.71%	1.H&1.I	64.29%	1.I&1.J	60.71%
1.G &1.I	64.29%	1.H&1.J	60.71%		
1.G &1.J	64.29%				

Table 5
Note: Higher percentage denotes higher similarity.

For P1, the elements most similar were Lesson planning, searching for new materials and ideas and Professional Development—Conferences, NCTM. These were most similar across all constructs. The least similar were Revamped lessons and Never satisfied, and the other least similar elements were Professional Development—Conferences, NCTM and Never Satisfied. 1.E, Efficiency/Organization, was highly similar in responses to 1.G Constant learning, 1.H Enrich/try new things for greater effect, and 1.I Never satisfied. 1.B and 1.J were also similar.

These were the elements With-it-ness and Share responsibility for student learning. Similarity scores help clarify how this participant views these elements.

The same procedure was used to determine the percent similarity scores for the constructs. In other words, the constructs that were closer in similarity were also calculated based on the element rankings for each. The construct percent similarity scores marked r denote manipulation of the poles, reversing the poles and adjusting scores accordingly. The object of the percent similarity exercise is to find how the constructs are most alike. It's arbitrary which of the elements were chosen for construct elicitation, and it is entirely possible that the relationship is actually the reverse of what has been written down in the repertory grid. For example, Construct 1.2 and 1.4 have almost the same descriptions, but 1.4 is a reverse of 1.2. Since the constructs are a continuum of ideas that are more alike and less alike, an eyeball analysis and common sense is important to consider here. Constructs with high similarity scores are bolded.

Table 6

P1's Percent similarity scores: Constructs

Construct	Similar	Construct	Similar	Construct	Similar
1.1&1.2	45%	1.2&1.3	45%	r1.3&1.4	55.00%
1.1&1.3	50%	r1.2&1.4	60%	**1.3&1.5**	**80.00%**
1.1&1.4	5%	1.2&1.5	55%	r1.3&1.6	45.00%
r1.1&1.4	35%	r1.2&1.6	35%	1.3&1.7	80%
1.1&1.5	40%	1.2&1.7	15.00%		
r1.1&1.6	45.00%				
1.1&1.7	60%				
r1.4&1.5	65%	r1.5&1.6	55%		
1.4&1.6	65%	**1.5&1.7**	**80%**		
r1.4&1.7	45%	r1.6&1.7	45%		

Table 6
Note: Higher percentage denotes higher similarity.

Construct 1.3 and construct 1.5 can be seen as high percent similarity. These two constructs Make instruction better—Climate/interaction and Key component of instruction—Approach you take in the classroom, may be the same type of construct to P1. Those that are in the lower range, such as 1.2 and 1.7, deal with a different aspect of teaching. One is tasks and key traits, and the other deals with preparation. As well, 1.5 and 1.7 are highly similar: Key component of instruction—Approach you take in the classroom and Outside the classroom—During instruction. Figure 1 shows the cluster analysis of Repertory grid 1 for P1.

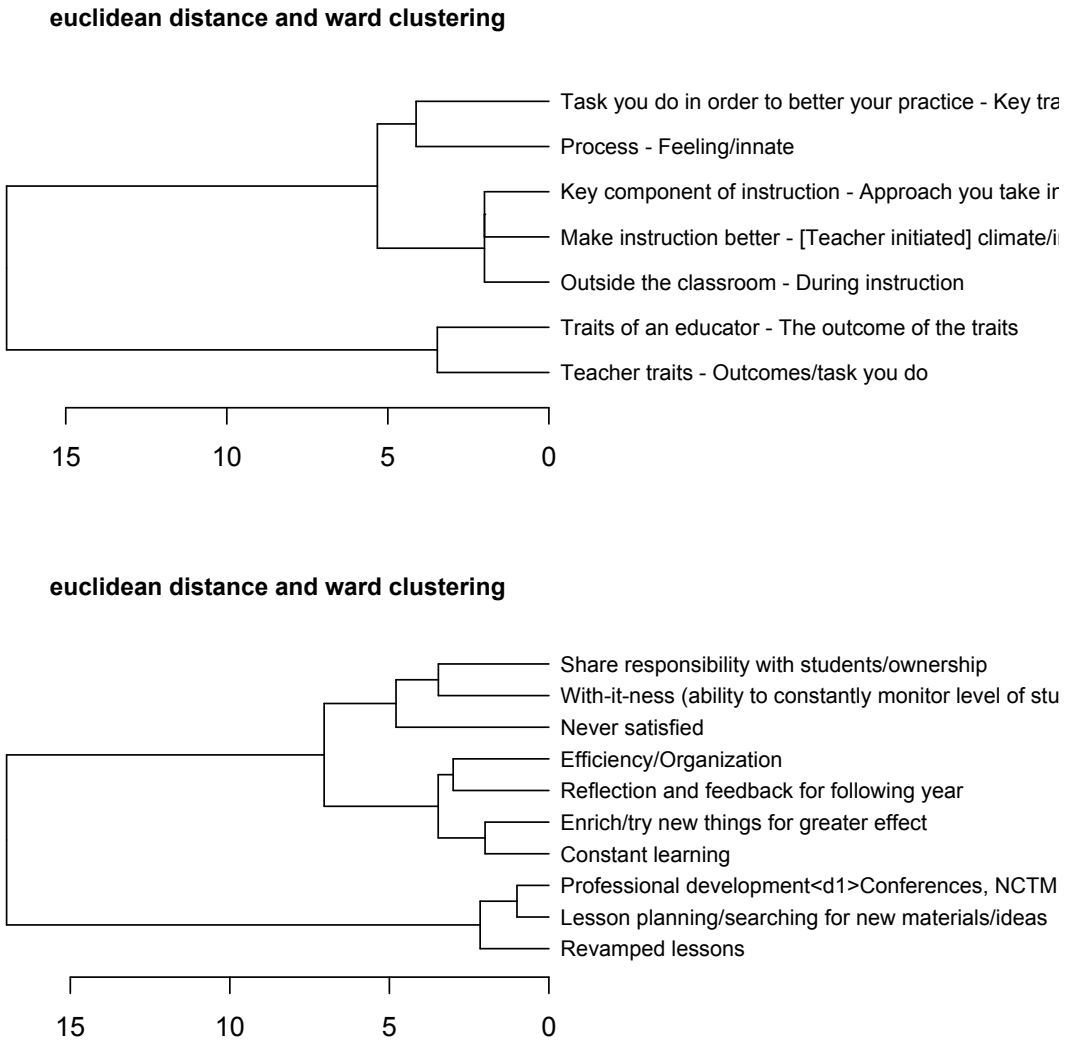


Figure 1. P1's elements and construct clusters. Shorter lines denote closer relationships.

Hierarchical clustering is a method by which similar scores for particular elements of a study can be grouped together. For P1, the element clusters Reflection and feedback for the following year and Efficiency/Organization are clustered based on the constructs she generated. These two form a larger cluster with the elements Enrich/try new things for greater effect and Constant learning.

The construct clusters fall into three main categories. These are the tasks in practice in one cluster, making instruction better in a second cluster, and Teacher traits in a third cluster. So P1's view of practice seems to be segmented into these three sections. Clustering in this way is a tool to help understand the individual's view of practice. It is only a tool.

Case Findings. Themes emerged from interview data and field notes, and the participant also completed a repertory grid interview. These two discrete findings are included to show how constructs influenced teacher behavior. The themes that emerged from the interview data are grouped in a logical order that helps outline how P1 works with her students to achieve success. The themes arrange themselves along two axes: the student axis is first. The themes that emerged from the interview regarding students were that P1 believes *both* the teacher and the students together are responsible for student learning. She makes herself constantly available, but student achievement is not limited to what she does for the students. Rather, they are taught how to learn so that they not only do well in her classes, but that they can also apply the knowledge of such skills as how to ask for help, how to explain where they had trouble in understanding, and the ability to explain the information to others. Supporting this theme for her practice was the use of tutoring. She uses tutoring both for students who need her help understanding the material and for students to tutor each other. She feels tutoring and group work are essential. "[T]he main thing is especially with larger classes I depend on peer tutoring." (Participant 1 Interview 2014,

line 107). “I tell them all the time if you can explain [the math] to someone you really understand what you’re doing.” (Participant 1 interview 2014, line 109).

The responsibility of the teacher is to provide adequate preparation for the instruction students need. This means that prerequisites and other skills may need to be visited (and revisited!) in order that students are prepared for the upcoming instruction and content.

> In calculus for example, I realized that some of their issues were algebra and not calculus, so I changed the first week when I do precalc and review, I’ve changed to pinpoint exactly what they need to know throughout the year. And then I hit it again when we get to that chapter. So I’ve added more targeted practice before they get to the calculus concept. So they may be factoring, but they don’t know why we’re factoring yet, and we’ll just practice that skill little five-minute increments for a week and then the next week they’ll actually use it when we’re doing derivatives. Things like that (Participant 1 interview 2014, lines 153-159).

Another theme that emerged is that reflection is fundamental. Reflection is used

- Before instruction to make sure important content gets taught. “I’m always thinking before I do the next lesson is there something I missed, was there something I needed to reemphasize, even after the test how can I bring that back in, catch up some gaps” (Participant 1 Interview 2014, line 337).
- During instruction to see that students are on task. This is the concept she calls With-it-ness.
- During instruction with the use of social cues to gauge that students understand the material “…every couple of years you have a new batch of students that you have to kind

of tweak how you deal with them based on their experiences" (Participant 1 Interview 2014, line 355)

- After instruction to check that content was delivered successfully. "[W]e have a way on our grade system to print a failure report. So I kind of look at who's low and focus on them that week" (Participant 1 interview 2014, lines 105-106).

The theme of consistency surfaced again and again as well. The act of preparation of the classroom before students arrive, the fact that she is available all the time and that students can count on this, and the notion of fairness to all students that she brought up in terms of offering ways for students to redeem themselves when they needed it and that this aspect of the work was available to any student who needed support in this manner. It's an example of giving students what they need. "You can do things like, oh, these two need a little retest of ten points. And I've never had a student come to me and say that's not fair. Because they know I'll do that if they need it. So it's just what they need at that moment" (Participant 1 Interview 2014, line 250-253). An overarching framework for the excellence in teaching is structure. Structure helps maximize time, student and teacher effort, and helps guide the course from beginning to end. It is what helps the teacher keep the course moving forward, allows the courses, specifically the Advanced Placement courses, to have enough time before the national test to review and practice the test skills students need and which are intrinsic to success on the test.

Teacher 2. Teacher 2 (P2) has been teaching over twenty-eight years. In addition to a teaching degree, she also holds bachelor's degree in electrical engineering. She has taught a variety of classes, and currently teaches Advanced Placement Statistics and Calculus AB, as well as geometry, pre-calculus, and math models. She was chosen as Teacher of the Year for the district, and she seemed to feel that this was an honor. She has extensive experience, but some

classes she has taught longer than others. For example, she has taught Advanced Placement (AP) calculus AB for ten years, but has only taught AP statistics for six years. She explained her way of getting ready to teach this class by spending hours and hours (her words) making sure she had enough examples not only for students, but also for herself. She put these into PowerPoint slides, and posted them to her web site so that students had access to them. She started getting emails from other teachers around the country about the activities, exercises, and tests she used. So not only was she teaching her own classes, but she also supplemented other teachers' work. In the direct lecture class I observed, she used her computer along with an Elmo projector so that students could follow how she was doing the math. In addition, she had a video to help them remember how to find limits that was actually a commercial jingle (Plug it in! Plug it in!). She had them sing it a number of times. These are 15- and 16- year-old students, and they go along with her. In fact, she nominated one of the boys to lead the chorus. As she solves the problems on the board using the computerized projector, she leads the students in a conversation about what they need to do to solve the problem. The classroom is very interactive. Although this day students are sitting in desks, another day was spent roaming around the school in groups in a treasure hunt that included solving problems to get clues to where the next problem was. We walked around to check on them, and they were all on task and seemed to enjoy it. Group work is another vital tool that P2 uses for her students to help one another learn math.

P2's description of performance. Organization is a key part of her classroom because it helps students be comfortable and to know what to expect. This included how papers get turned in, routines to follow, and what is expected of students. She feels this helps her students feel comfortable in the classroom and also improves her own performance. For example, she said that she takes attendance by where the students sit. Although they are not assigned seats they tend to

sit in the same places. She also uses homework as a way to help her take attendance because she has a very high rate of participation in homework.

> At the beginning of the year it's all about routines and procedure that deciding how you're going to organize your class physically as well as procedurally, during the class period—how do you pick up papers, how do you distribute papers, and there's never any particular great solution you just do the best that you can. How are you going to collect, how do you check homework? (Participant 2 interview 2014, lines 46-50).

P2 enjoys teaching. She would say that she is sometimes having fun laying out the lesson and wonders whether she is actually attending to the students as well as she is. When I made the observation to her that she seems to know what's going on in front of her all the time, she did not feel sure about this.

> Because I really like what I do, sort of like my stage up there, very cool, and it's very easy to get more involved in explaining something and I forget that "I wonder if they're even listening to this wonderful explanation that I'm doing." I have to work on that every single day, making sure that I'm aware what they're doing out there and that they are listening and participating and at least with what I'm doing. That's something I have to work at. That's a hard thing (Participant 2 interview 2014, lines 101-106).

She laughingly said

> I work really hard to go from beginning to end with something interesting. (Participant 2 interview 2014, line 142).

She is department chair and has occasion to observe other teachers. The sense that students are following the lesson and are engaged is extremely important to her.

> When I go and observe other teachers, it's probably the thing that I see more often than not, instructional—they're instructing! And they feel they're doing that great. Whoa look at that! And they could be! But—is anyone listening. So making sure that I track everybody and I'm not—afraid to call someone on it if they're not paying attention or not doing what they're supposed to be doing, and they don't think I'm putting them down, they don't. It just you're not doing your job, you get back to it and we're gonna be just fine (Participant 2 interview 2014, lines 106-112).

She explained that textbooks are supplemental, and are only used for problem sets and homework.

> We will not use textbooks in the classroom…Textbooks—I like having all the problems, but I don't have a classroom set. When I teach geometry or algebra I all the classes have classroom sets of those books, but we will not look at the book. We will do an activity that will reinforce the learning or there'll be some kind of challenge or there'll be something else, because that textbook, that's just a book, it has a bunch of problems that's homework. That's not the teacher, I'm the teacher, I'm gonna be in charge of the instruction (Participant 2 interview 2014, line 147, lines 161-166).

P2 wants the students to rely on her availability for help. She is available nearly all the time, describing how she helps students even after hours. She uses a program called Edmodo, which is a type of content management system developed specifically for k-12 education. The look and feel of the site is much like the social media site FaceBook.

> I choose something where I can facilitate, that I can be part of the process because I only have them for 53 minutes and I want to be part of that time. At home, they're without me. Then we have Edmodo that they can Edmodo me, and ask me questions on their

> homework, and I can do it on a piece of paper, take a picture and post it back to Edmodo (Participant 2 interview 2014, lines 170-174).

Although this does not tend to happen very much because she seems to be able to adequately explain the content so that students understand and are able to accomplish the homework on their own, she makes it clear that she is willing to try whatever is needed for students to understand the lesson.

Relationships with the students are extremely important to P2. She wants the students to know and absorb that she cares about each individual. This promotes buy-in on the part of the students. Their behavior, their presence in the class, and their absorption of the lessons matters to her, and she wants the students to know and rely on that.

> They have to—you have to more than pretend to care, you have to care, you have to find out about them, you have to sort of get to know them a little bit, I think you have to be in their face a little bit because it's sort of like being a parent— that it's not all—they don't always do the right thing, but you can't let them get away with that either, you need to correct that, you need to make sure that you get over on the right side again… At the very beginning—engagement is probably the biggest thing (Participant 2 interview 2014, lines 81-87).

Time and lack of time drives P2. She works at optimizing the time so that the students are getting preparation for future classes and also having enough time to learn the material. The concept of time and enough time came up over and over again in the interview.

> Our curriculum is such that especially in precal or a class like that, we don't have a lot of time. This is the first year we haven't had a STAAR [State of Texas Assessment of Academic Readiness] test. They took that one away. So we've probably had more time to

> do things like that, but my choice is to do laying the foundations, materials, instead of really going off the wall in terms of too much stuff like that. And do it aligned to calculus so when they get to calculus there's never any oh, I've never had to do anything like that before. That they know what to expect (Participant 2 interview 2014, lines 202-207).

Social cues drive P2's knowledge about student understanding. She monitors the students as she teaches. She feels that she does not do this well, but observation of the students while she delivered the lesson provided evidence that she has student attention well in hand. I asked her to describe what she does when she realizes that the students are having trouble understanding, or that they might be losing the thread of the lesson. She said:

> You don't let it get to the point that it's absolutely total mass confusion that there's a glint in someone's eye that you know uh oh I need to stop right now. And a lot of them don't really realize that you're reteaching it again in a different way, because they think it's part of the lesson. So that sort of happens, you know occasionally and once this year it did happen that I realized the next day whoa! That didn't go very well. And you know the best thing to do is tell the kids whoa I just didn't do a good job on this, and we're gonna work at this again. Let's figure it out (Participant 2 interview 2014, lines 274-280).

P2 wants the students to know that it's ok to make mistakes. She feels that the students need to know that everything is a work in progress, that they are not expected to know and remember everything. She is completely comfortable in the classroom and as a teacher. She does not feel that she has to be perfect, and models behavior that allows for others to do their best work without fear of ridicule or punishment. This attitude makes for a relaxed, easy classroom because the content can be so hard to master. She wants students to work hard and not worry about making mistakes.

> Also modeling that it's ok to make a mistake. I misspeak, I make mistakes, I don't do great mental math, that's not one of my strengths, and I admit it, they know, I'm not ashamed of it. So if I'm not ashamed of not being the best person at mental math, and if they're not so good at it, it must be ok, too. And that if I make a mistake then it's ok for them to make a mistake and you don't stop, you keep persevering until you figure out what it is you did wrong. You try to create a safe environment for the kids to be able to make mistakes. In math! My goodness! You make mistakes all the time! (Participant 2 interview 2014, lines 291-297).
>
> Risk-taking is the way to become better in math.
>
> We all get stuff wrong and as long as we learn from our mistakes then hopefully at the end we do show mastery, we still have to show mastery at the end I still give a real test that means they have to be right! But the process is that, it's a process, and we get things wrong while we learn how to do something. And it's ok. And it's gonna be ok (Participant 2 interview 2014, lines 302-305).

The concept of grit and teaching students to increase their grit is important, and math is a good place to learn grit. She believes that part of what it will take for her students to become proficient at math and to succeed in AP courses (which comprises getting as high a score as possible in order to be placed in a higher math class before they even set foot on a college campus) is to take risks and to practice grit. For her the concept of grit is important in life as well as in academics.

> [P]art of the thing is really good problem-solvers, really good people, I think, take risks, not risky risks, not jumping off buildings or anything like that, but taking an academic risk and having the determination and the whole TED talk Grit? We're trying to teach that too, and math is the perfect place to teach grit. Because you have so many

opportunities in math to have a do-over. We write an essay and it takes a long time to do that. And then, you mess up. And doing it again seems nearly impossible. But on a math problem, you know it might take a couple minutes and you get it wrong, it's like all right you haven't wasted your whole life—ok I think I'll try this again, it's a little more comfortable. The next time I did get it right, so I'm gonna keep trying (Participant 2 interview 2014, lines 307-315).

Table 7 shows P2's repertory grid elements and constructs.

Table 7

P2's Repertory grid data

Elements and Constructs

Elements
2.A Reflection
2.B Organization
2.C Planning
2.D Creativity
2.E Rapport
2.F Relationships
2.G Safe risk-taking for students
2.H Rigor
2.I Constant feedback via formative assessments
2.J Being able to change directions mid-stream

Constructs
2.1Objectives driven, lesson oriented—People oriented affective part of classroom
2.2 Content is the focus—(Emotional) Connection to students is the focus
2.3 Before instruction—During instruction
2.4 Take the temperature of the room (Checking for comfort level)—Try to push them beyond where they are comfortable, non-routine problems, out of the box thinking
2.5 How students are made to feel safe in class—Help students understand the content in whatever way necessary
2.6 Instructional—Relational
2.7 Accommodations when needed to support relationship—Finding a unique way to present lessons (pre-lesson)
2.8 Planning stage—People-centered
2.9 What they know/don't know informs practice—People oriented
2.10 What worked/what didn't, reflect on past—lesson in progress, reorient student thinking
Process activities pace—Environment, kids ok making mistakes

Table 7

Elements were compared for similarity using the procedure found in Jankowitcz (2002).

Table 8

P2's Percent similarity scores: Elements

Element	Similar	Element	Similar	Element	Similar
2.A&2.B	81.81%	**2.B&2.C**	97.73%	**2.C&2.D**	88.64%
2.A&2.C	84.10%	**2.B&2.D**	86.36%	2.C&2.E	25.00%
2.A&2.D	81.81%	2.B&2.E	20.45%	2.C&2.F	22.73%
2.A&2.E	31.82%	2.B&2.F	20.45%	2.C&2.G	25.00%
2.A&2.F	34.09%	2.B&2.G	22.72%	2.C&2.H	72.73%
2.A&2.G	31.82%	**2.B&2.H**	76.45%	2.C&2.I	56.82%
2.A&2.H	70.45%	2.B&2.I	59.09%	2.C&2.J	45.45%
2.A&2.I	54.55%	2.B&2.J	47.27%		
2.A&2.J	52.27%				
2.D&2.E	27.27%	**2.E&2.F**	97.73%	**2.F&2.G**	84.10%
2.D&2.F	25.00%	**2.E&2.G**	86.36%	2.F&2.H	36.36%
2.D&2.G	27.27%	2.E&2.H	38.64%	2.F&2.I	43.18%
2.D&2.H	75.00%	2.E&2.I	45.45%	2.F&2.J	50.00%
2.D&2.I	54.55%	2.E&2.J	52.27%		
2.D&2.J	47.27%				
2.G&2.H	40.91%	2.H&2.I	52.27%		
2.G&2.I	50%	2.H&2.J	45.45%		
2.G&2.J	61.36%	**2.I&2.J**	88.64%		

Table 8
Note: Higher percentage denotes higher similarity.

Constructs were similarly compared using the procedure in Jankowitcz (2002). Table 9 presents these findings.

Table 9

P2's Percent similarity scores: Constructs

Construct	Similar	Construct	Similar	Construct	Similar
2.1&2.2	55.00%	2.2&2.3	45.00%	r2.3&2.4	25.00%
2.1&2.3	35.00%	r2.2&2.4	25.00%	2.3&2.5	10.00%
r2.1&2.4	0.00%	r2.2&2.5	20.00%	2.3&2.6	45.00%
r2.1&2.5	35.00%	2.2&2.6	45.00%	r2.3&2.7	35.00%
2.1&2.6	80.00%	r2.2&2.7	45.00%	2.3&2.8	40.00%
r2.1&2.7	35.00%	2.2&2.8	50.00%	2.3&2.9	35.00%
2.1&2.8	75.00%	2.2&2.9	45.00%	**r2.3&2.10**	85.00%
2.1&2.9	75.00%	2.2&2.10	45.00%	2.3&2.11	70.00%
2.1&2.10	40.00%	2.2&2.11	70.00%		
2.1&2.11	75.00%				
2.4&2.5	35.00%	r2.5&2.6	55.00%	r2.6&2.7	30.00%
r2.4&2.5	35.00%	r2.5&2.7	25.00%	2.6&2.8	75.00%
r2.4&2.6	10.00%	r2.5&2.8	40.00%	2.6&2.9	75.00%
2.4&2.7	70.00%	r2.5&2.9	40.00%	r2.6&2.10	40.00%
r2.4&2.8	35.00%	2.5&2.10	25.00%	2.6&2.11	75.00%
2.4&2.9	15.00%	r2.5&2.11	30.00%		
r2.4&2.10	20.00%				
r2.4&2.11	25.00%				
r2.7&2.8	35.00%	2.8&2.9	75.00%	2.9&2.10	30.00%
r2.7&2.9	30.00%	2.8&2.10	45.00%	2.9&2.11	65.00%
r2.7&2.10	40.00%	2.8&2.11	55.00%	2.10&2.11	55.00%
r2.7&2.11	55.00%				

Table 9
Note: Higher percentage denotes higher similarity.

For P2, Reflection is highly similar to Organization, Planning, and Creativity. Because she is talking about teaching math, this makes more sense than if one were to compare the

similarities of the properties of these four elements in a more general way. Organization and Rigor are also highly similar. It is interesting to note that Planning and Creativity are also highly correlated. Constant feedback and Ability to change directions in mid-stream are also highly similar. It seems that this participant uses feedback from students to change her teaching according to the needs of the students. Observations bear out this notion. Objectives driven, What they know/don't know, and Planning are constructs that are also highly similar. She takes all these ideas into account when formulating lessons. Constructs 2.1 and 2.11 are highly similar across the elements, and this makes sense in that they are both process as opposed to affective constructs.

Hierarchical clustering was analyzed using Ward's cluster and Euclidean distance. Figure 2 shows P2's results.

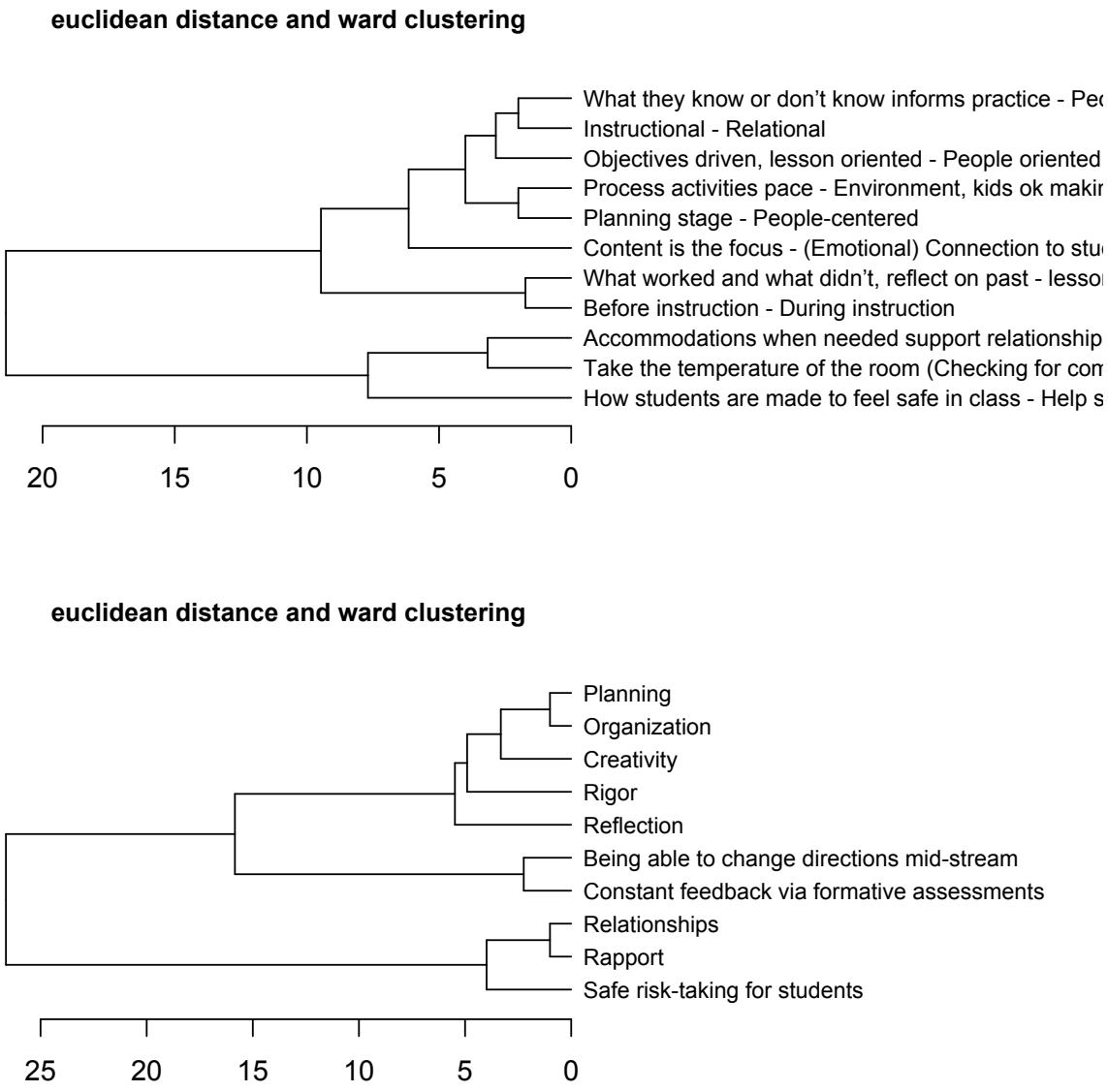


Figure 2. P2's elements and construct clusters. Shorter lines denote closer relationships.

The constructs elicited from P2 show instruction instruction-related topics are opposed to the interpersonal topics. For example, she views process, activities and pace as opposed to the environment and whether students feel comfortable making mistakes. P2's student-centered elements are clustered together, while under reflection, the elements planning, organization, creativity, and rigor are also together.

Case Findings. The constructs elicited from the repertory grid show that P2 construes her practice in terms of content and students, or instructional as opposed to relational. It seems that, although P2 may be delivering instruction, she is also monitoring how the students are receiving and perhaps perceiving it. She does not mention either in the elicited elements or in the constructs any type or list of topics. It is not important to her that she check off a list of objectives. She knows what the students need to learn, and she is constantly trying to find new and interesting ways for them to learn it.

P2 is a teacher who cares about her students as people first and foremost, and realizes that they have lives outside the classroom. Over and over again in her interview, she talked about how the students needed to know that she cares and that she will not let them down regarding mathematics learning support. An overarching theme of P2's practice is that *We're in this together*. Students did not have to worry that they could not get help at virtually any time throughout the school year. She mentioned that her availability extended to students who were not even in her classes nor were they ever her students. Her own students volunteered her to help friends because they believed she would be willing to help anyone who asked for it.

A second theme that arose was the issue of time and always wanting to maximize it for the benefit of the students. She made an environment in her classroom and in her behavior that was no nonsense yet the students were able to engage in some interesting activities that kept them interested in the content and feeling able to understand it. However, she felt that time was always short and begrudged, in her words, even having to do clerical things like check homework in class. The idea that she had enough time for herself was never the issue; instead, she wanted to spend more time with the students and teaching math. In observations the students

were working on something or doing math-related activities from the time they came into the room until the bell rang at the end of the period.

A third theme that supports her practice is that she is extremely organized in terms of knowing exactly what is going to happen in the classroom every day. She knows what students need to learn and in what order they need to hear it. She breaks down the instruction as well based on how much time there is to teach the lesson. She knows the content so well that she can add or take away parts of the instruction based on how much time she has and what the students need. She does not use lesson plans.

Teacher 3. Teacher 3 (P3) loves technology. She tweets, has a blog, and uses flipped learning to her students' great advantage. She enjoys using technology in the classroom, and the students seem comfortable with her use of it. However, on one of the days I observed, she was unable to utilize her classroom and had to use another room in the school to teach math. This room is the mock courtroom. She had no access to technology other than the students' calculators, and had them engaged and working hard throughout the hour. She teaches a block schedule, and has students from freshmen to seniors. Hers is a much more diverse group. She uses routine and structure to help bound the relationship she has with her students. Consistency is important to P3, but she seems to be able to be consistent because of the routines and structure she has put in place. Students know what is expected of them and they are working from the time they get into the room until the bell rings. One of the things she says to them is that eyes don't close when we're talking about math.

P3's description of practice. The one thing that P3 stated again and again in the interview was the idea of flexibility. She thinks that the skill of being flexible is what helps her most in her profession. This involves a fact of life in most high schools—namely, that teachers have little

control over their schedules or the school-based activities in which their students choose to engage. As well, she cited intense weather as another consideration, just to highlight the role that flexibility plays in her planning. In order for learning to occur, teachers have to be able to stretch time or condense it depending on the needs of their students. She used the word flexibility seven times during our interview, and also noted that to her it is an element of teaching in the repertory grid responses. When discussing a particular class period that I observed where she had to teach in the mock courtroom, and the students were still working hard on their math problem set, she said

> You have to be flexible, like today with my 8th period they'll be doing the same lesson, but they aren't going to be doing it in groups of two, they'll be doing it individually. So they're gonna have the benefit of a projector instead of me having to go to take a look at their handheld, so it's gonna go a lot easier, but you have to be flexible (Participant 3 interview 2014, lines 124-127).

This attitude of being able to work and be flexible and to not be blown off-course is seen all through her teaching.

Another aspect of P3's teaching is, as she would describe it, consistency. Consistency is very important to her ability to work with teenagers. There are many strong personalities in her classes and she needs some sort of backstop so that they work and are attentive in class. She laughingly said, "I have to be consistent and always be on top of them, because I have two different grade levels, I have ninth and tenth graders, and all the personality that comes with it" (Participant 3 interview 2014, lines 155-117).

She is concerned about the changing skill level in students she sees as well. She noted,

> When I was in school, whatever the teacher said I would do it. And I would do it with authenticity, I would do it earnestly, I would give my best effort forward. And I find with this generation of students, that's not something that they are 100% trying to do. They want a good grade, but don't necessarily care about the learning that goes with it (Participant 3 interview 2014, lines 26-29).

She also mentioned that in her opinion, students are in her words cognitively lazy. In order to learn, they have to make an effort. However, these students rely too much on the teacher to think for them about how to solve a problem that they are ostensibly in class to learn how to do.

> I have to literally train them to be specific. When they say *I don't get it*—get what? Point to me on what part of the question don't you understand? And it's easy to see a lot of time the kids are cognitively lazy. They don't want to take the time to spend to understand the question, so they'll glance over the question and say I don't really know what to do off the top of my head, so let me tell the teacher I don't get it (Participant 3 interview 2014, lines 156-161).

She also made the point that students need to learn how to communicate in mathematics. They do not know how to help themselves, because they do not know how to ask for help. Her job is to show them how to talk about problems they are having in math.

> [W]hen a kid comes over and asks me for help, they need to verbalize what they need help with. And if they can't verbalize it, they need to have it on paper. I can see where they got stuck. And if they don't have that, then I'll say *read the problem* and they'll try to read it out loud, and I'll say what does the problem mean for you? I want them to analyze what it means for them. And then once they've figured out what they don't know, then I'll come over and help them (Participant 3 interview 2014, lines 175-179).

This technique is used by many of the experts in this study. The ability of students to not only verbalize but also diagnose their own problems is a common technique.

P3 has a flipped classroom. Flipped instruction for her classes is basically a ten-minute video twice a week that students watch outside the classroom. There is a mini-assessment and notes. The assessment works as a formative assessment to allow P3 to put the students into groups based on the amount of support they will need to complete the work. They come into class and sit with the group whose members got similar scores on the assessment. She feels that this works very well and she has used it for over two years. It allows her to essentially run a tutorial every day in class, and students get targeted help based on what they need and not on lesson plan objectives. She has found that students want her to record the lesson so that her face is also included. She believes that students use the teacher's face as a guide to know what is important in the lesson. She thinks they have been trained to do this over the course of their education.

> I started doing it. And there were some bumps along the way, but the second year I felt *I'm in my groove, the kids are enjoying it*, then they said they wanted videos with my face included in it, which is interesting, but they are trained to listen to what the teacher says but also watch their face to tell what's important and what's not important. So this time I had to record the video and have my face be recorded while I'm doing the video. It was interesting! (Participant 3 interview 2014, lines 99-104).

P3 feels that buy-in is important to work at for teachers. Real-world applications help with this. She uses reflection-before-action to try to get the students to buy into the learning, "not just the doing of the math" Participant 3 Interview 2014, lines 36-37). Evidence for her that students may just be doing the work for a grade stemmed from this encounter:

> I remember at one point one of the kids saying something when we were doing something in an applied sense, and they were like Miss this is chemistry! Applied—It's like well, yes! Everything in math can be applied to many different areas. But in their mind everything is so regimented, and all we do in math is for math, and all we do in chemistry is for chemistry, and they don't understand everything is supposed to meld all together (Participant 3 interview 2014, lines 40-45).

She knows that they don't yet see the big picture regarding the powerful tool that math can be.

The repertory grid data for P3 is in Table 10 .

Table 10

P3's Repertory grid data

Elements and Constructs

Elements
3.A Reflection
3.B Knowledge
3.C Flexibility
3.D Students' previous learning not an issue (how they learned to do math)
3.E Consistent
3.F Understanding of students
3.G Creative
3.H Up-to-date on new technologies and strategies
3.I Organized
3.J Comfortable with presenting/being the authority

Constructs
3.1 Indication of change occurring—Unchanging
3.2 Student-centered—Teacher-centered
3.3 Be a better teacher for these particular students—Better teacher in general
3.4 Seek out knowledge/understanding—Innate, allow to come out
3.5 Classroom procedures—Approach to instruction
3.6 Something for self and students—For student benefit
3.7 Student needs—classroom culture
3.8 Professional development—personal development
3.9 Student performance—Teacher performance
3.10 Not obvious skill—commonly understood skill
3.11 Student-centered—teacher centered
3.12 Things you have to do—Personality-related traits

Table 10

Table 11 shows the percent similarity between P3's elements.

Table 11

P3's Percent similarity scores: Elements

Element	Similar	Element	Similar	Element	Similar
2.A&2.B	81.81%	**2.B&2.C**	97.73%	**2.C&2.D**	88.64%
2.A&2.C	84.10%	**2.B&2.D**	86.36%	2.C&2.E	25.00%
2.A&2.D	81.81%	2.B&2.E	20.45%	2.C&2.F	22.73%
2.A&2.E	31.82%	2.B&2.F	20.45%	2.C&2.G	25.00%
2.A&2.F	34.09%	2.B&2.G	22.72%	2.C&2.H	72.73%
2.A&2.G	31.82%	**2.B&2.H**	76.45%	2.C&2.I	56.82%
2.A&2.H	70.45%	2.B&2.I	59.09%	2.C&2.J	45.45%
2.A&2.I	54.55%	2.B&2.J	47.27%		
2.A&2.J	52.27%				
2.D&2.E	27.27%	**2.E&2.F**	97.73%	**2.F&2.G**	84.10%
2.D&2.F	25.00%	**2.E&2.G**	86.36%	2.F&2.H	36.36%
2.D&2.G	27.27%	2.E&2.H	38.64%	2.F&2.I	43.18%
2.D&2.H	75.00%	2.E&2.I	45.45%	2.F&2.J	50.00%
2.D&2.I	54.55%	2.E&2.J	52.27%		
2.D&2.J	47.27%				
2.G&2.H	40.91%	2.H&2.I	52.27%		
2.G&2.I	50%	2.H&2.J	45.45%		
2.G&2.J	61.36%	**2.I&2.J**	88.64%		

Table 11

Similarities of constructs were also calculated. Table 12 shows the percent similarity scores for P3's constructs.

Table 12

P3's Percent similarity scores: Constructs

Construct	Similar	Construct	Similar	Construct	Similar
3.1&3.2	25%	3.2&3.3	30%	3.3&3.4	20%
3.1&3.3	35%	r3.2&3.4	20%	r3.3&3.5	55%
r3.1&3.4	20%	r3.2&3.5	25%	r3.3&3.6	50%
r3.1&3.5	45%	**r3.2&3.6**	75%	3.3&3.7	60%
3.1&3.6	-5%	3.2&3.7	30%	r3.3&3.8	60%
3.1&3.7	50%	r3.2&3.8	50%	3.3&3.9	50%
r3.1&3.8	30%	3.2&3.9	60%	3.3&3.10	15%
3.1&3.9	45%	3.2&3.10	35%	3.3&3.11	25%
3.1&3.10	40%	3.2&3.11	85%	3.3&3.12	15%
3.1&3.11	40%	3.2&3.12	15%		
3.1&3.12	60%				
3.4&3.5	5%	3.5&3.6	25%	3.6&3.7	-30%
r3.4&3.6	20%	r3.5&3.7	80%	3.6&3.8	40%
r3.4&3.7	10%	3.5&3.8	15%	r3.6&3.9	40%
3.4&3.8	50%	r3.5&3.9	45%	r3.6&3.10	25%
r3.4&3.9	40%	r3.5&3.10	50%	r3.6&3.11	65%
3.4&3.10	5%	r3.5&3.11	70%	3.6&3.12	5%
r3.4&3.11	15%	r3.5&3.12	40%		
r3.4&3.12	45%				
r3.7&3.8	20%	r3.8&3.9	70%	3.9&3.10	5%
3.7&3.9	40%	3.8&3.10	5%	3.9&3.11	55%
3.7&3.10	55%	3.8&3.11	35%	3.9&3.12	35%
3.7&3.11	45%	3.8&3.12	15%	3.10&3.11	40%
3.7&3.12	45%			3.10&3.12	20%
				3.11&3.12	30%

Table 12
Note: Higher percentage denotes higher similarity.

The elements with the highest similarity ratings go together. Flexibility, students' previous learning not an issue, and understanding students had the highest percent similarity

scores. Although in her description of her work she was somewhat critical of student choices and behavior, she shows here that she wants to help them achieve and do well and is willing to be flexible in order to do this. As well, reversed 3.2 and 3.6 are highly similar: teacher-centered and something for self and students.

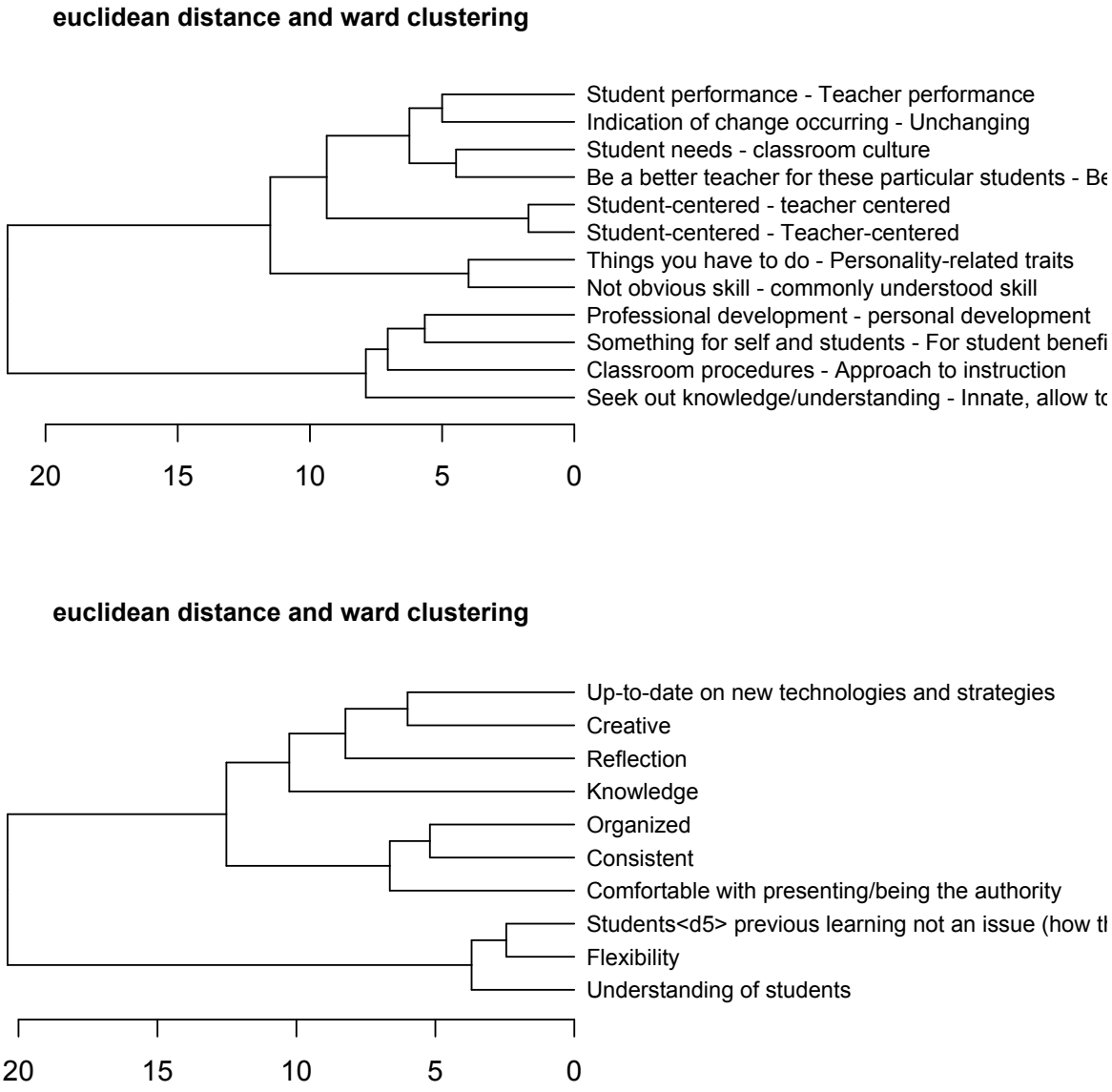


Figure 3. P3's elements and construct clusters. Shorter lines denote closer relationships.

Case findings. Flexibility can be seen as a theme in P3's work. She mentions it, works it when necessary, and believes that it's the only way that she can meet students where they are. More than any other teacher, the theme of flexibility came up in talking with and observing this teacher.

A second theme is that the teacher and the student are responsible for the learning. She runs a flipped classroom and the students have a responsibility to watch the video. When students have questions about problems, she will help them express themselves, but in order for her to help them, they need to be able to articulate the problem. This technique is an important part of her dialog with students. Ultimately, it empowers them to take control of their own learning.

A third theme is that she is fearless. She mentioned it in terms of student boundaries, in terms of being comfortable presenting in front of students and also in terms of running the different groups throughout the school day, and even that she jumped right into flipping the class because she could see that it would benefit her students and she was willing to take a chance. As well, she does not believe that lesson plans nor consortia-led assessments should run the class. Ultimately the responsibility is on her as the teacher and leader of the class. Students can relax and learn. She is in charge.

Teacher 4. The fourth participant in the study, participant 4 (P4) has a degree in mathematics, and came to teaching because of a fear as a math major of advanced calculus. She had tested well in a career placement test for teaching. In place of the advanced calculus I and II courses, she was offered instead the chance to teach. She discovered she loved teaching and has never looked back. She has been in the profession over eighteen years. She teaches students who are on-level, meaning that she teaches the general mathematics student, not the gifted and

talented ones. She says she prefers this. In observing her teaching, it is obvious that she enjoys not only what she does, but also being with the students. She had a student teacher this year. This allowed her a chance to revisit her teaching because the student teacher had questions about how she was able to remember that students had questions while she was delivering the lesson and that most of the time the question had been answered because she asked them to wait. In other words, she anticipated the question the student was going to ask, and she answered it within the lesson that day.

P4's description of practice. P4 prepares for teaching a unit by first setting out everything that needs to be taught. Then, she writes questions she wants to ask the students to engender higher-level thinking skills. When she first starts to map out how she will teach a class, she has a routine:

> I decide how I want to piece things together and each day what's going to be taught. And each day what I would do is I would decide what examples I wanted to use, what things I wanted to make sure they got out of that lesson. And I would do a lot of questions. I write down what questions to ask, trying to get the higher-level questioning in (Participant 4 interview 2014, lines 6-9).

She does not have to do this type of granular preparation anymore, because "This is my 18th year teaching Algebra II, if I know this is what I want to teach that day, I know what examples I want to use." She also uses a recursive form of teaching, in that she will, in her words, sprinkle throughout the lesson facts and information that will help students piece together their own understanding. She orchestrates her students' aha moments. She feels that this feeling of seeing how things go together in math is an avenue for students to change their views of themselves and of the subject of math.

> I like to sprinkle (math facts/information) a little bit because then I want them to make the connection. I don't want to be the one telling them look how this connects… I just love it when they say, oh! That's what we did over there and this happens here and that happens there! And that is the best feeling ever. Because that's why I sprinkled it through so they could have that reaction, so they could have that experience for themselves (Participant 4 interview 2014, lines 131-136).

P4 does not teach any upper level math courses. She teaches the average students, not the Advanced Placement students. She prefers this. She feels that these are the students who most need support and a chance to change their feelings toward math and toward themselves as math scholars. In our interview, she noted that

> I worry that I baby them too much~ I hold their hands too much and maybe I do, but with math—math is such a tightrope. Because some of these students are coming in with these terrible math experiences, and you just want to hand hold until they can get past that, so that they can feel more successful, basically. You want them to feel successful, but you also want to challenge them, so it's a real tight rope to walk. So I usually err on the side of making them not scared (Participant 4 interview 2014, lines 92-96).

Student feedback is essential to her teaching. She likes to give students time to work problems in class, because that also gives her an assessment of their understanding of the lesson. She also knows where many of the students' problems will be, and makes sure to cover that in the lesson. She has the students' desks in groups so that she can get to all of them in a more facile way. As this is happening, she is always scanning the room, including what I as an observer may be doing:

> I'm always scanning to make sure are you on task? Are you listening to me? Are you writing down what I'm asking you to do? What is it that you're doing? Are you kind of zoned out—I noticed in first period I noticed that you were writing down a couple times that I kept calling on a couple people *I'm up here* kind of thing—I just—I don't know, truly I just kind of do that (Participant 4 interview 2014, lines 40-44).

In her lesson delivery, P4 intuits what questions students will have. This reflects what many of the participants have said. When she is giving a lesson and a student has a question, she has a routine in place to have them wait until she is finished with the presentation. Then, she will go back to the student with a question. This routine has a two-fold purpose. First of all, most of the time the question will be answered because she has already anticipated where students will have questions. Secondly, she lets the students know that she sees and remembers them and that their participation is important to her.

> What I tend to do a lot of times and my student teacher didn't understand how I did this, but usually if there's a question...their question usually is about something I'm just about to cover. I'll just do this—I'll acknowledge that they are asking me a question and put up a finger for a minute, and they know by the second month of school, *just a minute, I'll come back to you.* And then I don't have to say that anymore. And then I'll finish up what I'm doing, or the example, or answer a question that's already been asked. And I would say 90% of the time I go back and they say you already answered it—and it's almost always the next thing I'm going to say. And that's because I think I know where their mistakes are, I know what kind of questions they ask. And it's not something I consciously do—I just have developed it I think over the years. But you'll see me put up

> the finger *wait a minute* and then the student says, you already answered it (Participant 4 interview 2014, lines 45 56).

P4 also has an abundance of examples so that if students need more help, she has it available at her fingertips. Where a novice or less experienced teacher might overplan in order to fill extra time and keep students working, she overplanned to have extra examples for students:

> I would overplan, but not for time; I would overplan for they need another example of one and make sure I would have another example, it came out the way I wanted. The way I teach is I kind of build—so let's do an easy one, let's put something else in to it and do a little bit harder one, now let's pull everything together and do another one. I always give them time to practice. Here's what I did, you practice. Here's another one that's harder. Now you practice that one. So now they've seen me do it and they've practiced doing it also. They need one more of something to make sure they get that base, and then we'll just pull out another example (Participant 4 interview 2014, lines 20-27).

For P4, the textbook is supplemental. **"**I use the book as more of a tool, and if I have a sub, I'll give bookwork, because then they can teach themselves and it's something they can turn in. And I have a classroom set. But I don't really teach out of the book per se" (Participant 4 interview 2014, lines 72-74). She tends to make her own worksheets and other materials because experience has taught her that students, especially freshmen, will stop working if they have to turn the page in the textbook. Also, it's an encouragement because they know that once they complete the worksheet, the work is done.

> I've learned over the years, and especially from teaching freshman—you ask them to turn the page, and they decide they can't do it and they just stop. They don't do all of it. You give them a worksheet—all I have to do is finish everything on this worksheet, I have a

> stopping place, I don't have any more I have to worry about—because if they turn the page they don't know how many more they have to do—I prefer worksheets (Participant 4 interview 2014, lines 65-69).

Her job is to help students think critically about their own learning. How she does this is essentially a conversation about where a student might be having difficulties. The student may feel confusion about the problem she is having, but P4 shows them they know more than they think they do, and how to help themselves isolate problems and learn to think critically about how to solve them.

> They'll come in at lunch or for tutorials and they'll say I didn't understand anything! And I'll say, you understood something… Something in there because we need to figure out where you stopped understanding so that's what we can address. So I'll say where did I lose you? Where did you get lost? And by this time of the year they'll say I understood that and I understood that, but then I don't know what happened. A lot of times I will ask them show me in here where you got lost, so that I can address that. Sometimes I just have to reword it (Participant 4 interview 2014, lines 183-188).

One of the most important aspects of her students' experience in her classroom is the interpersonal relationships she has with the students and relationships with one another. One example of this is encouragement that other students can give one another. She has incorporated the practice of what she calls yaying people.

> I make them Yay each other when they do something good. They start this in freshman year and they *look* at me, and I say, you better Yay them! If you do something good we're gonna Yay you too. After four weeks they say, we didn't Yay that person. So we clap and Yay that person. So when I have them in Algebra II, we start Yaying and the

> ones that had me Yay, and the other ones go, *what?* and I say: you better Yay! And the students say, you have to Yay people. This is her rule. So if you've said something that was good, that has to be acknowledged (Participant 4 interview 2014, lines 348-354).

She feels that these interpersonal relationships help students who might normally be afraid of math and not feel very confident obtain the courage to achieve above their expectations. She enjoys the students and they feel very comfortable with her, based on observations. This is extremely important to her teaching.

> I think it's the personal relationship I have with them, I really and truly do. Lots of people can teach math. Lots of people can get the information across. But I like the personal aspect of it and I like them to have a personal relationship with the math. Which sounds crazy, but I want them to see where this is going, and I'll tell them just stick with me and we will get there (Participant 4 interview 2014, lines 275-279).

Finally, P4 stressed that for her, teaching math is a calling. She loves the subject, but more than that, she wants students to love it, too. She wants them to not be afraid of math, and to give themselves a chance to succeed at a subject they may have felt was out of their reach.

> I was probably six weeks into my first teaching job… and I thought this is what I'm supposed to do with the rest of my life. They were right, I was wrong! [Career placement test] I can't imagine not doing it. And I've thought about trying to get out of the classroom and doing other things, and I've applied for other jobs, and it never quite fit, and I think it's because this is what I'm supposed to be doing! I love it. I do (Participant 4 interview 2014, lines 382-387).

Repertory grid data for P4 can be found in Table 13.

Table 13

P4's repertory grid data

Elements and Constructs

Elements
4.A Reflection
4.B Clear understanding of content
4.CConcern for students' understanding
4.D Feedback for students
4.E Positive relationship with students
4.F Student engagement
4.G Students on task in class
4.H Passion for your material
4.I Unafraid to try new things (could fail)
4.J Discovery for students—their thrill

Constructs
4.1 How I interact with students—Informs my teaching
4.2 My depth of understanding—Creating environment
4.3 Create the lesson (pre)—Adjust the lesson
4.4 Interaction and classroom environment—Adjustments in student conduct
4.5 Personal mathematics scholarship—What students need additionally
4.6 Determine if lesson was effective—What's happening in class
4.7 The exciting stuff—classroom management
4.8 The way I prepare a lesson (pre)—Did it work? What could I have done better? (post)
4.9 Take responsibility to make the content accessible—Classroom environment
4.10 Classroom environment—being able to teach on the fly
4.11 Share joy with the material—Meeting student needs
4.12 Ability to set up the learning (pre)—What happens in the classroom (during)

Table 13

Table 14 shows the percent similarity between elements for P4.

Table 14

P4's Percent similarity scores: Elements

Element	Similar	Element	Similar	Element	Similar
4.A&4.B	58.33%	4.B&4.C	41.67%	4.C&4.D	62.5%
4.A&4.C	66.67%	4.B&4.D	58.33%	4.C&4.E	70.83%
4.A&4.D	54.17%	4.B&4.E	37.5%	4.C&4.F	62.5%
4.A&4.E	54.17%	4.B&4.F	41.67%	4.C&4.G	52.08%
4.A&4.F	54.17%	4.B&4.G	27.08%	4.C&4.H	54.17%
4.A&4.G	75%	**4.B&4.H**	79.17%	4.C&4.I	56.25%
4.A&4.H	66.67%	**4.B&4.I**	77.08%	4.C&4.J	64.58%
4.A&4.I	60.42%	**4.B&4.J**	72.92%		
4.A&4.J	64.58%				
4.D&4.E	62.5%	4.E&4.F	83.33%	4.F&4.G	70.83%
4.D&4.F	66.67%	**4.E&4.G**	77.08%	4.F&4.H	50%
4.D&4.G	60.42%	4.E&4.H	47.92%	4.F&4.I	52.08%
4.D&4.H	58.33%	4.E&4.I	45.83%	4.F&4.J	56.26%
4.D&4.I	52.08%	4.E&4.J	56.25%		
4.D&4.J	56.25%				
4.G&4.H	35.41%	4.H&4.I	81.25%		
4.G&4.I	37.5%	4.H&4.J	72.92%		
4.G&4.J	37.5%	**4.I&4.J**	79.17%		

Table 14

Note: Higher percentage denotes higher similarity.

The percent similarity scores for P4's constructs are in Table 15.

Table 15

P4's Percent similarity scores: Constructs

Construct	Similar	Construct	Similar	Construct	Similar
r4.1&4.2	45%	4.2&4.3	62.5%	r4.3&4.4	50%
r4.1&4.3	55%	4.2&4.4	5%	4.3&4.5	40%
4.1&4.4	25%	4.2&4.5	30%	4.3&4.6	35%
r4.1&4.5	45%	4.2&4.6	25%	4.3&4.7	55%
r4.1&4.6	35%	4.2&4.7	15%	4.3&4.8	65%
r4.1&4.7	35%	4.2&4.8	35%	4.3&4.9	45%
r4.1&4.8	55%	4.2&4.9	30%	4.3&4.10	15%
r4.1&4.9	60%	r4.2&4.10	65%	4.3&4.11	45%
4.1&4.10	35%	4.2&4.11	35%	4.3&4.12	55%
r4.1&4.11	70%	4.2&4.12	50%		
r4.1&4.12	50%				
r4.4&4.5	25%	4.5&4.6	25%	4.6&4.7	40%
4.4&4.6	50%	4.5&4.7	15%	4.6&4.8	30%
4.4&4.7	60%	4.5&4.8	75%	r4.6&4.9	55%
4.4&4.8	10%	4.5&4.9	30%	r4.6&4.10	50%
4.4&4.9	35%	4.5&4.10	15%	4.6&4.11	30%
4.4&4.10	10%	4.5&4.11	85%	4.6&4.12	55%
4.4&4.11	10%	4.5&4.12	30%		
4.4&4.12	35%				
4.7&4.8	20%	4.8&4.9	25%	r4.9&4.10	50%
4.7&4.9	45%	4.8&4.10	10%	4.9&4.11	35%
r4.7&4.10	40%	4.8&4.11	70%	4.9&4.12	50%
4.7&4.11	30%	4.8&4.12	35%		
4.7&4.12	55%				
4.10&4.11	30%				
r4.10&4.12	55%				
4.11&4.12	45%3.7&3.12	45%			

Table 15
Note: Higher percentage denotes higher similarity.

Figure 4 shows the hierarchical clustering of P4's responses. Constructs are listed first and elements are the second cluster.

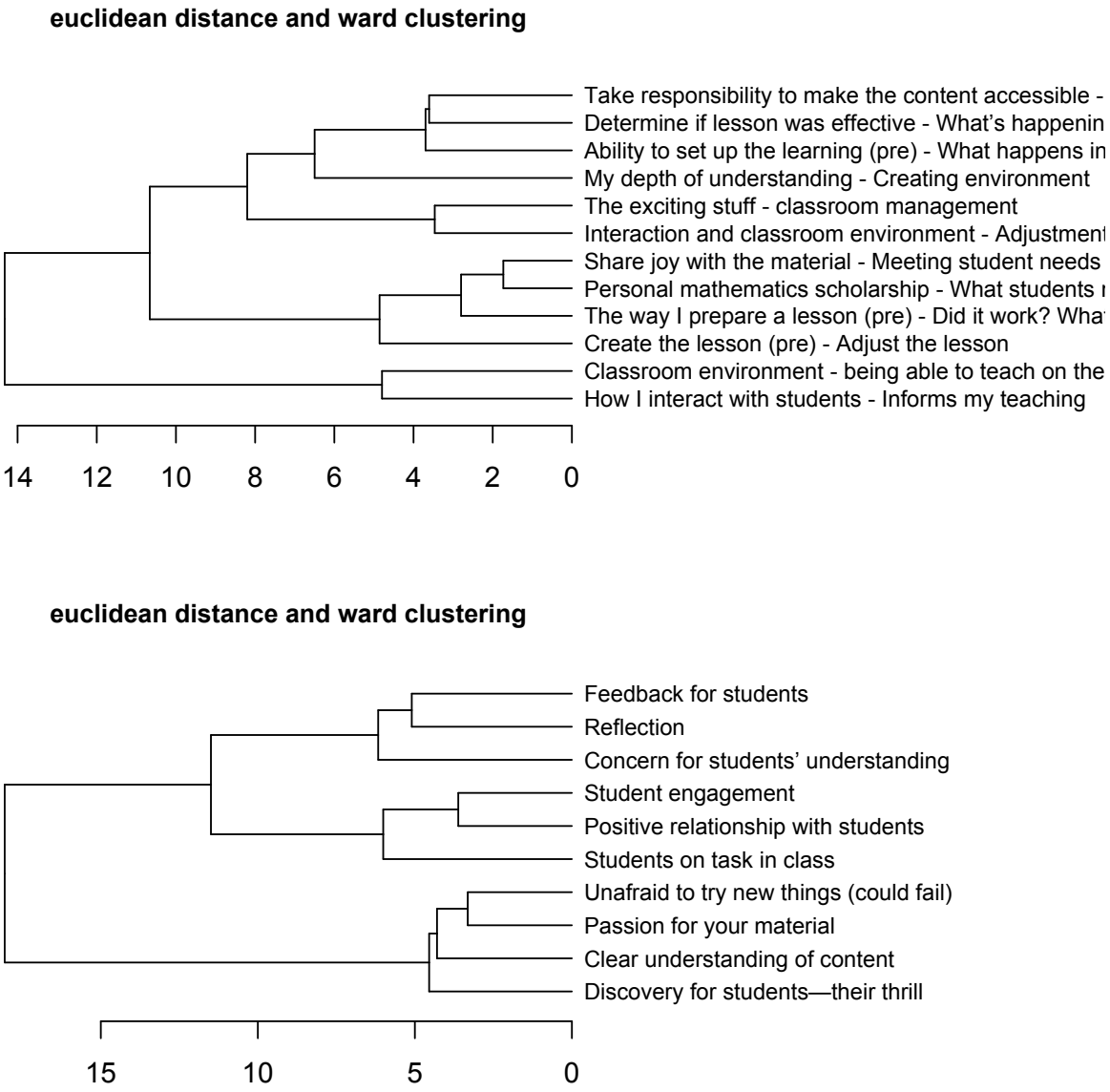


Figure 4. P4's elements and construct clusters. Shorter lines denote closer relationships.

For P4, the constructs are clustered around the notions of classroom management as opposed to personal preparation for the lessons (teacher preparation) and effectiveness of the lessons. The element clusters regarding reflection are closely related to feedback for students and concern for students' understanding, which can also be seen as feedback for the teacher. P4's

constructs were not closely similar in nature, as some of the participants' have been. Construct 4.8, which is preparation for and observations of success of the lesson, can be viewed as reflection-before-action and reflection-after-action. This is clustered with both wanting to share joy of the subject as well as personal mathematics scholarship. For P4, it seems that success of a lesson is wrapped in both personal authenticity in scholarship and the ability to make math be a satisfying activity.

P4's constructs about her practice show a repeated mention of joy of the subject, her personal scholarship, and the interplay of the classroom environment with her support of student understanding of math. She is still interested not only in teaching, but in the topic itself. It seemed from the interview that reflection played a large role in the creation of the course for her, but now it serves to help her gauge student understanding. She constantly uses social cues as feedback in the classroom to know if students are following the instruction and how well they understand the math. For instance, she talks about overplanning to have extra examples handy in case students need them. This shows reflection-on-action that these may be needed for specific topics. However, she also watches the students in front of her as she is teaching, and will stop to make sure they understand if the cues she receives from them tell her that they are losing the thread of the instruction.

Case Findings. Themes that emerged from the data regarding P4's practice are P4's joy of math and her ability to share this with students, especially those who may have had negative experiences with the subject. She describes her practice as a calling. This theme was revealed by her desire to highlight and celebrate right answers and the students who may have never gotten a right answer before.

A second theme of P4's practice is that interpersonal relationships are the most important part of her practice. She wants to get to know the students first and foremost as people, and wants them to at least not be afraid of math. She feels that she has the ability to understand where the students are having problems regarding the subject, and can help them to understand how to think critically about their own learning. She dialogs with them to help them reflect on their understanding of the math they are learning, and this conversation lets students know that she cares about them as people as well as students. The theme of student support and warm regard was felt in the classroom and was noted in the in depth interview. She related a story about a student's personal loss of her mother as being more important than class, and wanted that student to know she was seen and heard.

A third theme of P4's practice is reflection. Reflection plays a large role in her lesson preparation. She takes the big picture, the unit, and breaks it down using smaller steps and many examples to help students understand, all the while during instruction using social cues to help her gauge student understanding and stress levels, whether they are attending to the lesson, and how to get them to a place where they can appreciate their own mathematics scholarship. She describes herself as a right-brained math teacher. Although she loves math, her ability to connect with students and convince them that they are working together on the students' learning is, she believes, what makes her successful as a teacher.

Teacher 5. Outside teacher 5's (P5) classroom, there is a parade of famous mathematicians. These are posters, 16x20, and line the hallway opposite P5's classroom and all the way down the hall past three classrooms. At the head of the group is a poster, just as big, of P5. His humor is evident before one even enters the classroom. Work that students have done for calculus hangs on the wall below these pictures. One of the posters here shows how to find the

area under the surface of the ocean using calculus. Inside the classroom many different types of calculus-related t-shirts hang on the walls. P5 has also been known to have the number 5 shaved into his scalp as well as growing a Mohawk haircut with five dyed-yellow spikes coming up off his head. The focus on the number 5? It is the highest score on the Advanced Placement (AP) test, and P5 feels that this is his way of cheering on his students. He is a reader for the AP test in the summer, and has done this for the past ten years. He would probably be happy that he is participant number 5.

P5's description of practice. When P5 talks of his practice, he mentions at different times through the interview that it's important that students know what to expect. "[W]e try to mix it up a little bit but at the same time there's a lot of structure and the kids know what to expect" (Participant 5 Interview 2014, p. 63-64). "It's nice to know what to expect. I mean that's important" (Participant 5 Interview 2014, line 13). This could stem from his own practice to have a big picture of the year's curriculum and then set out the year's lessons. This is a practice in the math department at his school. In this way, if he has novel lessons or wants to try something new, he is able to make space for it.

> We've got this huge calendar like this, and then we can say ok here I want to put this, this, this, this, and see how it all flows, and then maybe there's not enough space, maybe we want to stick something in, so we can easily move the stickies (post-it notes with lesson titles on them) around to get a big picture of what we want. And then I'll make all of the six weeks calendars in the beginning of the year, and of course they can be tweaked as time goes on but I have the big picture in my mind of what I want for the whole year (Participant 5 interview 2014, lines 28-33).

This is a tremendous planning session, because he is talking about putting in all the lessons, tests, reviews, and any other activities he wants for the whole year. P5 is a reader of the calculus AP exam, which means he has a chance to see what students over the entire country are doing regarding calculus. It is a concentrated exposure to the thought processes of many high school students and how they solve calculus problems. He is able to take that experience back to his practice to improve and change it. Other teachers also share their experiences, what worked and what didn't, and this gives him material for his next year's classes.

P5's students do not just listen to calculus lectures every day. P5 tries to come up with novel ways of looking at things. For example, he calls his reviews House Parties or Beach Parties. In this instance and others, he tries to keep the atmosphere light and playful. It's not a raucous class, but students are definitely at ease with him and with each other. For example,

> I have them do dinosaur comics at some point in the year. This is a blank template that is – it's online, there's a guy who keeps up with comics … I give them a blank one and have them comment on a certain topic. Here the dinosuars are talking about logrithms. Just to make it light, or at least something separate and then again all of this and talking about Euler, and Euler's equation (Participant 5 interview 2014, lines 54-59).

He feels that students have enough stress, and this is a way for them to relax.

> [T]ry to keep the pressure or the stress low because I think everybody feels pressure or stressful when they're in front of other people and answering a question of any type—even asking a question can be stressful. So trying to keep it on a light level where they feel comfortable around their peers asking those questions or answering those questions and letting me know their understanding (Participant 5 interview 2014, lines 106-110).

Another aspect P5 describes in his practice is that he uses ideas from other teachers. He isn't averse to change if it means that students will benefit. He mentioned that the yearly calendar idea came from his math department chair. He seems to want to give credit and even says that he incorporates others' ideas on a regular basis. "I've gotten a few ideas from other people…" (Participant 5 interview 2014, line 103).

The hardest part about a lesson for P5 is to keep students motivated. From the many and varied activities he uses to teach, it is evident that this is a concern. However, in my observations the class was engaged even though the class was at the end of the day and students were wrapping up the year. "Keeping the students motivated, inside class and outside class, I try to find things that I think will be interesting for them, real world applications, but it's still hard to always make them interested in what we're doing" (Participant 5 interview 2014, lines 68-70).

P5 believes that students do not learn when you do the work for them, and sometimes it is better for students to work the problem with his prompting so that they can see where they may have made a mistake or where they need help with content directly.

> Usually I'll say ok, how did you start the problem, have them restart the problem and we'll kind of look at their work I'll say ok this looks good up to here, and at this point I may try to lead them, or I'll say exactly what the problem is, but I may say you know you might want to look at the exponent, what's going on there? What's happening from here to here? … If you just start doing the problem for them, they're not going to make that connection as easily (Participant 5 interview 2014, lines 200-203, 211-212).

Student critical thinking is important to his success as a teacher as well as their success in the subject matter area. He has to foster that, too. He creates and supports dialog with students to increase their math understanding.

Reflection plays a big part in P5's practice. He uses it during lesson delivery to gauge student understanding through questions, formative assessments, board work, and group work. When he talks about improvement of practice, he says he used a voice recorder when he first started teaching and would write down all the good ideas in the morning that he had had from the night before. "I think it's (reflection) one of the most important things we can do as teachers. Otherwise we're going to do the same thing we did the first time. And everything can use improvement. So I don't always have the time that I want to reflect on things, but I definitely try to do it regularly" (Participant 5 interview 2014, lines 215-216). Throughout the interview, it seemed that he had no ego about the practice of teaching and would do, or amend, anything to make it better. Being better at his craft seems to be the aim of reflection for him. He uses it to check for student understanding as well as polishing his practice.

Relationship with students is important to P5. He believes he has more influence and credibility if he takes part in after school activities, such as attending sporting events or fine arts recitals or exhibitions. Relationships with students help them live up to the expectation he has for them. Connections help them live up to that expectation.

> I try to go to at least have a relationship with the students, teacher-student relationship, in that I'll try to go to one of their activities, all of the sports we have, or fine arts, or whatever it happens to be, and try to make a connection with students that way (Participant 5 interview 2014, lines 76-79).

P5 has been a reader for the BC calculus AP exam for the past nine years. He has had a chance to explore how students understand calculus as well as learn what worked and what didn't from other teachers. The AP reading sessions seem to be a place where teachers can learn from one another.

Table 16 shows the repertory grid responses for P5.

Table 16

P5's repertory grid data

Elements and Constructs
Elements
5.A Reflection
5.B Classroom management
5.C Structure
5.D Planning
5.E Content
5.F Applications of the topic
5.G Connecting with students
Constructs
5.1 Lesson design—Assessment of success of lesson
5.2 Planning the lesson, part of that is application—Background component
5.3 Connect with students for cooperation—Drives understanding about practice
5.4 Reflect and refine for student interest—Classroom management
5.5 How to present the material—Relationship to students
5.6 Student-teacher partnership—Interest/future uses of content

Table 16

The element percent similarity scores for P5 are shown in Table 17.

Table 17

P5's Percent similarity scores: Elements

Element	Similar	Element	Similar	Element	Similar
5A.&5.B	41.67%	**5.B&5.C**	77.5%	5.C&5.D	62.5%
5.A&5.C	72.5%	5.B&5.D	70%	5.C&5.E	75%
5.A&5.D	85%	5.B&5.E	62.5%	5.C&5.F	54.17%
5.A&5.E	72.5%	5.B&5.F	60%	5.C&5.G	45.83%
5.A&5.F	75%	**5.B&5.G**	80%		
5.A&5.G	75%				
5.D&5.E	75%	5.E&5.F	66.657%		
5.D&5.F	54.17%	5.E&5.G	58.33%		
5.D&5.G	45.83%	5.F&5.G	37.5%		

Table 17
Note: Higher percentage denotes higher similarity.

The construct percent similarity scores found in the repertory grid for P5 are in Table 18.

Table 18

P5's Percent similarity scores: Constructs

Construct	Similar	Construct	Similar	Construct	Similar
5.1&5.2	28.57%	r5.2&5.3	57.14%	r5.3&5.4	57.14%
5.1&5.3	21.43%	5.2&5.4	50%	r5.3&5.5	42.86%
r5.1&5.4	42.86%	5.2&5.5	25%	5.3&5.6	35.71%
5.1&5.5	50%	r5.2&5.6	42.86%		
r5.1&5.6	35.71%				
r5.4&5.5	7.14%				
r5.4&5.6	35.71%				
5.5&5.6	21.43%				

Table 18

Note: Higher percentage denotes higher similarity.

The elements with high similarity scores are reflection and planning, reflection and applications of the topic, classroom management and structure, and classroom management and connecting with students. Constructs do not fit neatly into percent similarity for P5. Figure 5 shows the hierarchical clustering for P5's repertory grid responses.

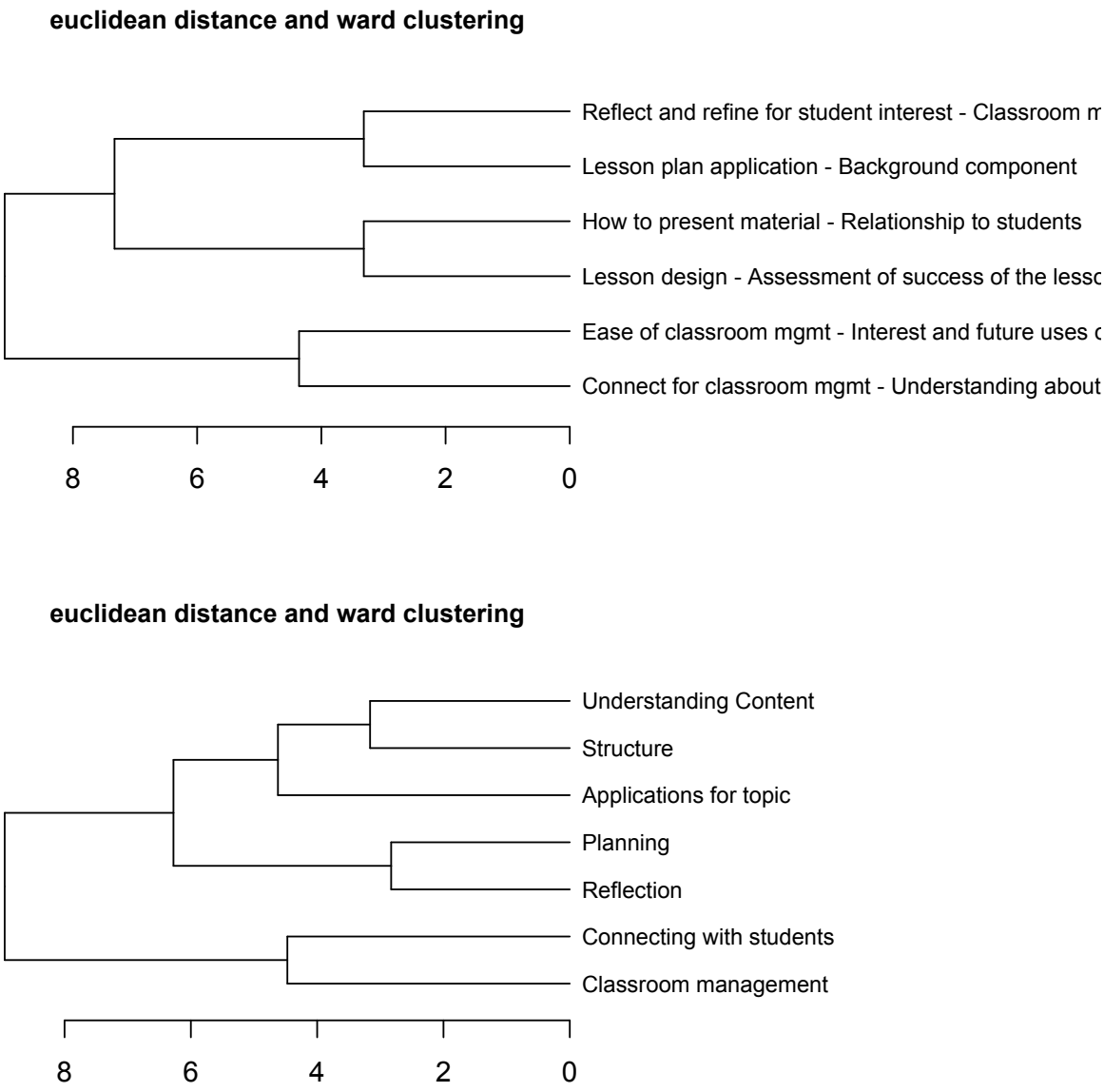


Figure 5. P5's elements and construct clusters. Shorter lines denote closer relationships.

P5's constructs align along three clusters. The first is student interest and th einprtance of planning for it. The second is lesson design and how to present material. The last deals with classroom management. P5 had difficulty understanding the directions for the repertory grid, but it is clear that he thinks of his practice in three discrete ways. I would like to have had a chance to get his reaction to the repertory grid if he could have better understood it. The literature does

say that not all participants feel comfortable with the sort of experience that repertory grid elicitation offers (Jankowitcz, 2002). His view of practice shows that it is important for him to retain control over the classroom, but also that it is important to present material in a way that will be interesting to students while finding applications for the subject matter as well.

Case findings. P5. The themes that came through the interview and repertory grid were threefold. The first theme is that the job is made easier if students are motivated and stimulated to interact with the material. He constantly strives to provide this. He uses everything from cartoons to hairstyles to get the students interested, motivated, and engaged. He mentioned classroom management in the interview, that even though his school is a good one that there are behavioral issues even there. That was a concern of P5's.

The second theme is interpersonal relationships. For P5, he feels this makes it easier for them to learn and for teachers to teach. Warm personal regard and a professional respect for one another makes students want to participate and cooperate. He goes out of his way to attend sporting events and fine arts events at the school. He has a Wall of Fame in his room which shows students who scored as high as or higher than he did on the SAT. He also posts those students who achieved a 5 on the AP exam for the subjects he teaches, all to celebrate the hard work they did and to encourage them in future. He feels that the subjects he teaches are difficult and that relationships with the students will make it easier for them to learn.

The third theme that emerged was one of keeping the work light. He knows that BC calculus is a difficult and sometimes scary topic. He wants students to relax and know that they are able to do the work. He strives to keep the tone of the classroom light so that students are able to work in a less stressful atmosphere. This theme is exhibited in the photos and memorabilia on the walls, in the hallways, and especially in the photos (and in person!) of the

wild hairdos that celebrate the hard work his students do to excel on the Advanced Placement calculus BC exam. It is also seen in the ways P5 utilizes different forms of media, such as the dinosaur cartoons, student activities, and the treatment of reviews and celebrations of success.

Teacher 6. Participant 6 (P6) has been teaching for twelve years. Previous to his teaching career, he was a chemical engineer. He moved to the US and began his teaching career. He teaches AP calculus BC as well as an AP statistics course that is held before the school day. He teaches a summer program in algebra II pre-AP for a group of students who must apply for this class. These students are members of the incoming freshman class at the high school at which he teaches. He will not see these students again until AP calculus BC unless they opt to take the AP statistics class before then.

P6's description of practice. P6 teaches at a school where, he says, teachers are happy to be working (Participant 6 interview 2014, line 33). He wanted me to know that collegiality is one of the best assets for him and his department. He began the interview by talking about planning and his belief in it. He felt that planning is essential to allow teachers to do their best work. "…what should I tell the new teachers? The first thing is how to be an extremely good planner to make your life easier, otherwise it's a stress every day" (Participant 6 interview 2014, lines 24-25). He also starts planning for his school year at the beginning of August. Although he has been teaching for twelve years, he still finds that he benefits from planning the school year. He plans in six-week increments, as does P5, and like P5 shares these lesson plans with students. This helps students manage what's going on in the class. He found planning has an added benefit. Because the school at which he teaches runs eight periods a day, his students are involved in many different subjects. With the courses planned out to six weeks in advance, the teachers were able to move exams around so students could benefit. Transparency is important to P6's practice.

Planning is a way to be more transparent, more understandable, and to communicate. This reduces stress.

> [C]an we do something to help them? Can we stagger our exams? It is not necessary that we do this without talking together. So why don't we talk? And the departmental meeting, what we decided was instead of four exams on one day, let's stagger it (Participant 6 interview 2014, lines 95-98).

Transparency and planning create a better learning environment. As he was describing his habit of planning, he cited many things that might disrupt it—field trips, other student activities—and said he learned to plan for this, too.

> I learned my lesson after teaching for one or two years, that these days I take up some number of days, one at least per cycle, then I realize one is not enough sometimes it goes to two. So I will take care of all those days out of my teaching plan, and the remaining days are to be distributed so that I finish everything on time. But it's a very tricky thing to do, and unless you are a good planner, that will not work (Participant 6 interview 2014, lines 18-23).

Planning is essential. Every year he has different students, so if there's a plan in place he can, in his words, tweak the schedule. He stressed that planning helped him be more creative, add more interest, and that it helped reduce the stress level of his students.

P6 regards his practice in terms of what will benefit students. He is willing to do whatever it takes to make sure students' academic needs are met. A teacher's ability to understand student perception is vital. He plans for teaching prerequisites, because he has found students need that. They may have never learned them or may have forgotten the math.

> Every second your plan is collapsing because you are looking at them and ok I'm supposed to be teaching this and it's new material, but there's a prerequisite thing for that, students, you know they have forgot a lot of prerequisite things, so you turn to teaching prerequisites because otherwise they will not understand the main thing (laughing). Your planning every single instant you look at the clock and you tweak around, it's a circus, to go with it (Participant 6 interview 2014, lines 46-51).

Consequently he has learned to make sure students are reminded of or taught prerequisites, and knows this is part of teaching the students well. He has had the opportunity for a number of years to read student AP exams. This has helped him understand how some students might perceive the math, sometimes in a surprising way.

> So when we grade so many examples we see what misconceptions are there in students' minds. What are they writing, what are they communicating to us for a particular concept? And it is amazing to see those things that doesn't even come to our mind that somebody will be thinking it like this. So when I see it I can have an open window to their minds, you know? Previously I did not have it! (Participant 6 interview 2014, lines 149-153).

He is always available to students, even up to the end of the school year. He noted, "Very few teachers are doing lunch tutorials now. So they are saying I need to have some breathing time" (Participant 6 Interview 2014, line 358). However, students who cannot come after school need to have their teacher available even at the end of the school year. Students need to know they can count on their teacher to help them.

> Here is a person who really cares, here is a person who will really help me… I'm going to try my best to help you out as much as possible. I don't care what questions you have.

> I will not go ahead unless I satisfy your answers, what your desires are, what you want. Unless you give that confidence in you will not have buy-in… I never say no to them (Participant 6 interview 2014, lines 355-357).

When students know the teacher will help them until they understand, they are willing to take risks. This is how students learn. P6's personal motto could be *I'm there to help you.* He offers tutoring before and after school, and the summer program he teaches is also designed to support those students who wish to continue on to the highest levels of mathematics the school offers.

When teaching, P6 never has his back to the students. He constantly uses body language and social cues to gauge how well the students understand the lesson. His delivery changes according to the needs of the class. "I try to gauge it. Is the pace at which I'm going, is it all right? Or the way I'm talking, is it all right? The complexity that I'm trying to develop, their eyes speak to me" (Participant 6 interview 2014, lines 307-309). He noted that before and after lunch, students have different needs regarding pace, activities, and motivation. As well, he watches to make sure students understand, and when he sees they are having problems he stops to process-check with them. If a student has lost the thread of the lesson, and they ask to go back he will certainly do that. However,

> [B]efore going there if I can find a simple easy thing, I'll always do a simple easy thing on the side. Let's do this first. Then we will go here. So that takes care of students getting lost because of their inadequate preparedness. Some are not really ready for (with) the prerequisite knowledge (Participant 6 interview 2014, lines 316-319).

Otherwise, he says, "they will feel lost" (Participant 6 interview 2014, line 320). P6's habit of dialog with students who have difficulties understanding problems is related to the notion that students do not always remember all the math they have learned, and may need re-teaching or

redirection. He asks them, "tell me what you understand" (Participant 6 interview 2014, lines 168-169). He believes the learning is more effective if students explain to him what they don't understand. Communication is fundamental. "Then I can help you" (Participant 6 interview 2014, line 173).

P6 makes a point to get to know his students. He wants students to like him and the class. In his experience, "if they don't like you, you have lost the whole thing. You may be a master of so many things, but if they don't like you it's a gone thing" (Participant 6 interview 2014, lines 256-257). Students can tell whether a teacher is truly available or whether it's a "ruse" (Participant 6 interview 2014, line 258). He feels this is essential to good teaching.

P6 uses his own materials. He has found, as have all the teachers, that textbooks are inadequate as teaching tools, and only uses them as a secondary source for material. His department has developed material to teach mathematics at their school, and he feels that these prepare students better for the AP exams. "…for each topic we have developed a book like this. And we follow this and the textbook is supplemental" (Participant 6 interview 2014, line 117-118).

When talking about his practice, P6 mentioned that he changes delivery not only for the students' benefit, but also because he needs to change. He talked about when he first started working as a teacher, that some people would use the "same transparencies, same assessments, nice little binders, topic on this topic, here's the transparency, let's take it out, put it there, and talk like every year that's a cookie-cutting approach. And I hated it because I don't like it" (Participant 6 interview 2014, lines 183-185). His method is to change things and keep them fresh. He observed,

> But that knack has to be there within the teacher. If you don't have it, then you're just completing your formality. You cover the material but they don't understand anything. That's not what we want to do. That's not teaching. That's a tricky part, it's hard. I understand, it's not easy (Participant 6 interview 2014, lines 334-337).

Finally, P6 believes teachers need to foster inter-professional relations. Teaching works best within a larger framework of professionals who can share materials, methods, ways of presenting, all for the benefit of their students. " 'These are my plans, can you give some more insight about what exactly we should be doing?' That's very good here. It helps to develop teaching" (Participant 6 interview 2014, lines 457-459).

Repertory grid data for P6 follows. Table 19 shows the elements and constructs for P6.

Table 19

P6's Repertory grid data

Elements and Constructs

Elements
6.A Reflection
6.B Pace
6.C Content
6.D Curiosity to know how to do it better
6.E Lesson design for prerequisites
6.F Time management for lesson design
6.G Accountability
6.H Make arrangements to take care of their needs
6.I Professional development
6.J Encouragement and motivation for students

Constructs
5.1 Lesson design—Assessment of success of lesson
5.2 Planning the lesson, part of that is application—Background component
5.3 Connect with students for cooperation—Drives understanding about practice
5.4 Reflect and refine for student interest—Classroom management
5.5 How to present the material—Relationship to students
5.6 Student-teacher partnership—Interest/future uses of content

Table 19

P6's element percent similarity scores can be found in Table 20.

Table 20

P6's Percent similarity scores: Elements

Element	Similar	Element	Similar	Element	Similar
6.A&6.B	31.25%	6.B&6.C	68.25%	6.C&6.D	50%
6.A&6.C	37.5%	6.B&6.D	31.25%	6.C&6.E	59.38%
6.A&6.D	75%	6.B&6.E	84.38%	6.C&6.F	71.88%
6.A&6.E	40.63%	6.B&6.F	71.88%	6.C&6.G	53.13%
6.A&6.F	40.63%	6.B&6.G	59.38%	6.C&6.H	50%
6.A&6.G	53.13%	6.B&6.H	50%	**6.C&6.I**	84.38%
6.A&6.H	68.75%	6.B&6.I	65.63%	6.C&6.J	34.38%
6.A&6.I	28.13%	6.B&6.J	21.88%		
6.A&6.J	71.88%				
6.D&6.E	34.38%	6.E&6.F	56.25%	6.F&6.G	56.25%
6.D&6.F	40.63%	6.E&6.G	56.25%	6.F&6.H	34.38%
6.D&6.G	59.38%	6.E&6.H	59.38%	6.F&6.I	62.5%
6.D&6.H	68.75%	6.E&6.I	56.25%	6.F&6.J	31.25%
6.D&6.I	53.13%	6.E&6.J	31.25%		
6.D&6.J	71.88%				
6.G&6.H	65.63%	6.H&6.I	46.88%		
6.G&6.I	43.75%	6.H&6.J	65.63%		
6.G&6.J	50%	6.I&6.J	43.75%		

Table 20
Note: Higher percentage denotes higher similarity.

P6's construct percent similarity can be found in Table 21.

Table 21

P6's Percent similarity scores: Constructs

Construct	Similar	Construct	Similar	Construct	Similar
6.1&6.2	15%	6.2&6.3	20%	r6.3&6.4	80%
r6.1&6.3	55%	6.2&6.4	30%	r6.3&6.5	70%
6.1&6.4	45%	6.2&6.5	40%	6.3&6.6	15%
6.1&6.5	45%	r6.2&6.6	45%	6.3&6.7	35%
r6.1&6.6	40%	r6.2&6.7	15%	r6.3&6.8	30%
6.1&6.7	18%	6.2&6.8	50%		
6.1&6.8	25%				
6.4&6.5	70%	r6.5&6.6	25%	6.6&6.7	10%
r6.4&6.6	15%	r6.5&6.7	55%	6.6&6.8	5%
r6.4&6.7	40%	6.5&6.8	40%	6.7&6.8	25%
6.4&6.8	10%				

Table 21
Note: Higher percentage denotes higher similarity.

The most highly similar elements of teaching for P6 are reflection and curiosity to know how to do it (teaching) better. Content and professional development are also highly similar. P6's constructs How to achieve your goal and Teaching proficiency are also highly similar.

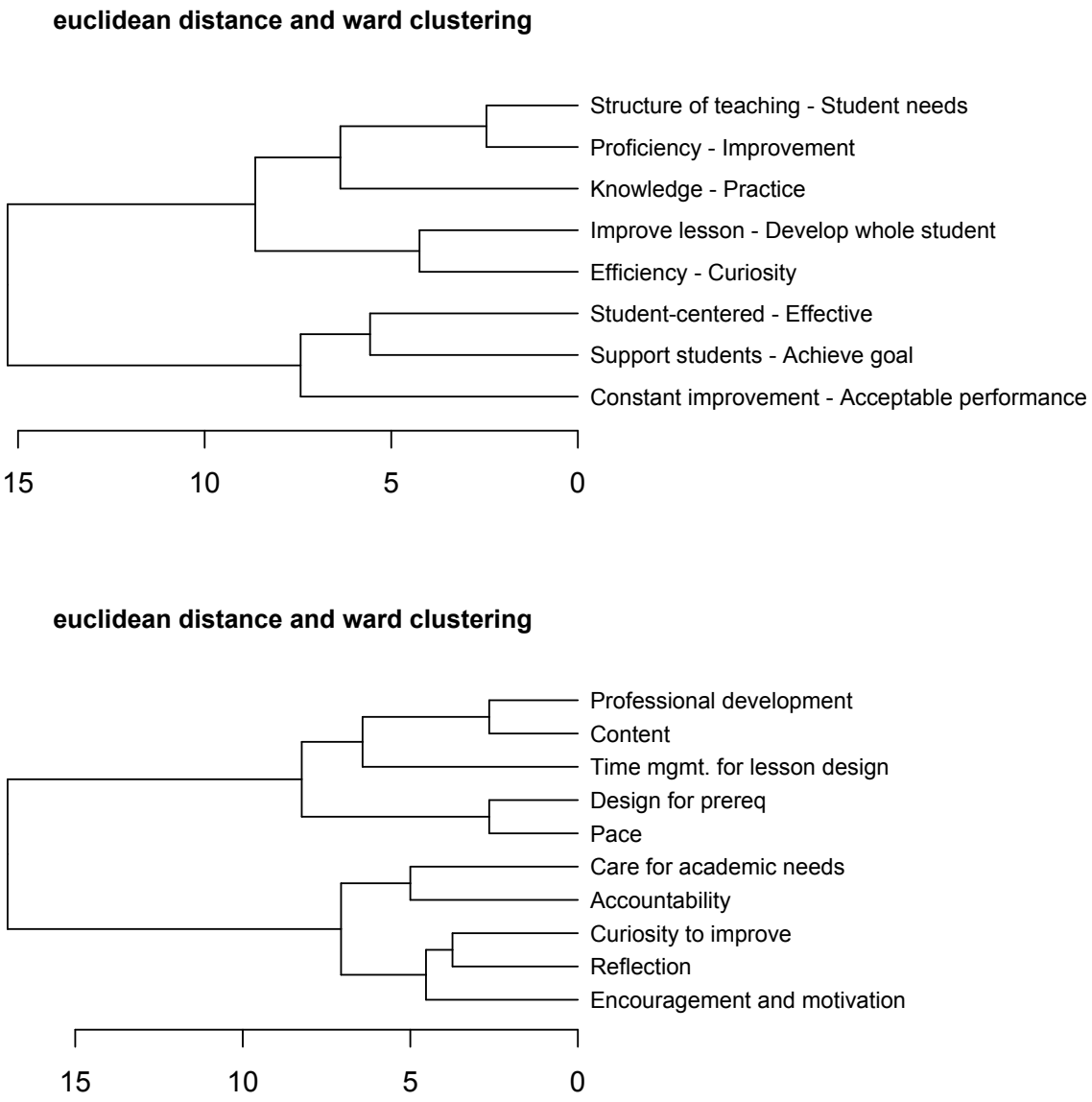


Figure 6. P6's elements and construct clusters. Shorter lines denote closer relationships.

The constructs Student-centered and Support students are clustered with constant improvement, which seems for P6 the whole point of improvement—to support student learning. This is borne out in the interview and observation. The elements Reflection and the Curiosity to improve practice are also grouped together, and this makes sense in light of P6's description of his own practice.

Case findings. An overarching theme of P6's practice is that of constant change. This may not be surprising given the fact that P6 moved to the United States and changed his entire career mid-way to begin teaching, which is decidedly different from chemical engineering. His need to change delivery of the same lesson even from class period to class period shows that he enjoys change, embraces it, and finds it exhilarating. The constructs that were elicited highlight his curiosity and willingness to change to meet the needs of the students.

A second theme of P6's practice is the support of the students in whatever way they need. He stressed many different times and ways that students, especially the weaker ones, depend on the teacher for help to understand the content, and this is an essential part of teaching. He makes himself available for them at all times. He shows that he cares about them as individuals. He watches for clues while delivering a lesson that students are with him, and if they are not, he stops and helps them to understand.

A third theme for P6 is planning. Planning makes all the rest of the instruction, learning, and success in the AP classes happen. The first evidence of this is the pre-AP algebra II class for students entering the ninth grade in order for them to be ready to undertake the BC calculus AP class and do well on the exam. Other teachers have stated that it is extremely difficult to get through all the material necessary and have sufficient time to review and prepare in time for the May examination date. This was his way of planning ahead of time to give students time to learn the prerequisites for the BC calculus test. He plans for unexpected shifts in the schedule, or any other hindrance to his students having every chance to succeed.

Cross Case Analysis

The purpose of the study was to see how teachers described their practice and also how they construed their practice. The approach used was constructionist in nature because it

attempted to get at how these teachers viewed the world from their point of view. The in depth interview to record how teachers describe their practice and the types of cues they use to gauge student understanding while teaching was of interest. The next question was if your students aren't following and you know this, how do you ameliorate instruction so that learning is achieved? What other practices do you use to support your work in this area?

The next area of interest was whether expert teacher constructs of practice were similar. "We construe things by means of constructs. To construe is to make sense of something; to have a personal understanding of it; to find meaning in it" (Jankowitcz, 2002, p. 13).

Since constructs are the way we make sense of the world, it is instructive to see whether exemplars view their practice in similar ways. The repertory grid gives two different types of information. First, it gives the participant's list of elements of a particular topic—in this case, the elements of their teaching practice. Next, it asks them to group the elements of practice in ways such that it gives the researcher a way to understand how the participant views these elements. The repertory grid is a situation where the person is asked to rate elements on a Likert-type scale (here I used 1-5) where the element in question is closer to or further away from an idea. The teachers were shown three of the elements they generated and asked which two of the three were more alike and which one was different. This provided a construct and the contrast which helps delineate the construct.

Elements of practice. The elements of practice in each participant's repertory grid were supplied by the participant, with the exception of the element reflection. Because my interest is in the role of reflection in teaching, I wanted to be sure to include it. The purpose of the repertory grid is ostensibly to elicit constructs from the participants. The grid data would still have been valid if I had chosen all of the elements (Fromm, 2004). The elements chosen by the participants

are similar in nature. Table three gives a comparison of elements for the six participants. Other than reflection, which I wanted to make sure was included in the repertory grid, the items in the list were generated by the participants. In terms of elements of teaching, the most frequently cited element is a concern for student needs and a genuine attempt to form true relationships with students. Next is creativity as an element of teaching. Two elements, rigor and accountability, were mentioned by two different teachers. Others may have felt that this was too obvious, as they all mentioned the ability to create rigorous lessons geared to tests like the AP exam. The elements are color-coded to show similarities.

Table 22

Element Comparison Chart

P1	P2	P3	P4	P5	P6
Reflection	Reflection	Reflection	Reflection	Reflection	Reflection
and feedback for following year	Organization	Knowledge	Clear understanding of content	Classroom management	Pace
Withitness	Creativity	*Flexibility	Concern for students' understanding	Structure	Content
Lesson planning searching for new materials/ideas	Rapport	Willingness to meet students where they are in terms of problem-solving	Feedback for students	Planning	Curiosity to know how to do it better
Professional development	Relationships	*Consistent	Positive relationship with students	Content	Lesson design for prerequisites
Conferences, NCTM	Safe risk-taking for students	Understanding of where the kids are coming from	Student engagement	Understanding the topic	Time management for lesson design
Efficiency/organization	Rigor	Creative	Students on task in class	Applications of the topic	Accountability
Revamped lessons	Constant feedback	Up-to-date on new technologies and strategies	Passion for your material	Connecting with students	Make arrangements to take care of their needs
Constant learning	*Being able to change directions mid-stream	Organized	Unafraid to try new things (could fail)		Professional development
Enrich/try new things for greater effect		Comfortable with presenting/being the authority	Discovery for students—their thrill		Encouragement and motivation for students
Never satisfied					
Share responsibility with students/Ownership					

Table 22

Constructs. Constructs centered themselves around three axes: Teacher traits, instructional design concerns and affective aspects of the practice. Table 22 gives a list of the constructs grouped by these axes:

Table 23

Construct groupings

Affective	
Instructional design	
Teacher traits	
1.1	Process—Feeling/innate
1.2	Task you do in order to better your practice—Key trait to being a successful teacher
1.3	Make instruction better—[Teacher initiated] climate/interaction
1.4	Teacher traits—Outcomes/task you do
1.5	Key component of instruction—Approach you take in the classroom
1.6	Traits of an educator—The outcome of the traits
1.7	Outside the classroom—During instruction
2.1	Objectives driven, lesson oriented—People oriented affective part of classroom
2.2	Content is the focus—(Emotional) Connection to students is the focus
2.3	Before instruction—During instruction
2.4	Take the temperature of the room (Checking for comfort level)—Try to push them beyond where they are comfortable, non-routine problems, out of the box thinking
2.5	Students are made to feel safe in class—Help students understand content whatever way necessary
2.6	Instructional—Relational
2.7	Accommodations when needed to support relationship—Finding a unique way to present lessons (pre-lesson)
2.8	Planning stage—People-centered
2.9	What they know/don't know informs practice—People oriented
2.10	What worked/what didn't, reflect on past—lesson in progress, reorient student thinking
2.11	Process activities pace—Environment, kids ok making mistakes

	Construct groupings
	Affective
	Instructional design
	Teacher traits
3.1	Indication of change occurring—Unchanging
3.2	Student-centered—Teacher-centered
3.3	Be a better teacher for these particular students—Better teacher in general
3.4	Seek out knowledge/understanding—Innate, allow to come out
3.5	Classroom procedures—Approach to instruction
3.6	Something for self and students—For student benefit
3.7	Student needs—classroom culture
3.8	Professional development—personal development
3.9	Student performance—Teacher performance
4.1	How I interact with students—Informs my teaching
4.2	My depth of understanding—Creating environment
4.3	Create the lesson (pre)—Adjust the lesson
4.4	Interaction and classroom environment—Adjustments in student conduct
4.5	Personal mathematics scholarship—What students need additionally
4.6	Determine if lesson was effective—What's happening in class
4.7.	The exciting stuff—classroom management
4.8	The way I prepare a lesson (pre)—Did it work? What could I have done better? (post)
4.9	Do what takes to being the content to a place that's easy to understand—Classroom environment
4.10	Classroom environment—being able to teach on the fly
4.11	Share joy with the material—Meeting student needs
4.12	Ability to set up the learning (pre)—What happens in the classroom (during)
5.1	Lesson design—Assessment of success of lesson
5.2	Planning the lesson, part of that is application—Background component
5.3	Connect with students to have classroom mgt—better chance of them doing what you want them to do—Drives understanding about practice
5.4	Reflect and refine to those students are interested in—Classroom management
5.5	How to present the material—Relationship to students
5.6	Easier to have classroom management when connected with students—Interest/future uses of content
6.1	Teaching knowledge—Intrinsic to teaching practice
6.2	Efficiency—Curiosity
6.3	Support students—How to achieve your goal
6.4	Teaching proficiency—professional improvement
6.5	The structure of teaching—Student needs
6.6	Constant improvement of practice—Standard by which you judge if you are doing your job
6.7	Student-centered—Do my job effectively
6.8	Constantly improve lesson design—Develop whole student

Table 23 Note: Constructs indexed to participant

In Table 23, teachers' constructs show that the way they view their classroom and the ability to teach well involves taking the affective domain into account. Emotional connection to students, students made to feel safe, and development of the whole student are mentioned. As well, in observation it was clear that the teachers were concerned about the students' emotional welfare. When students see the teachers' mistakes as nonthreatening to the teacher, this paves the way for student comfort. Personal engagement with students is also a very important aspect that can be seen within the constructs. This engagement was a contrast pole with lesson delivery. Construct 6.7, *Student-centered—Do my job effectively*, is one such example. Construct 5.6, *Easier to have classroom management when connected with students—Interest/future uses of content* is also an interesting continuum because it suggests the personal engagement with students is helpful in dealing with or minimizing negative behaviors. The other end of this continuum suggests the need to address student engagement with the material and motivational issues inherent in teaching high school-age children. Another aspect that many of the teachers shared was the notion that teachers can't fake caring about students. Students are able to discern who is really interested in them and in helping them, and who is not. This idea came up repeatedly within both the interview and the observations.

Teacher traits are seen as the engine for superior performance. They are not what you do as a teacher, they are the inherent characteristics of who you are as a teacher. Construct 1.2., 2.4, and 1.6, as well as 4.10 and 6.1 show that these participants believe there is a base from which to begin, and the tasks themselves do not represent teaching. They are only the outcome of the teacher traits.

In terms of instructional design, the relationship with students is intrinsic to good practice, according to this group of participants. Construct 4.12, *Ability to set up the learning (pre)—What*

happens in the classroom (during) implies that what is happening at the time of instruction, in front of the teacher, is more important to effective teaching than objectives for the lesson. Other constructs these teachers formed also show this idea. As well, reflection is implied as part of the teaching and learning process. Construct 2.10, *What worked/what didn't, reflect on past—lesson in progress, reorient student thinking* supports the notion that reflection not only works to hone practice for next time, but it also has a great role to play during delivery of the lesson.

Connors (1978) found that teachers in his study constantly monitored classroom interactions and interpreted classroom behavior to gauge the level of student participation, understanding, and the influence of teachers' own actions on the student learning process. The objectives and lesson content were rarely thought of. It seems that this research supports Connors' original 1978 finding. Constant interaction and checking for understanding are seen in both groups.

The three types of constructs—teacher traits, affective aspects, and instructional design, might seem to make common sense to educators, but other aspects of educational practice such as daily lesson plans, objectives, curriculum and pacing guides were never alluded to their efficacy in aiding their practice. In fact, they were viewed as deterrents to creativity (Participant 1 interview 2014, line 366). This study showed that expert teachers constantly interacted with their students to improve the students' chances of success on tests that can be argued are difficult to prepare for and need specialized skills to pass, as well as the mathematical knowledge which is being tested.

Themes. The first theme that emerged from the data was that all six participants talked about the practice of watching students to see that they understood the lesson. Whether this was through formative assessments right in the room—having everyone try a problem, for example—

or whether this was ascertained by asking questions regarding the content of the day's lesson, these teachers constantly monitored for this understanding. However, this monitoring was done against the backdrop of classroom management, lesson delivery, the physical barriers of the desks in the classroom, and disruptions in the flow of the lesson that tends to be seen in high school classrooms. This skill tends to show the capacity of not only classroom management, but also a level of interpersonal skill that makes experts able to stay on task (Elliot, J., Stemler, S., Sternberg, R., Grigorenko, E., and Hoffman, N., 2011). One of the participants mentioned as an element of teaching that the ability to feel comfortable as the authority in the room is an essential element of teaching. Another mentioned that his back was never to the students and that he watched for social cues to see that the students were following the instruction. If they were not doing so in his estimation or if questions were being raised during instruction, he would utilize some explanatory example to help them along. The key, though, was that all teachers used social cues and formative assessments both for student understanding and to gauge the level of engagement with the instruction. A finer slice of this interaction with students is interpersonal relationships, whether cultivated solely so that students might feel comfortable in the difficult classroom, for better classroom management, or so that shy students would feel comfortable asking for help. This notion of interpersonal engagement was an important theme within the descriptions of practice. These relationships gave the teachers valuable information about student understanding and fears as well as an avenue to teach or train or lead students into conversations about math in order for them to articulate their areas of difficulty.

Interpersonal relationships allow for another theme, that both teacher and student are together responsible for student learning, to come out. Comments like "We're all in this together" (Participant 2 Interview 2014, line 281) and "What I'm getting back from them" (Participant 4

Interview 2014, line 114) made it seem as though social cues are an important part of these teachers' success. They constantly use social cues to check for student understanding. The two cannot be separated. Teachers used social cues, but they also cultivated interpersonal warmth and genuine concern for students as well as regard for individual differences and skills. Interpersonal skills were seen as the matrix with which teaching could occur. In a recent study of effective teaching practice, it was "found that top-quartile teachers had fewer classroom disruptions, better classroom management skills, and better relationships with their students than did bottom quartile teachers" (Stronge, J., Ward, T., & Grant, L., 2011, p. 350). Another finding in the study was that teachers felt that fairness and respect were important parts of dealing with high school students. These experts wanted to celebrate the students' successes. From P5's Wall of Fame to P4's Yaying people, and P1's habit of handing out achievement awards as well as other examples of regard for student achievement, it is clear that these teachers hold their students in high regard. All teachers talked about their students with respect and allowances for lack in prior learning. What was interesting in P6's declaration that each student would get the same chance with him also resonated with P1's concern that when students needed a retest to boost points and reinforce understanding which would be available to any student who might need it. "Classroom management is based on respect, fairness, and trust, wherein a positive climate is cultivated and maintained" (Stronge, J., Ward, T., & Grant, L., 2011, p. 341).

A third theme that emerged from the research is reflection. When I asked one teacher what she did when she saw the looks of bafflement on some students faces, she said, "you stop!... I think if you're more experienced, you know how to recognize better when you've gotten to that point that you stop earlier, you know?" (Participant 2 Interview, line 274). This is an example of reflection in action. What teachers do next—reteach, ask questions *I lost you somewhere. Where*

did I lose you? (Participant 4 Interview 2014, lines 182-183) all help students to better understand the content. The most important response is to dialog with the student about what they do not understand. One teacher explained her rationale for asking the students where they were stuck:

> I need some specifics. I always tell the story about when you go to the doctor, when they ask what's wrong you don't just say "I don't feel good," you're specific with the doctor—you say my head hurts, my arm hurts, I've been having headaches—you're specific with the doctor but yet you come to me and expect me to read minds and know exactly what you don't get. And that's one of the things about math communication and verbalizing what you don't understand. I can look on the paper, with you doing a problem and know what you don't get from you working it out—but if I come over there and it's blank? I can't even help you! I can't even give you work. Like—I have their tests. I do standards based grading. I have a section here for teacher feedback because I can tell you, based off the paper, what you need to work on. But if it's blank, I can't help you! I don't even know what you're confused about! I'm like what was I supposed to do with that, you know?! (Participant 3 interview 2014, lines 163-173).

Math conversations are ways for students to get help, to understand the content, to remember forgotten math, and to understand the current problems. The theme of reflective practice is fundamental to student success. Reflection is visible in the conversations about what students don't understand. When students say they are confused about some aspect of a problem, these teachers might use a variety of techniques to help students in understanding—they might use an explanation that worked for another student previously, they might ask questions that help the student see where they made an arithmetic error, or they might outright tell the student. All these

different techniques are based on the reflection in action that these teachers employ. They may be able to get to the right response faster, but even novice teachers can utilize these techniques.

In terms of improving practice, one teacher said reflection is the way you improve your practice, and couldn't seem to stress this enough. "Reflection I think is huge. Huge huge huge. Being a teacher or anything that's how you get better at anything" (Participant 5 interview 2014, lines 229-230). Another teacher said that reflection did not have to be a conscious *now I'm going to reflect on my work today*.

> It doesn't have to be formal. A lot of teachers say they do the most lesson planning when they're driving to and from school. I sit and watch tv and think *maybe if I try this*—last night I was on Pinterest looking for activities for quadratic functions for geometry. It's not formal and it's not time. That's why I'm very anti lesson plans. I think they waste your time and stifles creativity. It's taking away the idea that teaching is an art. You're working with humans (Participant 1 interview 2014, lines 363-367).

Reflection is an integral part of these teachers' practice. Every single one of them alluded to this. Reflection as an answer to how I can do this better next time, what did I leave out, are they understanding what I'm saying, what does this particular group need came out as a recurring theme of teacher practice.

Description of the theoretical model

The theory that arises from this study is how these teachers have arrived at their exemplary achievement. The work flows together using the following components of teaching. All these tributaries form the main body of the practice.

- The student ability factor—diagnosed early in the course
- The belief that students *can* do the work

- Making students comfortable so they can/will try
- Knowing what students needs are, their worldview and the ability to understand their actions, not taking offense at it or judging them
- The ability to constantly gauge how the students are doing with the content
- Tutoring and group work as essential components of practice
- Constant attention to what's going on in the classroom
- Getting along with administration, perceiving that they are treated as professionals
- Continuing passion for the work, not bored
- No ego about what they do

Conclusion

An allusion to circus acts was used three separate times with three different participants. The first said, in reference to knowing who needed help and how to remember to get to them, "I think it's more like a juggling act" (Participant 1 interview 2014, line 105). A second was talking about how to challenge while remaining cognizant of previous math failure: "You want them to feel successful, but you also want to challenge them, so it's a real tight rope to walk. So I usually err on the side of making them not scared" (Participant 4 interview 2014, lines 95-96). Finally, a third comment: "Your planning every single instant you look at the clock and you tweak around, it's a circus, to go with it" (Participant 6 interview 2014, lines 49-51). All analogies represent a situation with many different things happening all at the same time, and the teacher is in the center ring so to speak, constantly on the move, and on the lookout for more and better ways to reach students no matter their level.

Chapter 5

Discussion

Introduction. The purpose of this study was to find ways to enter the world of an expert teacher through their understanding of how they go about their practice. This inquiry is driven in part by the social view of teaching in current society in the United States—namely, that anyone can do it, it is not a difficult career, and after all, they get summers off, don't they? Common Core, a set of curriculum guidelines for English and math that some states have adopted and others have not, have also increased anxiety about what is expected from teachers and students. Common Core standards can be found at http://www.corestandards.org/read-the-standards/. No Child Left Behind, a Federal program that has caused a number of changes to the way education is practiced in the United States has also given teachers even more parameters and metrics by which to judge their efficacy. However, even with all the guidelines, parameters, and benchmarks which can make teaching a fractious and fraught profession, teachers in this study were more than able to overcome and attain a level of teaching effectiveness that is borne out by their students' ability to achieve the highest grades on extremely difficult nationally administered tests year after year. The other reason for the study of these teachers is that the interplay between teachers and students can be hard to quantify, and perhaps difficult for novice teachers to see. It is my hope that this study will shed light on the work of expert teachers. The AP scores of these teachers' students show significant success over the year I observed. A look shows that scores were overwhelmingly in the four and five range. I asked participants to share results and they sent me student scores they received from the Advanced Placement testing service, College Board.

Rationale and Significance of the Study. Education in the United States has been impacted in recent decades by the No Child Left Behind Act (NCLB), "[a]n act to close the achievement gap with accountability, flexibility, and choice, so that no child is left behind" (http://www.gpo.gov/fdsys/pkg/PLAW-107publ110/content-detail.html). Its adoption has challenged schools to show that students are learning adequately. Standards-based testing has been implemented on a wide scale, and school accountability is based upon the achievement scores of their students. This change in accountability and accreditation has made it increasingly important that teachers become successful at teaching the standards so that their schools make Annual Yearly Progress (AYP). When the school cannot show AYP, the Federal Department of Education provides guidelines to manage changes. This research involved an exploration of those successful expert teachers' beliefs and behaviors in the classroom in order to help understand the relationship between expert teaching and successful learning.

Since the introduction of the No Child Left Behind Act in 2002, evaluations of teacher work have been an integral part of the overall view of school performance regarding student academic achievement and success. Different factors have been used to measure teacher efficacy and expertise in the field, including student test scores, graduation rates, and matriculation to the university environment (Darling-Hammond, Amrein-Beardsley, Haertel, & Rothstein, 2012). One aspect of teacher evaluation includes the notion of teacher quality, although this subjective metric has not been defined. The introduction of NCLB mandates that teachers be evaluated on their work performance. However, the metrics being used have not been outlined and therefore are not standardized across all teachers in the United States. As well, the metrics may not give either an accurate gauge of teacher performance or the influence of teaching on student learning. The use of standardized student test scores has been suggested for use as a measure of teacher

performance. This practice has been shown to be problematic (Feiman-Nemser, 2003). Student test scores are not reliable for teacher evaluations for many reasons, among them the fluid nature of classroom make-up and attendance (Kane, Staiger, & Geppert, 2002). A better understanding of how expert teachers are able to succeed with all types of students may inform more accurate evaluation methods.

Overview of significant findings

Group work and tutoring. One of the most interesting and significant findings was that teachers all relied heavily on tutoring and group work to reach students. When teachers have more than thirty-five students in a room, just the physical act of getting to every desk presents problems. Group work made it easier for the teacher to identify who truly needed their help. Groups also allowed students to network and remind one another of math that they had forgotten. This was not group work in the sense that the students in the group were working on a group project for a group grade. For instance, one of the teachers asked that students Tweet a picture of their study group so that she could see that they were preparing for the upcoming AP exam. The students in the photo all got credit for working. It encouraged them to work together, which this teacher found was helpful to their understanding of the content. Groups are mutually beneficial to both students and teacher. Group work in the way these teachers use it is one of the activities in active learning. It has been found that active learning increases student learning and success. "Active learning engages students in the process of learning through activities and/or discussion in class, as opposed to passively listening to an expert. It emphasizes higher-order thinking and often involves group work" (Freeman et al., 2014 p. 8413).

Teachers used tutoring extensively. Tutoring is mandated by law in the state in which the study took place. Teachers must make themselves available for at least two thrity-minute

sessions a week. Teachers in this study voluntarily made themselves available for well over the required time. They were available for students to get help before and after school as well as during lunch, teachers' planning periods, and well into the evening in some cases, using social media and other electronic technology. In fact, in the flipped classroom the time spent in class was ostensibly tutoring for the entire period. There are a plethora of studies researching the efficacy of tutoring for disadvantaged students. However, this study recorded tutoring both peer-to-peer and teacher-student. It seems to be a very useful tool for a number of reasons. First of all, as P1 noted, "I tell them all the time if you can explain to someone you really understand what you're doing" (Participant 1 interview, 2014 line 109). It is helpful for both the tutor and the peer. Secondly, the teacher is able to work with those students who cannot be reached in this way. They may be in the higher level mathematics class and there just aren't any other tutors, or they may only be available at certain times. The teachers all made themselves extremely available to help students. This notion of tutoring brings to mind Vygotsky's Zone of Proximal Development. In his theory, learning proceeds in advance of and solidifies development (Vygotsky, 1978). The scaffolding that is in place for the learner during tutoring allows students to learn and understand in order to internalize concepts and understanding. There is a sense that both tutor and peer learner benefit from this arrangement. It also frees the subject matter expert, in this case the teacher, to tackle problems only she has the understanding and tools to solve.

Routine and structure. The participants in this study all utilized routine and structure in their classrooms, both as a framework for student activities and as a way for students to predict and anticipate their learning. The use of planning and sharing those plans with students, it was believed by the participants, helped relieve stress levels and allowed them to be able to plan their day. In fact, one participant related that he learned to plan for the unexpected by building a few

unscheduled days into the six week cycle. Berliner (1992) found that expert teachers rely on routine and automatization to reduce the amount of hands-on management they need to do. For one of the teachers, the ability of her students to gather materials and be seated before the bell rang each day allowed her to be in the hallway to greet students and note who was absent that day for further follow-up. Another teacher used homework to check attendance, so the routine of turning in homework was used for dual purpose and had added benefit to students because they could show they had attended class. Other teachers passed out the schedule for the proceeding six weeks so that students would have an idea what would be expected of them. Routinization might seem as though students might become bored or disengage. However, as P3 stated, "the kids need boundaries and if you don't provide the boundaries they'll keep pushing you and pushing you to define the boundaries for the class" (Participant 3 interview 2014, lines 109-110). What might be counterintuitive is that routinization of tasks actually make for a more creative atmosphere and work life (Ohly, Sonnentag, & Pluntke, 2006).

Reflection. Reflection has been broken down into three facets: reflection-before action, reflection-in-action, and reflection-on-action. These experts employed all three types of reflection in their practice. They talked about getting ready for the year, and planning. This included the types of questions to ask students while delivering the lesson, the types of activities with which they wanted the students to engage, and what prerequisites the students would need and how best to teach that. During instruction, teachers used reflection-in-action to assess immediately the scope of student understanding, whether the lesson was paced right, and whether students understood not only the concepts but also the vocabulary. In addition they used reflection-in-action to explain concepts to students during tutoring, using experience and dialog to arrive at a new understanding for students. Finally, they used reflection-on-action both at the

end of a unit and on a daily basis to gauge the success of the day's lessons. One teacher even used a voice recorder to help him remember ideas and thoughts both for the next day and for the next time he taught the lesson. Others looked back on the day or at test results and realized that they hadn't done as good a job on their lesson delivery as they could have. They used this post-mortem to remind themselves to make sure it was covered better in the review, or even to reteach it the next day if there was time or necessity. In the repertory grid elicitations, reflection was listed first as I wanted to both reassure the participant that there was no right answer and to take pressure off them to start any type of list in front of another. I also had an ulterior motive: I wanted these experts to talk about how reflection is used in their practice. It seemed from the interviews and the repertory grid that reflection was used to improve practice and for ways to better communicate with students. One teacher even changed my suggestion of reflection as feedback for students. I allowed this because it seemed that this was an important element of teaching. However, as I was reading through the interviews and field notes, the notion of intuition came to mind. In their work, these participants were not always able to articulate how they arrived at a technique or activity, or how they knew to explain a problem in a particular way. In studies of experts,

> "The experts are not consciously choosing what to attend to and what to do. They are acting effortlessly, fluidly, and in a sense, this is arational because it is not easily described as deductive or analytic behavior. Though beyond the usual meaning of rational, because neither calculation nor deliberative thought are involved, the behavior of the expert is certainly not irrational" (Berliner, 2004, p. 207-208).

Collegiality. Teachers found it beneficial to utilize others' expertise to help them in their practice. This is a characteristic of effective teaching (Shah, 2012, Brophy & Hadar, 2010). One

teacher related that she talked with her principal about what type of persona she should take with a particular group of gifted and talented boys who could have made it difficult for her to reach out to the rest of the class. This was exciting news. It shows that teachers were interested in doing what was best for the students, whatever that was. These teachers as a group were never afraid of asking for help. In addition, they were always looking for new and better ways to teach their subjects, and were constantly researching to see where they might find new lessons and activities. It seemed that their ability to reach out to other colleagues and blend others' practice as well as adapt new information effortlessly made them seem as though they had no ego issues about being right or having any sort of bias against asking for a second opinion. Two of the teachers were readers for the AP calculus BC exam. This means that they have the opportunity to compile many years' experience teaching in only a few years. The AP exams are not all problem sets. There were free response questions which the student had to learn how to answer, a skill these teachers had to make sure they knew. Not only that, though. The teachers who read these exams have a chance to see how students reason about the math. One teacher estimated he had seen 850,000 problems in his time as a reader. This is a tremendous amount of exposure for him, and he was more than willing to share with other teachers. The idea that exams can be staggered and that student needs can be taken care of is a case in point. This teacher was instrumental in helping that to occur in his school, and the consent across disciplines to do this for students is remarkable given the sometimes segmented relationships that teachers can have with one another.

Interpersonal relations. Teachers fostered personal relationships with students in a number of ways, from publicly celebrating math successes to attending sporting events and fine arts concerts. They greeted students at the door every hour. It was as though someone had called them into the hall when the bell rang. One teacher even made a comment regarding it being her

job to know whether each individual was in her class that day or not. This concern and care for students is fundamental to these teachers' practice. As well, as has been noted, teaching is a dynamic profession—there is a constant flow between content and context, and between learner characteristics and pedagogy (Dal Schalock, Schalock, Cowart, & Myton, 1993). It seems that this concern and genuine care for students is one of the factors for success (Cornelius-White, 2007, Klem & Connell, 2004, Muller, 2001).

Implications for Instructional Design

K-12 classroom teachers are instructional designers for a very specific audience and for a specific clientele. They need support from their community, their administration, and from each other. This is not so very different from instructional designers in general, especially those who serve a specialized population. The identity of expert instructional designers, much as these teachers, is hard to tease apart from how they approach problems, how they view the issues involved, and how because of their expertise in this area, they may not be able to articulate just how they are able to do the work they do (Tracey & Hutchinson, 2013, Cross, 2001). The participants in this study used reflection in ways that were very different from one another. One teacher discussed the use of reflection-before-action while driving to work, and she believed that many teachers reflect and lesson-plan during this time in the day. Others used a voice recorder to make audio notes regarding ideas to try for the next lesson or the next time the lesson would be taught. Another teacher thought about the work after the fact—and talked about how one class went well and another did not seem to go as well. Reflection helped identify the factors that shaped these outcomes, and it seemed that all teachers used reflection to make sure that the job was done the way they felt it should be accomplished. All seemed to use reflection in ways that mirrored their personality—or maybe their personality was wound around the identity of what it

means to be a teacher to each individual. "…[R]eflection becomes a crucial tool for the formation of professional identity" (Tracey, Hutchinson, & Gzyrbk, 2014, p. 317).

Instructional design practitioners would do well to utilize the notion of routines and structure both within their designing and also the delivery of instruction. This aspect of these teachers' practice came up repeatedly. As well, one teacher felt that it helped everyone to know what to expect. While I wondered if he was specifically referring to our interview, I could see that he prepared his students well for the structured use of their time in his classroom.

One of the greatest and most used theories in use at the schools at which I observed was Activity Theory. The Zone of Proximal Development as outlined by Vygotsky (1978) was used in group work, peer tutoring and teacher-student tutoring, and also in the ways teachers encouraged the students who needed help to talk through the problem or where they needed the help. It allowed the students to strengthen connections between what they already knew and the new knowledge. As well, active learning through the use of groups, discussion, and discourse, has been seen to help students in science, technology, engineering and mathematics learn more efficiently. "Active learning engages students in the process of learning through activities and/or discussion in class, as opposed to passively listening to an expert. It emphasizes higher-order thinking and often involves group work. (Freeman et al., 2014, 8413-14). Freeman et al.'s (2014) research also posits that 3.5 million dollars would have been saved in tuition if more students had been exposed to active learning.

Assumptions

The observations and interactions with expert teachers revealed the essence of expert teaching for student success. The ways expert teachers approach lesson planning, the creation of the culture of each class, ability to meet student needs, and make decisions as situations arise that promote student learning consistently and allow them a measure of success such that they want to continue in the profession will be of use and interest to the educational community as a whole, and to those who educate future teachers in particular. It is also hoped that these types of investigations helped expose teacher beliefs about themselves in the profession.

Limitations to the study

In this qualitative study of expert teaching behavior, the constraint of the number of participants and the limited time available to speak with them, although adequate for this study, opened avenues for more questions. Only six teachers were studied, and one repertory grid and one in depth interview were taken from each. The study relied heavily on participants' ability to clearly articulate their experience and the identification of and care taken to sidestep blind spots I have in terms of the practice of teaching and of these participants in particular. I believe that having other researchers involved in thoughtful and thorough analysis of data helped to bring to light the conclusions reached in this study. Since teachers sometimes do not realize the depth of their implicit knowledge, checking with participants themselves is not as useful as it seems. One of the participants, P2, described getting ready to teach a new course that she had not taught before. She said,

> At the very beginning, when I'm starting a new course from scratch, there's a better framework that I go through, to be able to organize myself. And I think that would be very similar to how a new teacher would work through that, but after you've done it

> awhile you know how to break things down better and you know where the kids' strengths and weaknesses are going to be, and experience—you can do things on the fly a little bit more, too. (Participant 2 interview 2014, line 26).

I am not sure it is at all the way a new teacher would set up a course. Novices use means-ends analysis much more than experts do (Larkin, McDermott, Simon, & Simon, 1980, a, b, Sweller, Mawer, & Ward, 1983) it could be argued that preparing for a new subject is like being a novice in some ways. However, expert teachers have a way of seeing the work that is shaped by the experience they already have. Expert teachers may not be able to adequately articulate their practice because it has become part of their identity.

Recommendations for further research

Further research in the area of teacher expertise is of interest. By interviewing these teachers and their students to see whether their behavior has changed and how it has developed, conclusions may be drawn as to a template for future teachers to emulate. I would also like to ask the teachers in this study to do the repertory grid again, just to see if things change based upon time of year, types of classes, and other variable factors. Further research may also involve spending more significant amounts of time with these teachers to record how they developed their lessons: what factors influence their instructional design? Video taping of a lesson and listening to teachers narrate it may help researchers understand how expert thinking differs from that of novices in the k-12 arena.

A final note

During the study, two novice teachers in this school district handed in their resignations. Both were first-year teachers. Their performance was acceptable, yet they both decided that the profession was not for them. The attrition rate for new teachers is still at 50% within the first five

years of a teacher's career (Ingersoll, Merrill, & Stuckey, 2014). Teacher attrition is thought to cost the country $2.2 billion annually because of cost to train and support teachers (Alliance for Excellent Education, 2014). There may be attributes of teaching that these teachers do not practice and that may be of facility to them. Connors' (1978) participants were elementary school teachers. My participants work at the high school level in 2014. It seems that the level of the student does not matter in light of the fact that both his and my participants do not often or frequently think about objectives or the content of the lessons. Rather, they are very aware of their behavior and its influence upon what goes on in the classroom. This research may help identify habits of mind or process that can be passed on to new teachers so that their desire to teach can be helped to become a reality. As well, it has been shown that quality teaching increases student achievement on standardized tests, so the teacher does matter in the teacher-student equation (Sanders & Horne, 1998).

APPENDIX A

TEACHER ORIENTATION SCRIPT

This script is offered in order to maintain uniform instructions for teachers in the observations, in depth interview, and repertory grid interviews that will follow.

Thank you for offering to participate in this research. I would like to document your work in the classroom in order to help new and/or struggling teachers learn how to use successful strategies in the classroom. The observations will be in two parts. First, I'll observe in class as you teach. Next, I will observe and take lots of notes on the lesson of your choosing. I will also interview you to get a little more information about how you view teaching. Let's talk about the timeline so that you will have some idea of the time I will be asking of you!

I would like to observe in your classroom for about a week. This is so that the students and you will become accustomed to my presence. Next, and within a few days of personal observation, I would like to pay special attention to a lesson as you teach it. The lesson will be of your choice, and I will have some questions to ask you about it to orient myself to the lesson. These can be answered the previous few days before I observe it. You will need to be available after work that same day to go over my notes with me. We will need about an hour and a half to talk about this lesson. We will be talking about what happened in class and discuss aspects we feel will help us understand the technique and intentions behind your actions.

The third part of this research involves getting at your thinking about teaching. This will involve a rather structured interview with me to help us understand what you think is important in teaching, what you try to remember when teaching the students, and other aspects of your overall worldview regarding your place in the profession. This interview will last no longer than

an hour and a half, and can be done at your convenience within two to three weeks of our first observations and interviews.

If you have any questions, I would be happy to answer them now, or you may contact me via email or phone. Again, I sincerely appreciate your time and all that you do for the students!

APPENDIX B

CLASSROOM OBSERVATION CHECKLIST

Teacher name: Date:

Course/School:

***Bold** indicates research-based effective teacher characteristics.

Organization	Observed (y/n)	Comments
~Arrives early to class (may chat with learners before class): **~Begins class on time in an organized manner:** ~Arranges materials/information before class: ~Share session agenda/outline with class: ~Clearly states session objective and significance of objective activities (& periodically overall course objective) with class: ~Reviews prior class material to prepare class for new ~Clearly demonstrates transition from one topic/activity to the next ~Periodically summarizes material addressed during class session ~Adapts smoothly to back-up plan when necessary (use of board if overhead malfunctions, addresses misunderstandings, provides additional activities if needed) ~Ends class on time ~Reminds students of assignments, tests, quizzes, etc. ~Summarizes main point at end of class ~Appears well-prepared for class		

~Organizes lecture/strategies so students can easily take notes Frequently checks student understanding		
Clarity	Observed	Comments
~Provides examples of each concept ~Uses concrete examples to explain ~Concretely defines/explains difficult or unfamiliar terms (or directions or procedures, e. g.) ~Clearly explains relationships among topics/facts/theories, etc. ~Repeats challenging/unfamiliar information ~Remains focused when answering questions ~Clear and legible writing on board or overhead ~Relates usefulness of content to real world ~Repeats questions from student(s) so all hear ~Describes terms/concepts/theories in more than one way ~Uses emphasis for important points ~Visuals support instruction ~Answers questions completely ~Shares tips to learning difficult information ~Shares key terms visually **~Explains in easy-to-understand terms/language** ~Provides sample test questions ~Shares tips with students regarding taking exams, mastery, etc. ~Clearly explains what is expected on tests and assignments		

Enthusiasm	Observed	Comments
~Speaks in an expressive manner ~Smiles while teaching ~Shows respectful facial expressions **~Shows appropriate sense of humor** ~Moves around room while speaking **~Gestures with arms, hands, head, or body** ~Appears relaxed with class ~Does not coniually read from notes ~Distracting habits at minimum or absent		
Content	**Observed**	**Comments**
~Uses several visuals during class ~Uses appropriate examples ~Shares/encourages diverse points of view ~Shares thought-provoking information ~Shares up-to-date information in the field ~Relates assignments to course or session objective ~Distinguishes between fact and opinion		

Interaction	Observed	Comments
~**Praises student answers/uses probing questions to build on answers** ~Uses a variety of strategies in class ~Encourages student participation ~Asks questions to entire class ~Answers questions clearly and directly ~Refrains from answering own questions ~Encourages students to answer each other's questions ~Encourages student to answer difficult question by providing cues ~Constructively admits error or insufficient knowledge (i.e. suggests strategies for finding correct information) ~Integrates students' ideas into class ~Guides student whens/he errs ~Provides ample demonstrations ~**Provides frequent feedback (Corrective when needed)** ~Shows respect/sensitivity to diverse learners ~Promotes active learning/student participation ~Encourages/facilitates relevant student-led discussion ~Asks questions of various levels (i.e. Bloom's Taxonomy)		

Pacing	Observed	Comments
~Students are not rushed ~**Ask/check for understanding before moving to next topic** ~ **Covers an appropriate (not too little or too much) amount of material during class** ~**Does not engage unrelated issues/content during class** ~Students have enough time to finish tasks		
Speaking	**Observed**	**Comments**
~Speaks in appropriate tone/volume ~Speaks clearly (does not stutter, slur, mumble words, or say "uh/um") ~Speaks at an appropriate pace ~Speaks with expressive manner ~Uses appropriate (non-distracting) gestures ~**Maintains eye contact with students (i.e., does not talk toward windows/walls)** ~Speaks in respectful, easy-to-understand language ~Speaks slowly and clearly when covering difficult terms/ideas/content		

Rapport	Observed	Comments
~Encourages student feedback ~Encourages student thought and participation ~ Responds constructively to student opinions/contributions ~Encourages (and may present) diverse points of view **~Warm classroom climate (students speak freely, relates to students as people, appropriate humor)** ~Responds to student misunderstanding or confusion respectfully ~Treats students/class equitably ~Listens effectively/closely to student comments/concerns/questions ~Encourages mutual respect, honesty, and integrity among class members ~Responds to distractions effectively ~Encourages constructive criticism ~Admits errors with honesty/integrity ~Provides constructive feedback ~Responds to students by name ~Informally talks to students before and/or after class ~Accessible to students outside of class		

Appendix B adapted from University of Minnesota Center for Teaching and Learning, *Peer review instrument*. Retrieved from http://www1.umn.edu/ohr/teachlearn/resources/peer/instruments/, Copyright 2013 by the University of Minnesota.

APPENDIX C

INFORMATION TO BE SHARED WITH PARTICIPANTS BEFORE THE IN DEPTH INTERVIEW

Introduction

The use of the in depth interview has been found to be of significant value in understanding how people see their world, from their point of view. Think aloud protocols, where the individual says what he or she is thinking while doing a task has been employed with some success for situations where people are interacting with web sites and objects. However, when working with people, the think aloud protocol does not fit very well as a way to find out how people think about their work. In depth interviews have been chosen in this research because it seems the best way to find out what teachers are thinking while they are teaching.

Objectives

The main objective of this research is to find out what you were thinking while you are teaching—the in-the-moment decisions you made, classroom activities you noticed that may (or may not) have changed your original line of thinking, and other aspects of the instructional session. We know that

- Teachers are aware of more of the students' behaviors and thoughts than they may overtly indicate
- This awareness helps guide student learning
- Teachers make emotional and/or intellectual decisions in the moment that cannot be overtly gauged

- Teachers make decisions about what they need to say to students or what not to say based upon their inner pedagogical hierarchy, and that these decisions are not readily available to the outside observer
- Teachers use instructional strategies, principles of instruction, and rationale of which others are not aware.

Instructions for In Depth Interview

I will be asking you some questions regarding what you were thinking and feeling during specific times in the lesson. Please feel free to talk about your thoughts and feelings during the lesson. As well, you may talk about the conscious choices you made to say or do (or not say or do) while teaching. The interviewer will also ask questions in order to more fully understand your thought processes during instruction. Remember, the interviewer wants to help you remember what your thoughts, feelings, attitudes and motivations were during lesson delivery. It will be tempting to analyze your performance. This is **not** what is important here. We want to capture thoughts and feelings during the lesson to understand better how you processed information you got from the students that guided your instruction, as well as your pedagogical aims and beliefs about what these students can achieve.

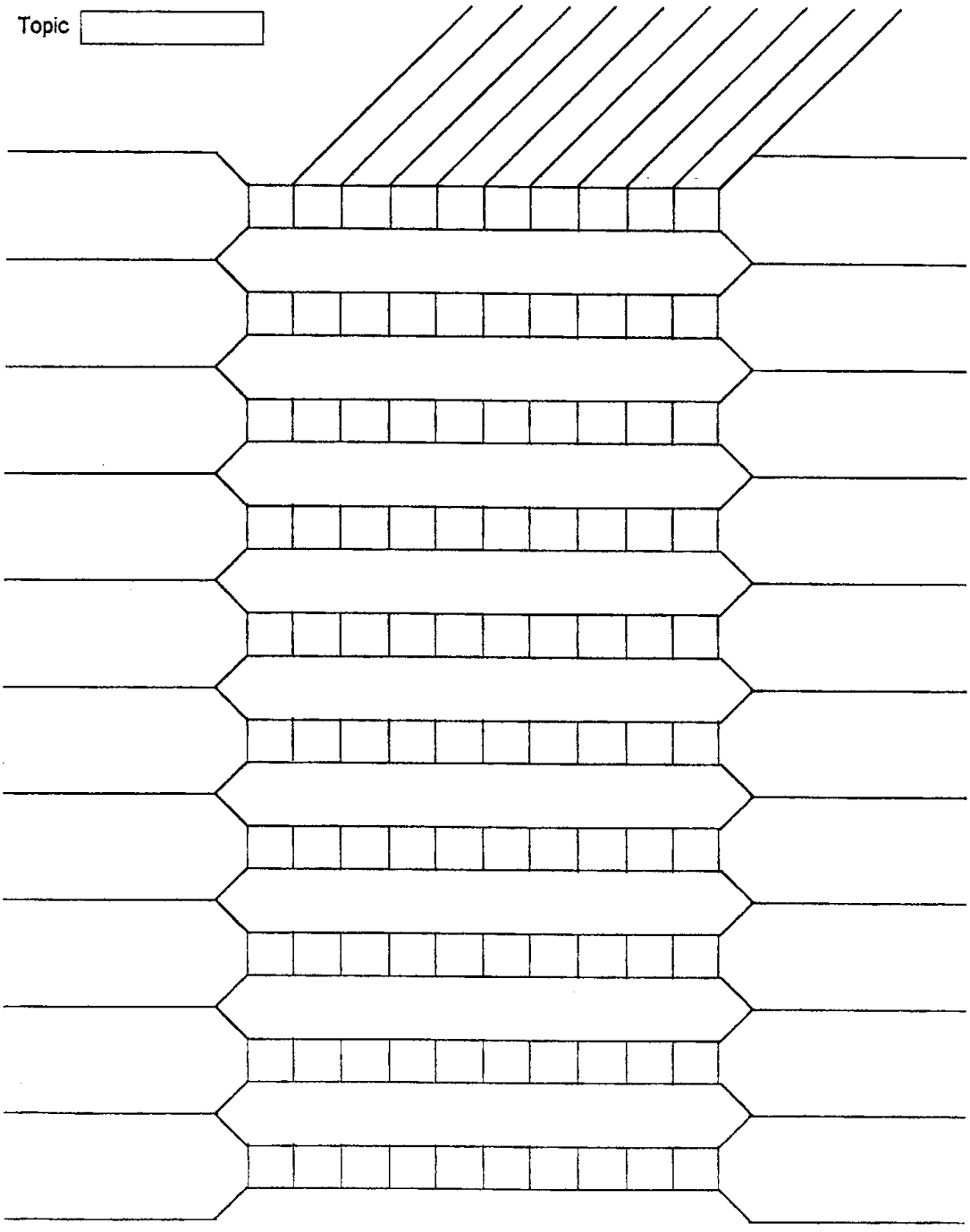
APPENDIX D

ORIENTATION QUESTIONS FOR THE IN DEPTH INTERVIEW

1. The focus here is math. In particular, what will you be teaching?
2. What was your goal in this session?
3. Keep in mind that this interview is to help you remember thoughts and feelings during the lesson delivery. Is there anything significant that you would like to focus on that will help get at your thoughts or feelings during the lesson?
4. Is there anything that you know in advance to take more care or time with in this particular lesson?

APPENDIX E

REPERTORY GRID CHART



Appendix D adapted from *The easy guide to repertory grids* by D. Jankowicz, copyright 2004

APPENDIX F

PARTICIPANT 1 INTERVIEW TRANSCRIPT

Walk me through how you—I mean you know you are gonna teach the curriculum, but what are the pieces you use to set this up so they find some kind of access point and they don't feel overwhelmed or whatever it is that a kid would feel sitting here thinking, "ok, I'm in AP calculus", but how do you get that started? Because I'm walking into the middle of a routine and I see that they're ready for you and you're have something for them—how do you get that started?

The most important thing to me is that table in the back with the materials. So there are already—first day I put it back there. And I put on the board "get your materials from the back" well most of them, are you know, new, and a little nervous the first day and they don't read the board but I make them physically, Day One, go back and get it. They're really nervous, at the beginning of the year cuz it just sounds like a very challenging course—which it is—and you know I have a wide range of students. I have those that ace everything, and those that barely made it though regular pre-cal, but they want to be an engineer, or they want to be in a field that requires this. So I think just letting them know and trying to give them the attitude like "this is a work in progress" I'm here at lunch, consistently here at lunch—and then this year I started—we had to do these "Ippy Dippys" like a personal development goal—and I decided that since I'm off seventh—and most of my seniors don't have a seventh—I'll use Tuesdays at seventh period, and whoever failed the test the previous week I just stapled a small little piece of paper to their test "Holding a special session next Tuesday. Please come!" And most of them are, you know, good students and on top of things, and, for the most part I had everyone come that I asked. And it just gives them time to work on the corrections without the chaos of lunch. Because you've

seen how many are in here at lunch (And it's everything but the kitchen sink going on in here) and I think more than that it just give them the realization that she's here to work with us she's willing to work with me and put in the extra time and I'm willing to do my part and it makes them more comfortable to approach me at lunch because the stronger students come up to my desk with no problem but it's the weaker ones that'll sit and stew and worry and be shy and not ask me. So I've found that, and then I tried to offer some before they would take a test, and those that got used to coming to my 7th period would just automatically come and work on the review just to give them extra time with individual attention.

Well that's the thing too that if I failed the test or did really poorly and I come in ad there's 16 other people and I don't feel so dumb or inadequate and I'm not going to be able to make this because there are other people that have trouble with this too.

If they made a really low grade I sometimes say come to this tutoring and then we'll talk about not a retest but I noticed you missed this one concept so I'm gonna give you 2 or 3 problems and then I'll let you earn up to ten points back just something to keep them working.

Cuz you really just want you to learn the thing that's the point—

It's very easy for them as a senior to just quit.

I made a note about your hyperawareness about what students are doing that's something that I really noticed. How did that come about? That's something that a master does. But. You're always aware what's going on but you're still delivering content so it's not like you can just—how do you do that?

One thing is just time, especially with calculus you know the first year I taught this I had my notes in my hand, and I was very focused on what I was teaching because I was working on the content and how to explain it. Now I've done it so much that I can look and say "oh I'm teaching this today" and not even have to review my notes, but I don't know, I just remember early on in professional development, them talking about "with-it-ness", and I think that's really the most important aspect a teacher needs to have. So I do a lot of management with my eyes or proximity or things like that, where I'm not interrupting the flow of the lesson, but I can just say "so and so are you with me?" and it kind of jumps them back to attention or I cam just mouth to someone "put your phone away" and I just found that most effective if they know I'm seeing what's going on.

This girl that was sitting over here said "When you tell me to put it away I just take it out in another class because they don't care" (about doing homework for another class) that was her comment "they don't care" but you do care. That was her observation.

I don't let them sleep and I don't get other teachers who let them sleep. Because it's tiring. It's an effort to be consistent.

It is! And you're on all the time. You don't give yourself much of a break. You're correcting tests, you're having them correct tests, put in test grades, and doing it all at the same time. And I just keep thinking about how if somebody were to see you do this, I don't know if they'd go into teaching—because they would either have to make that commitment or be stuck with subpar performance.

It's getting more and more challenging—they have shorter attention spans and have access to technology *(in their pocket!)* but the good thing is that with the brighter students, they can multi-

task and that was something I really had to adjust to the first time I taught gifted students because they could talk during group work about other things and still be on task. I kinda had to let that go a little bit.

You have to take the whole picture and not just what they're saying.

Yes

So that's part of whether what's going on is math talk or is a distraction.

Another thing that I noticed is one time is that a student came up for help and he was having trouble with a concept and you said "I'll have to think about how to explain that" but when you're up in front of a group of students and you're seeing and everyone's doing the same thing and it's not a tutoring situation what things do you use to figure out what you might say that would help more people understand what they are having trouble with? Does that make sense?

Yes—maybe to use different vocabulary to explain it? Or then I ask, "where did you lose me? What step, what number don't you understand?" So I'm trying to see where their misunderstanding or misconception is.

So you're trying to figure out where thee hole in their understanding of what's going on is.

And also just the experience gives you a broader toolkit—" ok well a student I saw one time did it this way, so maybe this student will understand it that way too." You're accumulating different methods and tools to explain as you go.

I don't see any textbooks, so tell me about that.

They use them in calculus as homework, because there is not an ample amount of calculus worksheets you can pick up at the teacher supply store! I get them from other people in workshops and I tend to supplement. Geometry I have taught that for fifteen years now, and I have so many sheets that I like better than the textbook. Also, I've found that they do more homework if they do a worksheet with space to write on. Homework out of the book where they have to use their own loose-leaf and there's less space—they don't do as much. My school's very supportive about—you can use however much paper you need—I pretty much ise the textbooks as student that need extra practice. I'll tell them "if you need extra practice, come in Wednesday before the test. I give them my teacher's edition and they practice out of there. Or the tutors use it to kind of match up. Cuz I always put on every worksheet where out of the book it comes from. But I used the book more in my earlier years of teaching, but now I pretty much don't use it at all.

Do you give the kids books to take home?

Yes. They check them out through the book room. And I also have a link to the online textbook on my web site. Sometimes it's missing good problem-solving-type activities or especially teaching college prep or pre AP the rigor isn't always there, and I find it's easier just to supplement and I've kinda made my own course.

Plus you have all the AP test material to work from—and that's your target anyway, so that makes sense.

The thing I was wondering—how many FTE do you have? Like a 180 or something? And you can look and say "I know you're weak in this, or I know you are having trouble with this" how do you keep all that in mind for each individual student?

I think it's more like a juggling act. Like we have a way on our grade system to print a failure report. So I kind of look at who's low and focus on them that week. And then if you notice someone slipping or—the main thing is especially with larger classes I depend on peer tutoring.

I noticed that, which is awesome, because it again is math talk and it them talking.

I tell them all the time if you can explain to someone you really understand what you're doing.

Right. Absolutely.

And it's easier with them, because with the brighter students they've already figured out "I need to network well." So it's not as much as when I taught regular geometry I'd have to develop that situation—put them in groups and get them comfortable with people around. Advanced students do it more easily and more readily.

I think putting the students in groups helps a lot that the one guy I went to go observe— Sergio— and that's a straight up geometry class, they were doing the same things that the more advanced students were doing— I know that that's not how those students used to see themselves. Now they're seeing themselves more that they can do this stuff.

He's a first year teacher and he has a lot of promise.

Some of the stuff he's doing it's like dude how do you know to do this? You're doing it right!

And he's going through ACP while he's teaching this year. He's doing very well. I have a lot of respect for him.

Yeh. That was a great chance to take a look at what was going on in there.

A lot of times, when I started teaching college prep I just took what I was doing in the regular classroom and bulked it up a little bit. I think when I was in the regular professional learning conference they'd say "They can't do that" and I'd say yes they can, I gave them this" you can't freak them out or give them so much difficulty that they shut down, but they can handle a lot more than people think.

That was the thing too that I noticed was the one particular student wasn't getting it about squared and cubed. But he was on his way—when he was corrected you could see he was trying to formulate what was going on there.

That comes with time, too. I think as a new teacher you want them to do well so badly, you just—and plus you're more frantic about management, so you want to jump in there and get them to the answer real fast. But I think with experience you learn to just step back and give it some time, and your student learn that's your style. Because they'll say "she's not going to tell you," or I'll give them a hint, they can struggle with it a little bit.

He didn't really let the students—kinda showed them what was happening, but he didn't really explain it, and he didn't really need to. It was one of those things that—he was about to have an aha moment, and the teacher didn't step in and mess that up.

The other thing—this is just classroom clerical stuff—when do you take attendance?

I typically do 1 and 2 this period, 4th at lunch, and then fifth and sixth at the end of the day. It's kinda like a personal challenge to me. At the beginning of the year, I have a seating chart, but to me it's a personal challenge that I should know whether a child was here or not. And if I can't remember I didn't do my job. Cuz I didn't greet them when they came in, or I didn't make a connection with them that day. So it's kinda my personal challenge each day.

That's pretty interesting. What I'm really trying to focus on is – and maybe I should just flat-out state my research questions, but what I really want to know is, what factors you use, and it's kind of really a tiny little moment in the day, but when you are actually teaching and somebody or the class, or – what course-corrections you make, and what you bring into that decision. You're going along and you're thinking ok I've done this 8 times in the last 8 years and it's worked every time, and this time you have these deer in the headlights. What do you fall back on to drop back and punt or sidestep or—has that happened at all recently? Or does that just not happen—

In calculus for example, I realized that some of their issues were algebra and not calculus, so I changed the first week when I do precalc and review, I've changed to pinpoint exactly what they need to know throughout the year. And then I hit it again when we get to that chapter. SO I;ve added more targeted practice before they get to the calculus concept. So they may be factoring, but they don't know why we're factoring yet, and we'll just practice that skill little five minute increments for a week and then the next week they'll actually use it when we're doing derivatives. Things like that. Every year, I think you don't teach something well. And it changes every year. I don't know if it's the time of the year, the week it fell, too much other stuff going on, or you just weren't with it that day and you just didn't teach a lesson well, but every year there's a one topic that I'm like oooh I did not do that well. So what I like in calculus is that you have that review time to cycle through everything again. So I'm thinking as I go through the course to really hit this topic hard, so that's gonna be my focus when we get to the review.

So you have a "folder" that holds the things you know you have to do these again. Now—he told me (Mazzoni) that they were just finishing up their content, and you had been reviewing for quite a while before then.

Yes. He teaches two semesters of college in one year. And I just do one semester. So most of the time he's doing a new lecture lesson every day. And I'm doing a lesson, have a practice day, then a new lesson We pretty much have two days plus for each section. So I taught BC one year. And it just didn't really suit my style. I'm not a lecture bell-to-bell type teacher. I like the activities and things like that so the AB course suits my teaching style more.

So really in a way it is content specific so the ability that you feel you have or you do have to get the content across is partly a function of the actual content that you have to teach. I guess what I'm getting at is like—it's almost domain-specific if you have a way of teaching and you have content to teach it's better to match up the style with the content rather than trying to force somebody into that role that's not really suited to them.

With geometry it's a little different with course-correcting because it's so building. Calculus is building, too, but with geometry it's even more so. If they don't understand trig, they're gonna have a problem when they get to area, and they're not going to be able to do volume. So it's kind of like you're always checking how they're doing as a whole, and that's one reason why I do the test corrections and things—you're trying to catch them up before the next unit comes.

Right. Wow.

Another thing I was wondering was do you have to turn in lesson plans.

No.

That's nice (very nice). *So do you have lesson plans? Do you have a master plan?*

I use the calendar as the major idea for scope and sequence and pacing. In my early years of teaching the course I would have all my notes written out and then I would have—I like to use

post-it notes like an agenda for the day—we need to check homework, we need to first do this activity and then give these examples and they're gonna work on this.

So you had yourself a routine

And then since I've had the smartboard I've taken a lot of my notes as far as the examples go and put them into ppt slides. That way I can also save them. If a student or a bunch are out on a field trip I can just save my notes and post it or email it to an absent student, but really now I can look at what we're doing this week and there's not that much—I can find new activities—what I do is I have folders for every topic. As I go to workshops or I find things online I'm either putting a hard copy in there or I'll save it on a flash drive I have folders by topic so then when I start a new unit I'll go look in those two places and see if there's anything new I want to pull in this year. But that's probably the extent but as far as formally looking at "I'm doing this TEK and this objective" we're lucky that we can just teach our course. I know I'm very spoiled!

Well, it's working that's the thing

That's their philosophy—we're professionals and as long as well get the results, they leave us to do our job~

And that's another thing too the emphasis on class scores because Sergio does it too—they have a reason to help each other because each class is—not competing—but comparing to another geometry class they kind of have some stake in the result and other people's result and that's kind of interesting too because I haven't seen that—I don't know if it's a new thing but I haven't really seen that.

They do like to be the class with the highest median or whatever it is. Kind of give some of them a wake up call – oh look 20 people made an A or B on this test. Why did I make a D? I need to get my act together…

It's interesting too because so much more of what's going on the workplace to me is so much more collaboration so much more caring about the other person's ability to do the work. I personally do not like competition, but it's out there so we have to find a way to protect people while in the midst of it.

That's why I do the improvement awards and I always start with those—to show them that's where my importance is placed—because the same kids may get an A every time. But really they come in if they know they did well they saw their score online they come in and know they're getting a prize that day it's just the silly pencils, you'd think 18 year olds would not but they collect those medals and they—

It means a lot

It's just the recognition that I know they're doing well.

And their effort is being not just rewarded with a better grade but it's being seen and it's being honored.

And you do it differently when you teach regular, you know, a child that passes for the first time they get a prize, or everybody did their homework. Small baby steps!

That's the other thing about teaching that I don't think new teachers realize and maybe they are starting to how social it is the whole thing we're doing here is it's obvious, but maybe it's so obvious that it isn't even visible—

These are humans with motivation issues—like for AP I struggle to capture their attention. They have so much else going on. I do things to make them want to do my work first! They will! They'll say "I didn't do anything else last night except your homework" what's causing them to choose mine over another teacher's? It's a dynamic that's very difficult to quantify.

And I don't necessarily know if it necessarily takes overt thinking about—I mean, you're not a real warm/fuzzy touchy-feely—I mean you're business, all business in here all the time, even at lunch, so It's not like you're mom of the block, not at all, so there's something else going on there that they want to do well for you, or for themselves, but they're taking this on rather than letting it slide.

The thing I've found is that if they know a teacher works hard and actually cares what you do, then they'll work for you.

I think about the ones that I remember, and those are the ones, the ones who stayed after school who had a green house, and I don't think after he left they kept the green house. It was all him. And he would let us go back there and poke around, and that was IT for me. I really got into it and probably did much better on tests and things in that class than other classes just because of that connection.

Another thing I thought about was that when I first started teaching I was very concerned about being fair. Like very—not-- I'm still concerned about being fair, but equal, I guess. And now, the more experience you get the more comfortable you get with giving students what they need. I never say who's getting a prize, for example, because if a student's used to getting hundreds and she makes a 90, she's not getting a prize. That's not her potential. You can do things like, oh, these two need a little retest of ten points. And I've never had a student come to me and say

that's not fair. Cuz they know I'll do that if they need it. So it's just what they need at that moment

The fairness is that everyone gets what they need at the moment. That's huge too because you're seeing each individual student.

How do you get buy-in? And that's still kid of nebulous, it's not easy to see or say, but I will say that the fact that they have something they can do right the minute they walk in here makes a huge difference I think. Anecdotally they know what they're supposed to do.

The responsibility and onus is on them. I'm out there, I'm trusting them to run the show in here.

And they do! The fact that you have these chairs set up like this is nice because they can turn around and talk—

And you're not constantly moving desks. I special-ordered these tables. I'd prefer them to not have that inside part where they shove all their junk, and trash… One year I requested tables—especially in geometry, they have so many materials. I like them to spread out, and I like them to be able to turn chairs…

Sometimes I can understand better if I see how someone else has solved a problem. Sergio's class as well is the same way.

I've been in this room two years. In my other classroom there was enough room to make a U. And that was actually my favorite. Because I could more quickly get through all of them. In my geometry classes I'm hurdling so I don't walk around as much as I normally do.

Right and you can pretty much see what they're doing from anywhere in the room. That's helpful too. Is there anything else I missed that you think I should know? I'll probably call you in the summer! One thing I wanted to ask you is do you ever use the library?

The only time—well now with the laptops and everything that solves my problem of trying to reserve-- we would have to reserve time in the computer lab and we would use Geometer sketch pad but it was always a problem of getting the software loaded on everything then not having anybody else remove it, and I had to check it every time. So to avoid the library I would switch with the computer teacher. And she would like it because they would be sitting in a classroom setting and she would not have to compete for students' attention with the computers. So we started doing that once every six weeks. But now with the laptops I can use technology all the time. The only time I ever wanted to use the library beside technology is I wanted my seniors to do an end of year project like explore a some topic in math that interests them or some kind of mathematical research, but that's when the library would shut down to do inventory, or testing, and I would be locked out.

That's hard. I remember when I was in high school, I didn't take calculus but the guy who taught it did a project like that.

Back when we had videotapes, we would keep them in there. I've used the digital camera to make movies and things.

That's good to know too— seems like there's more we can do, too, but it has to be a paradigm shift in a way because there's so much more the students can access online. Do you ever use a flipped classroom?

I've done it before because of weather, and I needed to keep calculus on pace, but I don't know—Ed Mazzoni does it because his course is so packed for time. Some of the simpler topics, he has them watch the video at home. I don't know, I value the interaction and me knowing that they're getting it and focusing.

Somebody had mentioned it about Khan academy, the person was making the case that it really isn't part of the network of understanding it's just "here's a thing you can do" but it doesn't really include the social aspects and they found that to be wanting.

I think if you're crunched for time, but I have plenty of time.

I noticed some schools have block. Did you ever have that?

My first semester teaching. It was a messed up year. I started teaching in January, there were only two math teachers in the small rural school in Mississippi. I was the pre algebra algebra one geometry teacher and the other guy did the upper level. So I wouldn't quite say I had the true block experience but I don't feel math should ever be in a block situation. Too long, doesn't give them the practice they need, they need the daily practice.

I had worked in a block schedule building and also traditional and I just wondered about math department.

We had the geometry being taught to the 8th graders this year in a lot of the middle schools, and one girl that we keep in touch from Pershing middle school, she's the only geometry teacher so she's kinda talked to the pre ap & geometry teachers here and made a little bit so she's staying on and doing what she's supposed to be so her kids will be on level with our kids next year and she just can't keep up—with the block they lose so much time. I think they figured about two to

three weeks of time. Especially with a holiday you might not see them Thursday and then not see them again until Tuesday. They say when you teach block don't let them do homework in class. But how can you move on to the next thing if they haven't practiced the first thing?

Makes sense. That would take a lot finagling to give them the same experience. It seems like a long time to pay attention to that.

So we're gonna give our younger ones longer time to pay attention. I think they would do better in middle school if their math weren't blocked.

The place where I do yoga there's a breakfast place next door so I'm watching all the families walk by Saturday morning, and the kids all have ipad under their arms and I'm thinking it should be a book #1 and #2 you guys should have a conversation and #3 you're not making it any easier for us to try to get their attention because they're so used to being able to not be bored automatically.

I was a at Katy Mills Saturday and there was this mom with four little girls, and not the two baby ones but the two older ones, and I say older—they weren't more than 14, and the mom were all on their phones. Walking through the mall. I wonder about their language scores because they are missing out on the whole verbal component—are they seeing gaps in language development. That's what I would wonder.

That's a whole other thing.

How reflective are you?

For the first few years it was hard to shut my brain off: lesson planning, in terms of students—how I am going to get him to do this work how am I going to get him to come to school? And

that's lessened over the years. The best thing you can do as a teacher is to shut your brain off when you leave school, and have yourself some down time, but still I'm always thinking before I do the next lesson is there something I missed, was something I needed to reemphasize, even after the test how can I bring that back in, catch up some gaps,

So that's what you think is one of the key components in your opinion has made you at the level that you're at right now.

I think the reflection you do, the withitness, and your consistency if I had to narrow it down to a few key aspects that you need as a teacher

Cuz that's what I'm really hoping to see: what skills and techniques that I can have you practice that will get you there faster. Just the exposure year after year the experience is gonna come. But the other part –

It's a motivation part on the teacher too. Do they have the internal drive to succeed or for their students to succeed. Do they have the inner motivation to succeed or for their students to succeed?

They might have that but is the incremental success enough to make them continue to keep wanting it? That's the hardest part I think. Because the first year you think it'll never be that hard again. But I think it gets harder in a different way.

It gets easier in some ways but there are always new challenges. You have students who have had different experiences—whether it's technology or I see a big difference with this group I see now have been given calculators since early elementary, but they're moving away from that. So maybe number sense will improve or so it's kinda like every couple of years you have a new

batch of students that you have to kinda tweak how you deal with them based on their experiences.

And probably the sooner the more reflective you are early on

The more you adjust

Some people might just not realize until it's too late that nobody's with them. The kids are getting the content but don't feel good about math or not thinking they're gonna be successful. The reflection—the piece that I think has a lot to do with it—but it's been so overused – refection journals

It doesn't have to be formal. A lot of teachers say they do the most lesson planning when they're driving to and from school. I sit and watch tv and think "maybe if I try this" last night I was on Pinterest looking for activities for quadratic functions for geometry. It's not formal and it's not time. That's why I'm very anti lesson plans. I think they waste your time and stifles creativity. It's taking away the idea that teaching is an art. You're working with humans. What if they don't get it? I'm sorry my lesson plans say we're moving on to this. We've had a lot of teachers we've interviewed ask how flexible their teaching can be. And I think they're starting to feel the robotic movement of it and want a place where they have the freedom.

A lot of brilliant teachers have said the same thing—calling that out and saying "we don't need this. We can get there. Let us just get there." It's exciting. Thanks!

APPENDIX G

PARTICIPANT 2 INTERVIEW TRANSCRIPT

Walk me through how you plan for a lesson. What's the first thing you do?

The first thing I do is I sort of isolate—what it is that I want to get across that day

So the goal, you figure out the goal—

Yes, but it's not just by itself though, if you've noticed how I taught continuity, I had an end in mind, what I wanted to do every single day so I could get to that end and be as fluid as I could possibly be. Because there are so many different pieces that come together and that if you—I mean, you could teach the whole concept in a day—but I had the luxury of time, so I look at where am I going, and how much time do I have to get there, and figure out how they're best going to understand it, because we're not talking about easy math concepts, but I want to make it seem as easy as possible. I want them to be able to see it.

I'm seeing it unfold and it's a beautiful thing. I mean, it's pretty elegant. Taking these little pieces of stuff they already know so they don't feel so overwhelmed. Because they actually do know pieces of the new stuff.

But now we're finally taking all these things they've learned in math classes in high school and putting it together so they can see what calculus is all about. Whenever someone asks, when am I going to use this? In calculus you're going to use it everywhere. It may be in a more abstract way, and I might not have a real life application to share with them, but they're certainly going to use all these little bits and pieces.

You don't have to turn in lesson plans, is that right?

No.

So do you use them?

No. I've done this a long time. At the very beginning, when I'm starting a new course from scratch, there's a better framework that I go through, to be able to organize myself. And I think that would be very similar to how a new teacher would work through that, but after you've done it awhile you know how to break things down better and you know where the kids' strengths and weaknesses are going to be, and experience—you can do things on the fly a little bit more, too. I know better how long things take, and so I don't have to write things down the way that I used to. Like when I started teaching AP stats, and I taught that for the first time six years ago, I didn't remember ever taking it in college! I know I didn't do some of the things myself as a student that I am now teaching. So the way I started out there was, ok I am going to start out with a basic PowerPoint. And every night, I have to put hours creating a skeleton of here's what I want to do, and insert examples where I need to show them, as much for me as it was for the kids—and if you look at my web site right now, and all my AP stats, I'm not the only one who uses them. There are now other high schools that are now using those PowerPoints because you don't know what you're doing, this organizes you through the class that "now we're going to do this activity"—do the activity. "We're gonna talk about this thing" and here's an example on that thing, that my PowerPoints are all very much mapped out so that someone who's never done it before can do it. And it's all there. I get emails every once in a while from different people, asking "what was that activity you did there? Can you give me more information on that?" One of the girls who sits over there, her dad teaches at another high school, he uses all my stuff. And she was in my class last year, and she would save all her tests and she would hand off to him, so he would have materials. Sorta weird— Sometimes teachers get trained in weird ways, through their own children. She made a 5 on the AP so I can't complain. (Laughs)

How do you approach the beginning of the year? How do you set that up so that it turns out the way you like it to?

At the beginning of the year it's all about routines and procedure that deciding how you're going to organize your class physically as well as procedurally, during the class period—how do you pick up papers, how do you distribute papers, and there's never any particular great solution you just do the best that you can. How are you going to collect, how do you check homework? For a math teacher, that's one of the biggest issues. How do you check homework? Because checking homework takes time. And if you're actually going to check to make sure kids are doing it you're gonna have to physically look at their papers. And I will tell you that I begrudge instructional time to no end, and I hate doing it, but I have to. I have to. Even though I might lose five or eight minutes of my period, but I have to do it. I don't like to do it. And every class is different, like this class right here, this is a pre-AP precalc class, which is generally—most kids are juniors or seniors. Half of those [in this class] are sophomores. Half of them are fifteen years old. They're still kids they're still have a hard time sitting still, and they don't have college-level attention spans yet, but they're taking a course that is equivalent to pre-cal college algebra when they get to college. And they're having to sit here. And this is right after lunch, end of the day, last thing they really want to do, and this class has some very interesting strong personalities in it. And that's a part of it, too, at the very beginning I remember consciously—I talked to our principal about it, too, cuz at the beginning I have to decide what personality I'm going to have. Am I gonna be the real, strict,-- still nice but how far do I let them go in terms of their giggly humor and the boy stuff the boys do. The girls at this level aren't an issue, but the boys tend to be. GT boys, are tough. But GT boys, there's a fine line between turning them off and they stop doing anything, OR, sort of being an amusement to them, where they will continue despite that

they might not even like the stuff that we're doing. And GT boys if they don't like it, they'll stop working for you, and then it's over. So. And I remember for the first week I was struggling. Okay, do I rein them in more, and be a lot more hard about their funny little, quirky behaviors when they're all such good friends with each other and then I made a decision that you know, it's not working for me that way, I have to find a way where we can all sort of have fun but still accomplish just as much. That's when I made the decision that we can be how we are. And it's worked, it's worked real well, the kids are still working and quite diligently. I would say we nearly have a 96% homework return, they nearly all do their homework, and there's one boy who tends not to and was offered a chance to move down to a lower level and has refused. Wants to stay. Will not move. He's not gonna pass, but he's with me still. When he could be passing a lower level of pre-cal. Not good, but—

So what do you think you're doing that promotes this buy-in? What pieces are there do you think? Looking back on the year? You have some loyalty here—

Yes, there is—

Gosh you know it's hard to put my finger on exactly what engenders that, too. They have to—you have to more than pretend to care, you have to care, you have to find out about them, you have to sort of get to know them a little bit, I think you have to be in their face a little bit because it's sort of like being a parent— that it's not all—they don't always do the right thing, but you can't let them get away with that either, you need to correct that, you need to make sure that you get over on the right side again… At the very beginning—engagement is probably the biggest thing. I don't do very much the same every single day I try to really sort of mix up the kinds of instruction that I do. They're not always—well actually there's probably always a little bit of instructional time where I'm on. If you came on Monday, I'm not instructing at all. It's a

complete 55 minutes of discovery on Monday and I'm only going to be visiting and watching what they're doing. They don't know it, they walk in the door and they're not sure what they're do each day. You know, are we gonna do a Kahoot? Are we gonna cut-and-paste? Are we going to do a scavenger hunt? They don't know what we're gonna do. And so, it's sort of like wow! And they like it being different. One of them made a comment "getting into my class was sort of like winning the lottery." We have other teachers who are teaching the same class, but none of them teach it the way that I teach it. And so a lot of them know that being in this class was something that is special to have happen and they're not going to take the chance of not being able to stay. And that comes with reputation.

That's pretty cool! I noticed that you always know pretty much what's going on in front of you

Not all the time—I get too much into what I'm doing. But I try to know. If there's anything that I'm working on as a teacher is to try to be more aware of that. Because I really like what I do, sort of like my stage up there, very cool, and it's very easy to get more involved in explaining something and I forget that "I wonder if they're even listening to this wonderful explanation that I'm doing. I have to work on that every single day, making sure that I'm aware what they're doing out there and that they are listening and participating and at least with what I'm doing. That's something I have to work at. That's a hard thing. When I go and observe other teachers, it's probably the thing that I see more often than not, instructional—they're instructing! And they feel they're doing that great. Whoa look at that! And they could be! But—is anyone listening. So making sure that I track everybody and I'm not—afraid to call someone on it if they're not paying attention or not doing what they're supposed to be doing, and they don't think I'm putting them down, they don't. It just you're not doing your job, you get back to it and we're gonna be just fine. It's not a bad thing. Whereas until you get to know a class—that's not how everyone

responds. “Why are you picking on me? I wasn’t talking!” I don’t get a lot of backtalk. And a lot of times they will watch each other and or correct each other. Because they know. They know when they’re not doing what they’re supposed to be doing. So if I call them on it it never fails, someone will say *whispers* “oh lookit someone…” and that’s ok!

That helps everyone! So today you did some instruction and gave the students something to do, and it seemed like everybody—most kids were following it. It’s Friday afternoon, after all. But really, looking at them, most people were looking up, they might have been looking at their notes—this might have already been answered, but how do you actually—you have an overall goal, and then you break it down and bring it down and bring in the things you know are going to support that, is there a time when you look up and you see these blank faces, or

Oh, yeah!

And then what?

Then you have to go back! Today I could feel, I knew, that we were all on the same page, even the 2 kids who were absent yesterday and those were the ones I looked at specifically to see if they were catching on, and they were, and if the kids who weren’t here yesterday were following what I did today, then I know I was pretty much ok.

So you are doing a check—

But I went around to every single kid and looked at their work to make sure they were on the right track and if they hadn’t shown the right notation, they didn’t show the limits, or they didn’t know what they were doing, but they mostly knew what they were doing. It was also self-checking, the solutions were right there, so I like that. That’s one of the reasons I chose that instead of doing a work sheet. Which is not self-checking because any way they can sort of keep track of their progress themselves is cutting down on mine. But this is just stage one of the – well,

this is stage four of this whole lesson plan. We're moving on to Monday, and there will eventually be some kind of hands-on, or something that I will be before we actually test, I will know what they know and what they don't know. Before we actually test over this. You haven't seen that part yet. We had a quick quiz on one-sided limits they took one of the days you were there, they got the papers back. I knew where we were at different parts. But sometimes it doesn't happen until things get put together. I can only fit so much into a period, and I work really hard to go from beginning to end with something interesting. [Laughs]

That's tough too because you have interruptions –

Yes, and now they're sending out reminders for those reminders. It is horrible. [Laughs]

Talk about how you're using their classroom texts? Do they have them at home, so you pass them out—

We will not use textbooks in the classroom. They have them at home, their homework comes from the textbook, but this isn't the time to do homework. It's sorta like you know how we have flipped classrooms and blended classrooms—my goal because I like to teach and I want to teach in person so I can get that interaction and sort of feel—if I created a video for this lesson I would still know nothing. But also they don't do homework in class because that's for home. There'll be an activity or a computer thing, or a game, or something that I will be able to use formatively to see whether they're learning what they're supposed to be learning.

So that gives them practice but it also lets you know where they're at.

Sometimes it's very disguised textbook, ok, like the wall problems that they did—those weren't special. I just took some problems and stuck them up on the wall. And they had to go outside and change positions and move around and look for them—it was just practice, and it was in a

different environment to make it seem different and makes it more fun and they're outside in the hallway, and it's different.

And it doesn't feel like class—

Textbooks—I like having all the problems, but I don't have a classroom set. When I teach geometry or algebra I all the classes have classroom sets of those books, but we will not look at the book. We will do an activity that will reinforce the learning or there'll be some kind of challenge or there'll be something else, because that textbook, that's just a book, it has a bunch of problems that's homework. That's not the teacher, I'm the teacher, I choose something be in charge of the instruction. Another thing I'm not good at: If I had them work in the book independently, I don't know what to do with myself. I feel like I'm not productive if I'm not—I will tend to draw kids off task. Because I'm like ok, what am I doing with this time, you're supposed to be working in the book and I'm now getting bored because I'm not having anything to with what you're doing, so I choose not to do that. I choose something where I can facilitate, that I can be part of the process because I only have them for 53 minutes and I want to be part of that time. At home, they're without me. Then we have Edmodo that they can Edmodo me, and ask me questions on their homework, and I can do it on a piece of paper, take a picture and post it back to Edmodo. That doesn't happen a whole lot. If I do a good job first time around, there are never huge issues in terms of some concept. That doesn't happen much. There'll be bits and pieces and I can always predict what the problems are they're going to ask about. And if they don't ask them, I ask them!

Well because you know exactly where they're going to have problems, or which problems are stepping-stones to the next concept. That's what I was noticing.

I'll have teachers who say, we'll open it up for homework and ask "who has homework questions?" What are the kids gonna do? They're gonna go, "well—I didn't have any! Let's move on!" Well, it doesn't work that way. I know there are questions!

This is kind of a random question, but do you ever use the library?

Before we had laptops I did.

So you used it more for the technology aspect and not necessarily for research.

Not for research. Yes.

I know for stats, for data collection and that, we've used it in a lot of weird ways, one of the activities we've done is to find the correlation between the width of the spine of the book versus the number of pages in the book to see if we could come up with a regression model. One of the things we did was go to the library. They had to have a random number generator to find a stack, and a random number generator to randomly choose a book on a particular row, and then based on that they had to come up with this. We did that first semester and then second semester I know this is not research or anything like that but we did also to get an idea in our library what the average reading level is, and you can estimate that by randomly choosing a book and on one page choose the first 100 words on the page and then write down how many letters are in each word. We did that. And we were doing that for confidence intervals to know what the true reading level of a high school library would be. And so everyone generated their own confidence level was based on their book. And then we went from there. It was interesting. I don't know if it was really---it was good enough for us.

It gives them a chance to think about it in a way other than in the classroom.

Yes.

Our curriculum is such that especially in precal or a class like that, we don't have a lot of time. This is the first year we haven't had a STAAR test. They took that one away. So we've probably had more time to do things like that, but my choice is to do laying the foundations, materials, instead of really going off the wall in terms of too much stuff like that. And do it aligned to calculus so when they get to calculus there's never any oh, I've never had to do anything like that before. That they know what to expect. What kinds of free response questions they're going to get. That when you justify something mathematically that they know it's not a yes or no answer they have to actually explain.

Another thing I was wondering as I'm watching—it seems like you have a pretty good handle on each students' strengths and weaknesses, and how many FTE do you have? It's like 165?

I don't have that many. I only teach four classes. Let's see what's my total? 36, 38, 40—oh wait, no I have a new class now. Well, before that class—36, 38, 40, and this class that's 30 that's my smallest class. I don't know—it's a lot of kids. I know I know these kids better than I do in my 40 class, that's for sure! I know that I don't have the relationship that I have with all of those kids. Some I do. But not to the degree that I have in my class of thirty.

That would make sense… So is there anything that you would keep in mind or think about if some particular student maybe didn't get some concept in 8th grade that now is coming back to haunt them or is there anything that you do like that where you know that there might be a student that might have trouble or anything like that?

Well, since we do tutorials during lunch, and that has happened occasionally, the kids are really good about coming in at lunch and that if I say hey can you come by at lunch um, Havah one of those girls is in lunch every single day in here. Even if she's really doing well, because she sorta has some highs and lows, they know that they can come, and it doesn't bother them if I ask them.

It doesn't seem to be a very big deal. Maybe it's the culture here at the school is that lunch is for, you eat lunch but it's also a prime opportunity for tutorials. It might only take five minutes. Five minutes might be it. And then your question can be answered.

Do all the teachers do tutorials?

We're required to—

Oh, ok.

We're required two out of the five days for like 30 minutes, because the whole state of Texas has a rule about duty-free lunches. I'll tell you that most of us—there's no such thing as a duty-free lunch. I'm here every single lunch, not two times a week. That's why I sometimes eat lunch during 7th because I don't have time. And it's not just my kids, the kids hear who's willing to help and then all of a sudden these people you don't know say oh I heard from my friend that you can help me with this—and I say ok!

Makes a difference to a kid that they're not struggling with this alone. A couple of clerical things. When do you take attendance?

When I check homework. And today, I could tell who was here and who wasn't here. They always sit in the same seat whether you assign seats or not. It's sort of like a mental snap shot and it's sort of like oh ok everyone's here today and I wait until after it's over. I'm glad I don't have a second hour class, because that's when we do our ADA (average daily attendance), I'd be horrible at that having to do it on time. When I check homework. You can see how everybody does homework in here and so when I check homework I can tell by the gaps who's not there, and that's how I know, and in case I wait too long to take attendance, but since we've had testing it's been a little bit—and sometimes if I for sure if I know that I want to make sure that I ask them to show their homework. This is for that math models class. And these are the homework

248 averages that you can see over here at the side. And I've come from having everyone have
249 probably a 15 for homework average and we're getting there. We actually—I'm moving up in
250 the world. But on them, because it's harder, there's more absenteeism, I keep track on the hw.
251 And then that's how I take attendance later.
252 *Is there anything else that your admin need from you besides attendance? Obviously grades and*
253 *all that stuff, but is there anything else that you have to do for them?*
254 Administration?
255 *Yes.*
256 If I weren't DC (department chair), probably nothing more. Being the DC there's a lot more stuff
257 that I do, and I always have something to do. But if I were just a regular teacher, this time of year
258 we're getting close to being able to turn in kids that aren't going to pass, that sort of thing, but
259 during a regular six weeks there really isn't anything.
260 *They just let you teach*
261 Yeah.
262 *So the only other thing I guess I wonder is if you're seeing that you're showing something and*
263 *you probably don't have this happen very much anymore, but if you're going along and you're*
264 *teaching a lesson and you're seeing that this is just not—what happens.*
265 You stop!
266 *And then what do you do?*
267 Well, you have to go back to the beginning again and this come with experience, usually there's
268 some other way to do it.
269 *So you kinda like go through your mental file—*
270 Yeh

Because that's part of the whole thing with experience, you learn more from the stuff that didn't work than from the things that worked, and after you've taught long enough, you know sort of , and if you see—I think if you're more experienced, you know how to recognize better when you've gotten to that point that you stop earlier, you know? You don't let it get to the point that it's absolutely total mass confusion that there's a glint in someone's eye that you know uh oh I need to stop right now. And a lot of them don't really realize that you're reteaching it again in a different way, because they think it's part of the lesson. So that sort of happens, you know occasionally and once this year it did happen that I realized the next day whoa! That didn't go very well. And you know the best thing to do is tell the kids whoa I just didn't do a good job on this, and we're gonna work at this again. Let's figure it out. And also, making sure that they realize that their job is to ask question to help me determine what that is and we're all in this together and that I'm not the only one that's in charge of their learning, And when they realize that whoa, we're having to redo this because she didn't do it right or whatever it happens to be it's like well I'm gonna make sure I figure out what this is so that we can move on from this.

That's pretty empowering though to be in tandem about the students' learning instead of opening their head and dumping it in, it's more you help me and I'll—you can't necessarily expect—I think that's different. I don't think that something that everybody thinks about. I think that a lot of teachers do a good job but they don't really think about how the kids can actually take some of the responsibility of the learning, too, and maybe they'll want to, maybe they'll feel more empowered that way and able to learn better how to learn. That's part of that too--

Also modeling that it's ok to make a mistake. I misspeak, I make mistakes, I don't do great mental math, that's not one of my strengths, and I admit it, they know, I'm not ashamed of it. So if I'm not ashamed of not being the best person at mental math, and if they're not so good at it, it

must be ok, too. And that if I make a mistake then it's ok for them to make a mistake and you don't stop, you keep persevering until you figure out what it is you did wrong. You try to create a safe environment for the kids to be able to make mistakes. In math! My goodness! You make mistakes all the time! You start a problem, and you get "oh my gosh I'm stuck I don't know where to go" and you start again. And the kid that starts again and is willing to keep starting again until they get to the solution strategy that works, those are the successful ones. But if there's no comfort zone or safety net that allows them to feel like it's ok to get something wrong, then they stop trying. They're not they don't have that fear of me getting on their case for getting anything wrong. We all get stuff wrong and as long as we learn from our mistakes then hopefully at the end we do show mastery, we still have to show mastery at the end I still give a real test that means they have to be right! But the process is that, it's a process, and we get things wrong while we learn how to do something. And it's ok. And it's gonna be ok.

Otherwise you'd be frozen!

Exactly, part of the thing is really good problem-solvers, really good people, I think, take risks, not risky risks, not jumping off buildings or anything like that, but taking an academic risk and having the determination and the whole TED talk "grit"? We're trying to teach that too, and math is the perfect place to teach grit. Because you have so many opportunities in math to have a do-over. We write an essay and it takes a long time to do that. And then, you mess up. And doing it again seems nearly impossible. But on a math problem, you know it might take a couple minutes and you get it wrong, it's like alright you haven't wasted your whole life ok I think I'll try this again, it's a little more comfortable. The next time I did get it right, so I'm gonna keep trying.

That's true

APPENDIX H

PARTICIPANT 3 INTERVIEW TRANSCRIPT

How do you start out your school year? How do you get the kids to—

To set the tone for the school year?

Yes—and if you have any routines what are they?

Definitely at the beginning of the school year is the time for the students to find out about you. So if you're strict on something or if you have a plan or procedure I have to go over it. So the main thing is I need to get their attention. We do have "class class class" "yes yes yes" (a call and response to help students attend to the lesson) you know something like that. As far as procedures—keep the input box for the returning papers the same, when they come into class what are they expected to do, things like that. And then it's one thing to introduce it to them, but then you have to have it reinforced every time, so that's the tricky part, because you would think "I just told you about this!" you know,

So the consistency is also—

Very, very important.

That makes sense! So just a couple other little things—do you have to turn in lesson plans?

No. That's really—to me, I have my challenges with lesson plans, because I would make my lesson plans, but then it wouldn't go the way I needed it to go because I'd have to adjust because of the students' learning or lack of learning or any type of formative assessment. And so now, what I do and I make that available for my principal I share the document on Google docs. I use a spreadsheet, with topics and what we are covering what the objectives are, where we can find it in the book and things like that, and as I need to change or modify stuff I can do that with Google

docs, and she can still access it at any time if she needs to and see that I have my semester mapped out, but as things come up I might change or modify things.

How do you get buy-in from your students? What procedures do you use or behaviors do you exhibit?

That's an interesting thing that's really something I've been struggling the whole time I've been teaching. When I was in school, whatever the teacher said I would do it. And I would do it with authenticity, I would do it earnestly, I would give my best effort forward. And I find with this generation of students, that's not something that they are 100% trying to do. They want a good grade, but don't necessarily care about the learning that goes with it. So you can design lessons that will motivate them and interest them in that sense, really it's right where they're at, and where they think it's of use. So I deal with teenagers who think they have it all figured it out, they don't need this stuff at all, so trying to put forth a lot of real life "when are you going to use this" like that activity we did in class—this is how we can track income, that's where we use what we're doing in real life situations so I always try to bring in real life applications. But I tell them you really won't see it all until you finish your math course. It's one of the if not the most difficult things as a teacher is to try and get students to buy into the learning not just the doing of the math.

--Being able to let it sink in and have meaning outside the classroom--

Yes.

Other than for the grade

I remember at one point one of the kids saying something when we were doing something in an applied sense, and they were like Miss this is chemistry! Applied—It's like well, yes! Everything in math can be applied to many different areas. But in their mind everything is so regimented,

and all we do in math is for math, and all we do in chemistry is for chemistry, and they don't understand everything is supposed to meld all together.

Sounds like they are just starting to see that, but it's just barely beginning to register—

Yes.

What's the hardest part fort you about delivering a lesson?

The different levels of preparation. And I try to accommodate that. I flipped my class about 2 years ago. And the idea is that—traditionally, kids come to class you give them the notes they copy stuff down, you show examples they copy that down, and whatever time is left in class you have them work independently on practice problems and they go home and work independently on practice problems. I wanted them to spend the majority of time in class working on problems with me *here*, not watching me work problems, not copying down notes, the flipped model is now homework is to watch a video I've made, no more than ten minutes, and with the video I've provided the notes online, print out or copy down in your book, but you watch me work the problems or why something works the way it works, and then they take a mini assessment (I do it through Google forms and when you get into class I already know where you're supposed to be and so that's why I have these groups set up, so you're going to be sitting with someone who has your same ability level as you on the content. And then each of you have your own set of assignments that you're doing based off your knowledge.

So you're individualizing instruction doing it that way

To a point—I mean we could have 12 different groups! But I just make it four groups. The red groups were the ones who didn't watch the video, or they watched it and didn't understand it. What I've found is they didn't watch the video, they just took the assessment—so many questions wrong it was obvious you didn't watch the video. So you have to do concept building

activities, because you definitely don't even know what we're talking about. Then there's the yellow group who watched the video, got enough questions right that I know you watched the video but hadn't quite mastered it. So you need more practice problems, not more concept. Just to reinforce the learning. Then there's the blue group people who watched the video did really well on the assessment, now I'm going to give you extension-type stuff. And then the Greens are the people who got everything right. Not a lot of people are always in the green group, but they get the really challenging stuff, but we set it up this way so they are still working in groups, still working on the same concept, but it's a different assignment. So that way it helps me assess ok when I go tot this group mentally I already know right off the bat these people have no idea what we're talking about or these people have an idea what we're talking about so I have an idea where they're at.

That makes a lot of sense and it's different way of approaching the problem—you're not "spray and pray," you're actually focusing on each student—

And it works really well, but the level of preparation—I shouldn't have a red group of 13 people! You should be doing the homework—that is the main problem why the kids are lost it's not meant for you to watch the video and know how to do everything, but you should at least have that introduction! And that's a lot of the challenge is that a lot of them don't do the background work in time for the class and so it makes it difficult. They have to at least do that—that one piece. Let me show you—I have them put their agendas—at the beginning of the class they would have their seats assigned on the board, sot hey know where they need to sit, and this is the red group, this is what you have to work on, which is an activity, the yellow group has more practice, the blue group can use the inspires, more kinesthetic stuff, and the challenge is down here, and after a certain time period everyone stops and everyone does the classwork for the day.

90% of the class time is spent with students working on problems, not watching me doing things. I'm floating around to do all of that.

It's nice.

Yes it works really well for those who work it.

On the same hand I think that would take a lot of preparation and the first year going through it you must have had a tremendous amount of work!

Definitely! And then I did—I'm the type of person that if I like an idea I just jump right in—and my sister is a high school teacher in Florida, and she teaches a foreign language. She was telling me about it on a weekend and I brought it to my kids that Monday and they said they were interested in doing it and I started doing it. And there were some bumps along the way, but the second year I felt "I'm in my groove, the kids are enjoying it," then they said they wanted videos with my face included in it, which is interesting, but they are trained to listen to what the teacher says but also watch their face to tell what's important and what's not important. So this time I had to record the video and have my face be recorded while I'm doing the video. It was interesting!

Really interesting! I noticed in the class that you really know what everybody's doing all the time. And how did that come about—that kind of hyperawareness?

I guess it was because I know that because they're teenagers and one of the ladies who mentored me when I first started teaching told me a couple of very profound things. And one very profound thing was that the kids needs boundaries and if you don't provide the boundaries they'll keep pushing you and pushing you to define the boundaries for the class. If I just leave them to their own devices the teenager in them will rise up and want to be lazy and won't want to complete the assignment—but if I'm constantly on them and letting them know at least they

understand that in Ms. Riggins' room she does not tolerate off-task behavior. I try to tell them if you finish your work, fine! If it's because hey, you finish your work, that's perfectly fine you can chitchat with someone else who has finished their work. But I have to be consistent and always be on top of them, because I have two different grade levels, I have ninth and tenth graders, and all the personality that comes with it. (Laughs)

But I'll have to say yesterday when you were teaching in the courtroom and you were actually teaching. And I don't know if you realize how profound that actually is~

Really ?

Well, because you had people behind you and other people running to the gym doing this and doing that, and you still managed to get a lesson in, and it was something the kids could concentrate on and focus on, and actually do. Which I thought was amazing!

Thank you! You have to be flexible, like today with my 8th period they'll be doing the same lesson, but they aren't going to be doing it in groups of two, they'll be doing it individually. So they're gonna have the benefit of a projector instead of me having to go to take a look at their handheld, so it's gonna go a lot easier, but you have to be flexible.

The thing I'm taking away from that is that there can be a lot of chaos but if you know what you're doing, and you know what you want to get done, that's the piece about buy-in and you know they could have said "No! we're not gonna—I don't know what you think you're doing cuz we're in the courtroom, but they said, "alright— it's geometry class, let's do it~"

And that's where I really want to get them in that mindset—and I used to be in another school where there was an even lower buy-in, and I even had a little pledge sticker on the desk and every morning and the beginning of class I would have to make them say the class pledge: " I pledge to be focused, on task, and finish my work, and minimize my talking" probably a three-

sentence statement that was just an understanding that now is not the time to chitchat and socialize, now is the time to be focused on learning. At another school I had to do what I call a "readiness checker" it was in the back of the notebook like I would come by and stamp if you were ready—if you had your supplies, if you had your pencil, if you had your homework on your desk and I would sacrifice that first ten minutes of class going through and checking everyone's readiness checkers. Just so they could understand "ok, now's the time for me to get ready to work." And that helps the kids because I don't think they know how to police their own selves with that. I understand—they're very social beings and I have very large classes so it's hard—they get distracted.

How do you decide what's going on is math talk or just distraction?

I understand that if you're be in groups you're gonna socialize. My ear is in tune to—and that's why I like the usage of the handhelds cuz if their heads are together over a calculator, I know it's about math. If their heads are together over a piece of paper, it's the same. But I always say no idle hands—if I see no pencils moving or no one looking at the paper or going over the notebook, I know they're chitchatting. So that's one of the easiest ways to see if they're off task. "No idle hands!" Laughs

When can you tell a specific student right away what to focus on in a problem—whether it's a I don't understand this—or—

That's one of my pet peeves, because they're used to saying I don't get it or I don't understand, and that's it. And a teacher started from the beginning and explained it to them [again]. But because of the size of the class and the limited time, I can't do that. So I have to literally train them to be specific. When they say "I don't get it"—get what? Point to me on what part of the question don't you understand? And it's easy to see a lot of time the kids are cognitively lazy.

They don't want to take the time to spend to understand the question, so they'll glance over the question and say I don't really know what to do off the top of my head, so let me tell the teacher I don't get it. So then it's my job not to reteach, but say ok, let's be specific, what don't you understand? What's confusing? Do you not know how to start, how to set it up, do you not know what this word means, I need some specifics. I always tell the story about when you go to the doctor, when they ask what's wrong you don't just say "I don't feel good," you're specific with the doctor—you say my head hurts, my arm hurts, I've been having headaches,-- you're specific with the doctor but yet you come to me and expect me to read minds and know exactly what you don't get. And that's one of the things about math communication and verbalizing what you don't understand. I can look on the paper, with you doing a problem and know what you don't get from you working it out—but if I come over there and it's blank? I can't even help you! I can't even give you work. Like—I have their tests. I do standards based grading. I have a section here for teacher feedback because I can tell you, based off the paper, what you need to work on. But if it's blank, I can't help you! I don't even know what you're confused about! I'm like what was I supposed to do with that, you know?!

It's a give and take, and if you're not gonna give me anything, I can't give you anything back.

Exactly. That's one thing—when a kid comes over and asks me for help, they need to verbalize what they need help with. And if they can't verbalize it, they need to have it on paper. I can see where they got stuck. And if they don't have that, then I'll say "read the problem" and they'll try to read it out loud, and I'll say what does the problem mean for you? I want them to analyze what it means for them. And then once they've figured out what they don't know, then I'll come over and help them.

One thing I was wondering is how do you keep each student's ability level, record in mind? Maybe there's a student—I mean you have like 165 FTE? How do you know every single kid's needs/record/ whatever it is—like you're gonna be introducing something—and reducing fractions is part of the operation—and you know that a specific student—but how do you remember that in the moment?

That's when having conversations with students about their math background. At the beginning of the year, in the little info thing they fill out I ask them to tell me about their essential math class experiences, some of that really describes their ability, or their experience in math class and some will say well my 8th grade year was really challenging, we didn't have a math teacher, or our teacher was pregnant—and I'll say ohhh that explains about 8th grade math. Oh, my 7th grade math teacher was great, I learned a lot. So I'll know ok, this person is really strong in math. Having personal conversations with them, or having them do writings, and I do have them do writings describe the concepts we've been talking about, explain it to someone as though they do not know how to do it, so I can see where they're like understanding it. But it is very difficult—almost impossible to know every deficiency that they have. But that's where giving them the calculators—free to use—personally I don't think you should need a calculator to add 2+2, but if that's what you need right now, go right ahead! The calculator does minimize that. Also having them work in groups. Or pairs also helps, because a lot of times it's—the kids don't even realize how much math they know, they just have forgotten more math, and they might need a refresher. So you'll hear ohhh yeah I remember that—or that kind of thing. Because they do know it, but they can't recall it as quickly as you would want. So they say I don't know how to do that—that doesn't meant that. It just means they can't recall.

How do you anticipate what will help solidify the concepts you're trying to teach?

That only comes with experience. You know because there are certain things that I know every year they have challenges with and I have no idea why. So of course reinforcement, practice, more visuals, anchor charts a lot of foldables too. That helps. It's just how their mind—if they're not gonna spend the time to learning it, to reviewing it, to getting in their brain they're always gonna have problems with it, we can only do what we can do.

When do you take attendance?

With the seating it helps. I try doing it at the beginning of class. Sometimes I get distracted because kids come late or whatever, but I try and do it at the beginning of class, and once I get them seated and working I'll come back to my computer and actually put it in. But I can do attendance visually and say that person is missing, and actually go to my computer and actually put it in, then I need assistance.

Little clerical things— so that was the other thing—is there anything admin needs from you that you have to routinely process check. Is there anything like that?

They do want to know—we have common assessments—which we have schools in a consortium, get together, write it, and give the assessment to the kids every so often, like every 2 weeks. So that's kinda to me intrusive.

So a kids says that they don't get it, they look through it, then tell you where they're stuck—how do you know what to say or what decisions do you make to help that student over that hurdle?

There're several reasons why kids don't get it. And one of the ways is they're cognitively lazy. They don't want to put forth the time and the effort. Very rarely is it that the kid's just clueless, has no background knowledge. So it's really them saying I only want to put this amount of effort towards solving this problem ad if that amount of energy or effort puts me at a wall where I can't finish the problem, then I'm gonna call the teacher over, and that means me trying to encourage

them, coax them out of—I don't even know how to describe it but they're really not trying to put that much cognitive energy into it and I'm trying to encourage them to do it.

Do you think that's a habit that's entrenched?

I think it is! Think of it—like whenever you didn't understand something you would raise your hand and the teacher would explain something and even give you hints and steps on how to do it—in their mind it's a lot easier to have the teacher tell me what to do than for me to do it.

Well it is!

It is by nature, but do you learn better by the teacher telling it to you? In class I've had to repeat the same thing over and over again, not because they didn't hear me the first time, but they really were not listening the first, or second, or third time, I just say can someone else say it? Because maybe you're tuning my voice out. So in the same sense, when they are working on problems, sometimes some are really quick so I can say oh yeah, your mistake is right here—so I can tell where they get stuck and I can give them a hint to get them out of that rut. But for those people who just look at the problem and don't even know where to start, it's because they're not putting forth that much energy so you really gotta coax them. Into ok, let's think a little bit more, let's put our thinking caps on (laughs)!

That's a huge thing, just inner motivation to just say I'll go along with it—I'll play the game—

Yeah, I remember my first year here, and this is after final exams some kids had finished early and I just put this problem on the board and it wasn't even a word problem, see if you can draw it was like nine dots and see if you can connect all the dots without lifting up your pen—maybe it was ten dots. It was something that was not trivial, but they at first glance you'd think it would be trivial. But these kids started working on it before they even finished their final exam! And I'm telling them, no, you can do this after the final exam and it was shocking to me because it

had no assignment, no grade I was gonna give for it. It was nothing. But they were more interested and really motivated to figure out that problem than the forty problems I was gonna give them a grade for. And I was like why is that so? And I heard about Dan Pink—he wrote that book Drive and that's what it's aligned to, if they think they can solve a problem that is solvable, then they will want to do that. I think that a lot of times when they see our work, they think it's not solvable—by their own hands, and then they won't attempt it.

So the message may be that they are taking away from having someone show you how to do something is that it's not doable for them on their own.

Right. "I can't do it." That's their mentality. I can't do it without someone helping me.

Right. So it's a totally different worldview. Honestly.

That's their buyout That's their thing to say "I'm done with it cuz I can't do it."

See? I have a teacher, so obviously I can't do it.

That way that helps them with the idea that "I don't have to work on it by myself anymore until the teacher can come" I've had kids get upset because I couldn't get to them in time, and I'm like "well you can be working on other problems or you can be working" and they say "I waited on you" and they want to get it done but they don't want to be the ones to do it if they feel they can't do it. It's very interesting. They already decided in their mind if they'll be able to do it "oh this is a problem I can do or this is a problem I can't do. And they kind of opt out if they feel they can't do it until someone comes and helps them. Then get upset at me "but you didn't come I called you but you didn't come," and I say why are you upset?

These are ninth and tenth grade geometry?

Yes

What other classes are you teaching?

This is math models, which is an application class for students who are in geometry who need extra math help, and I also teach algebra 3 which is a senior level course after students have completed algebra 2 but really don't belong in a pre-calculus class, there's no need for them to do pre-calculus or AP calculus. Then I teach a dual enrollment class for college credit—algebra first semester and trigonometry second semester. And these are for seniors who have finished pre-calculus and not going to calculus because they're not a science or math major, but they still need a math class, and this the class they can take

And that's useful

Very useful.

Do you ever use the library or its services at all—

Well, we don't have a librarian~

You don't??

No—We have a teacher who doubles as a librarian—because we're a small school the principal is very limited on staffing, there was a librarian, but enrollment dropped, and she needed him more as a teacher than as a librarian. We utilize the library in the sense of using the computers, but nothing where they have to look up books.

You don't do any sort of research—

No—

[Moving on] So when you go ahead and map out your semester, and you take into account all the benchmarks, everything you have to get to, do you ever switch things around, I know you said you could do that, but when you do that, what's going on? What motivated that?

First of all, I like being at this school because I like the flexibility, I don't have to stick to any particular calendar, the principal trusts that we understand our content and what needs to get

done, and all the kids are prepared for the course exam or any exam that they would have to take. But I'm also at a responsibility to make sure they prepare for their next class, too. And the kids would love for me to spend time on the same topic until everyone totally understands it, but we don't always have that time. But I can change it because these kids aren't getting it, the majority of the kids didn't get it we will try something else, or the majority of the kids didn't get it, or a lot of the kids have been absent, you know we had all that flooding, so a lot of the kids were absent, a lot of kids missed it or AP testing so that just means we are gonna stretch it out. But that just means we're gonna have to shorten something else in the long run and so you can always make up time. In my opinion better than at the end you can't add time, you can just make it up. You can only do what you can do. But I try to at least be done with the content before we get to AP exams so we can add that flexibility, go back do stuff.

So you are trying to anticipate what might come down the road that you already know is part of the schedule in order to make it as easy on everyone as possible.

And that's the benefit of having taught the course before. First time teaching a course, you would have no idea so--

Even through the school year, knowing what this school does, not AP because that's nationwide, but this particular school might have—

We have this thing called law day, where the whole school shuts down and different legal professionals come in and speak to the classes and you're just like oh, so that's happening tomorrow? That's good to know—you gotta be flexible, or there's a field trip and half the class is gonna be gone, had no idea~ so some courses get the condensed version, and some kids don't.

For your videos, how much of that is covered? Is that pretty much the whole semester, everything you teach is flipped and it works for you?

Yes—it works for me. It doesn't work for them if they don't work it, so if they're not watching the videos and then I've heard so many different excuses, but they're just excuses—I mean, you have two classes where you're in front of a computer, you know, you're in a computer lab doing credit recovery or even on your phone! You have a phone that you can use. I don't take those excuses, but the ones who really enjoy it are the "student" students. The ones who don't enjoy it are the ones who are *not* students. Once in a while I'll take a break and do direct instruction. And they really do like that because #1 it doesn't happen that often, therefore they really are paying attention. What just took me 45 minutes to do takes me 10 minutes in a video, because I don't have to answer the same question over and over again, and having to repeat myself and go you can slow me down on the video—

That's the other thing too, you're not just doing that all the time, you're doing notes, and you're doing foldables, and you're doing other stuff, it's not like it's every single day canned instruction. And it's hard for the parents to understand, because the kids will come back and say all we do is watch videos [and parents will say, I didn't know it is an online course!] and I'm like it's not! It's a ten-minute video twice a week! How is that an online course?

Somebody's gotta be the vanguard, trailblazer~

So it comes with its own challenges…

How did you get that—you said that your sister told you she was doing it? Cuz they tried that at Spring Branch in the middle school and the math teacher came over to me before school started and said you've got 6 imacs and ipads, that's great—and now nobody's doing it. One of our colleagues' son goes to the middle school and he said, "we pretty much sat around and did nothing." So it was kinda like these guys didn't know what they were doing, I don't think they had enough professional development—

Yes, or freedom or flexibility—that's a possibility. Trying to follow someone else's model, although you might think you want to know exactly how someone else does it you really don't because if you do it exactly like someone else does it, it doesn't feel authentic. I'm naturally a computer geek at heart, but a lot of times we spend time focusing of the newness of the stuff but how are you gonna use the newness in the classroom? So with the videos it really helps that I'm spending most of my time thinking about how the class is gonna run after they have watched the video. I'm not putting all of my efforts—that's why even when I record the videos it's a 1 stop shop like if I make a mistake I'll say oops on the video I made a mistake not gonna go back because I don't start over in class I just say oops I made a mistake, and I'll erase it. What you do so don't spend a lot of time making the video, spend a lot of time thinking about how now that they've watched the video how are they gonna use what they learned?

I see. I didn't think about that, but that's pretty important, what's the next—kids have watched this, now, what do I expect?

How do I take advantage of that?

So even when you're recording the video itself, you're going to be anticipating questions that might come up, and because you've taught it so many times you are aware of where those sticking points might be—

Yes

That's fascinating. That's the best success I've heard of using flipped—I think it's a great idea but I don't think people understand that talking isn't teaching… They don't realize that, they think that's gonna do it, and it isn't.

The whole reason I did flip is because I want the students to spend more time working instead of just listening—

Much better if I have something to do—

Break it up into chunks, we have 1.5 hour blocks to sit is a very long time. So that's why I do give them freedom get up and walk around, and go get things in the room, things like that. I don't give them just one assignment, I give them two different assignments, so they don't have to continue working on the whole class period.

Somehow you've managed to extend that time because they've had a chance to look at it, and it kind of sank in a little, and they come to class to work on it with a guide rather than sit at home and do homework, which kind of makes no sense—

And I understand their frustration and working. You don't have a math teacher at home.

You might not even have people at home to help

I used to have this article about homework what I can do as a parent to help child with math homework—just ask what's the problem, and if they can't communicate that, ask them where their notes are, ask did the teacher do something like this in class, there are certain things you can still help with homework at home without even knowing the concept, but even then, when they get higher in math it becomes more complicated. So let's take that out of the equation. All that you do for homework is go home, watch a video, print out or copy down the notes, and take the assessment. Then in class, they're with the teacher who can help them.

This is really encouraging. You're not using technology for technology's sake, you're using it as another tool. That's awesome, too.

If I could, you can take away the smartboard and you can give them tablets so I can have them working on something, but that's the thing!

APPENDIX I

PARTICIPANT 4 INTERVIEW TRANSCRIPT

What are the steps you take in order to be ready to be "on" in front of students?

It's different depending on the class. Like with my Algebra II classes in the past what I've done—I go through the beginning of the unit I'm going to teach and I write down everything I need to teach that unit. And then I start deciding how to piece it together so it'll flow together—and so I can give a little bit of data here so we can come back and pick it up later in the unit, and I decide how I want to piece things together and each day what's going to be taught. And each day what I would do is I would decide what examples I wanted to use, what things I wanted to make sure they got out of that lesson. And I would do a lot of questions. I write down what questions to ask, trying to get the higher-level questioning in. I don't tend to do that so much anymore. I piece it together still I know what I'm going to cover, in which order, I do that part of it, and I have down what I'm going to teach each day, but I don't have to map out anymore exactly what I'm going to do in each class. This is my 18th year teaching algebra II, if I know this is what I want to teach that day, I now what examples I want to use. Sometimes I'll look in the book for extra examples. I think I've taught it so much it's just been in the last three years that I've moved away from "step-by-step make sure I cover this."

It's like anticipatory or reflection before the action. You think it over and so after having taught it that many years you kinda know or can anticipate where kids in general might have problems in understanding.

Yes. I can just remember where they've had difficulties, and if they're having extra difficulties I can see it on their faces. And I can always come up with another example. I would overplan, but not for time; I would overplan for they need another example of one and make sure I would have

another example, it came out the way I wanted. The way I teach is I kind of build—so let's do an easy one, let's put something else in to it and do a little bit harder one, now let's pull everything together and do another one. I always give them time to practice. Here's what I did, you practice. Here's another one that's harder. Now you practice that one. So now they've seen me do it and they've practiced doing it also. They need one more of something to make sure they get that base, and then we'll just pull out another example.

Do you have to turn in lesson plans here?

We do, but they're not very exact. They're just a general "here's what I plan to teach and what days I plan to teach it." And what I plan for my homework to be. We don't have to go through the whole what TEK is it and all of that. So—we're very very spoiled because we don't have to do that. There are teachers that do here, but that's because—something's happening that's not they're not thinking through their lessons well, so they're wanting to see how they're thinking through their lessons. But my students end up doing well on any test that they give them, on any standardized tests, so I think I have the privilege—they know I'm covering the material, so I don't have to have lesson plans that are particular and exact.

One of the things that I noticed that I see like today with Joy and the food—you have a hyperawareness of what's going on in the classroom. How did that come about?

I have no idea! (Laughs) What I do—she was making a lot of noise—but I'm always scanning and I try and look at people and it's not hard—I have to remind myself sometimes—because I'm always scanning to make sure are you on task? Are you listening to me? Are you writing down what I'm asking you to do? What is it that you're doing? Are you kind of zoned out—I noticed in first period I noticed that you were writing down a couple times that I kept calling on a couple people *I'm up here* kind of thing—I just—I don't know, truly I just kind of do that. And I'm sure

it's built over the years and what I tend to do a lot of times and my student teacher didn't understand how I did this, but usually if there's a question, not necessarily an AQR especially with this cuz they have questions about things I don't know but a straight math class—their question usually is about something I'm just about to cover. I'll just do this—I'll acknowledge that they are asking me a question and put up a finger for a minute, and they know by the second month of school, just a minute, I'll come back to you. And then I don't have to say that anymore. And then I'll finish up what I'm doing, or the example, or answer a question that's already been asked. And I would say 90% of the time I go back and they say you already answered it—and it's almost always the next thing I'm going to say. And that's because I think I know where their mistakes are, I know what kind of questions they ask. And it's not something I consciously do—I just have developed it I think over the years. But you'll see me put up the finger wait a minute--and then the student says, you already answered it.

How do you use texts in the classroom? Or do you? Or do they go home—

I have a classroom set of textbooks. I tell the kids "don't bring your textbook in here. You don't need to drag that thing back and forth between school and home. Leave it home. Just don't lose it! And have it on a shelf in case you need it. I use it more as a supplemental. So if you need another—you don't understand what to do and you want to read it in the book, it's in this unit. Or it's in this chapter. I prefer doing worksheets, and the only reason is that the way I group things is not grouped the same way in the book. And I may want you to do about five problems from this section and five problems from another section, and ten from this section—for these reasons—I've learned over the years, and especially from teaching freshman—you ask them to turn the page, and they decide they can't do it and they just stop. They don't do all of it. You give them a worksheet—all I have to do is finish everything on this worksheet, I have a stopping

place, I don't have any more I have to worry about—because if they turn the page they don't know how many more they have to do—I prefer worksheets. Now, this last unit I did with algebra II, it's all out of the book. The reason was because there was AP testing, there was standardized testing, all these things happening, and this way the students were absent, they could just go to the book and learn from there. As a rule I don't. I use the book as more of a tool, and if I have sub, I'll give bookwork, because then they can teach themselves and it's something they can turn in. And I have a classroom set. But I don't really teach out of the book pre se.

One question I just wondered: do you ever use the library?

Not anymore. With AQR (advanced Quantitative Reasoning) at the beginning, we did go down to the library for the computers, because there are some research elements to this class. But I ended up getting laptops this year. We had some leftover laptops from a couple years ago. I usually put them in groups of 2 or 3. They can bring their own laptops, they can use theirs or mine, so we can do all of it from there. So I really have no reason for going to the library. The reason used to be for the computer usage. Especially since I got wi-fi. I just got wi-fi this year. And so before I didn't have wi-fi and needed someplace that could access the Internet, but now I don't have to do that anymore. Now in the past I have given students online quizzes, and so especially the first time we took an online quiz, we don't have a computer lab but the library duals as our computer lab also so I would take a class in there and the first online quiz we did together in there so I could walk around and make sure everybody knew where to go and understood what to do and answered the questions, so I have used it in that aspect. But only as a computer lab really.

But that's another place where you're anticipating the students may have problems so you're setting it up so that they have every chance of success rather than cutting them loose and letting them try without knowing whether they have enough skill—

I worry that I baby them too much~ I hold their hands too much and maybe I do, but with math—math is such a tightrope. Because some of these students are coming in with these terrible math experiences, and you just want to hand hold until they can get past that, so that they can feel more successful, basically. You want them to feel successful, but you also want to challenge them, so it's a real tight rope to walk. So I usually err on the side of making them not scared.

Makes sense! So, when you're doing a lesson delivery, how do you anticipate what will help solidify the concepts that you're trying to teach? You kind of answered it a little bit but let's talk about that a little more—you have you have your focus, you know what you're going to do in the whole unit, and them you break it up to the steps you it's gonna take to get to that final point—but how do you – when you're standing in front of the students, what decisions do you make, what content do you bring in do you think, or where does it come from that helps you to make sure that what your telling them is going to help build the next concept?

Right.

By getting them to work problems it makes a big difference because they always tell me (I've always had them work problems in class) they still say, "well, when you did it in class it was so easy, and when I got home I had no idea what to do." So I try to be extra careful about what was the first step, what was the second step we did, what was the third step we did. And some of them write it down and some of them don't. I try to explain what my thought process is. "Okay I looked at this and I had to make a decision about this and then I chose to do this and this is my

reason I chose to do this"—and some classes like this and some classes glaze over and don't listen to it. (They won't even listen to it anyway I just won't worry about them).

So It's kind of—

It's what I'm getting back from them. What did you need? And I'm offering this and if that isn't helping I can offer something else. And I think it's probably because I have a degree in mathematics, I have a full understanding of math especially this level math, if you asked me about calculus I wouldn't be able to help you right now—but this level of math I have a very full understanding of what it is we're doing why were doing it, and where it's going next. What this is doing and try to make sure they understand conceptually rather than "here are the steps you take to do it" because nobody's gonna remember the steps, but you'll remember concepts. So I think it's because I have—well, I have another thing that doesn't happen anymore, but up until probably five or 6 years ago, every single year, I would see something I had never seen before. It was so great! If you knew more math you would see how cool this is! They say, "you get so excited!" and I'd say, "Y'all don't understand why this is cool, but this is really really cool." And what it was is that I would see how other things connected together that I had never seen, that wasn't something we taught in class, but it was something that mathematically fit together and why "oh, now I understand better why this happens because this happens because this is gonna come around" whatever it was I can't think of an example right now—and it would happen in algebra 1 and it happened for a very long time in algebra II and it just doesn't happened anymore and I kinda miss that! I kinda miss it. But I love math. And I love how all this stuff just fits back together and I like showing them that it fits back together. I was telling you the other day I like to sprinkle (math facts/information) a little bit because then I want them to make the connection. I don't want to be the one telling them "look how this connects" I just love it when they say, "oh!

That's what we did over there and this happens here and that happens there" and that is the best feeling ever. Because that's why I sprinkled it through so they could have that reaction, so they could have that experience for themselves. So now you have that experience for yourself, hopefully it makes a connection stronger, and you get to succeed at math and you get to make this connection that—I knew you were gonna make that connection, but you had no idea where I was going with that. But that's what builds, that's that feeling in math that I just love, for me even, "Oh my gosh I saw that! I came up with that on my own! Who knows who got me there but I came up on that and I was able to find it." And that's the experience I'm trying to create, because that's the one they make connections to. And hopefully makes them not scared of math.

Take the chance, and try again--

Exactly, and have some kind of success.

How do you keep each student's record in mind? How many FTE do you have? And how do you know each kid when you're standing there and you know ok so and so this is what you were talking about earlier or knowing that this kid hadn't had enough practice in reducing fractions like we had talked about. How do you do that with each kid?

When I grade I'm bad about grading—well, I grade quizzes, because on homework I just do completion—I might spot-check a couple things, but I am asking did you show all your work and did you do all your problems. You have to show your work. I take off big big big points if you don't. So if someone skipped a whole section I look back to see who it was and I kinda keep that in the back of my head. If I'm doing a quiz and I'm seeing they're making the same kind of mistakes I don't usually look at who I'm grading at the time, and then I go back at the end of the quiz look at who I've graded, and keep that in the back of my mind. I might forget, but by around Christmas I have a really good feeling of what you are successful at and what you're not

157 successful at and I can kind of watch out for that then as we move across the year. It takes me at
158 least until Thanksgiving for that to happen. And then I feel much more comfortable with the
159 students. We have them for the year, we don't do semester. I'm able to carry that over into the
160 spring semester and be able to watch out for things I know and I know they have a problem with
161 this so I make sure I ask them a question in class, or I know they nod off or zone out, so I'm
162 gonna make sure that I ask them a question in class—you're falling asleep in class so you're
163 gonna stand up in the back of the room. So that's what happened with Sarah, she asked to stand
164 up.*I was wondering about that.* That's the rule: if you're falling asleep in class, go stand up in
165 the back of the room. (laughs) I keep an eye out for it I know what questions they're asking. I'm
166 thinking about Hannah from first period. If she's on, she wants to know what's going on and
167 she'll ask me questions in class. If she's feeling overwhelmed, she'll just shut down and so that's
168 when I have to start gong back and asking her questions. With today's stuff I try to make sure
169 that I remember something someone asked or they asked a really good question and I want to go
170 back to that I try to make sure I remember who asked that question because this makes that
171 person feel that I'm paying attention and that I understood what they were asking or I like the
172 point that they made they made a really good point. Let's bring that in again because that was
173 really good, and that's answering that over here. So it's kind of an interpersonal thing and it's a
174 habit now, something I try to make sure that I am able to bring that back in especially on kids
175 that feel beat up about something. I want to make sure that I'm bringing back their stuff just to
176 bring up their name again, just so they know I'm watching them watching out for them and some
177 of them watching them!
178 *When you see a blank look on a student's face, what kinds of things do you—I know you're in the*
179 *moment doing your thing, but what do you think you're doing when you see a student just blank*

and not getting it? So what do you think you do to reroute or redirect or what do you think you do when that happens?

I will say what do you need? You tell me what it is you need. I lost you somewhere. Where did I lose you? They'll come in at lunch or for tutorials and they'll say I didn't understand anything! And I'll say, you understood something… Something in there because we need to figure out where you stopped understanding so that's what we can address. So I'll say where did I lose you? Where did you get lost? And by this time of the year they'll say I understood that and I understood that, but then I don't know what happened. A lot of times I will ask them show me in here where you got lost, so that I can address that. Sometimes I just have to reword it. Sometimes I have to just say it again. I tell them I get to talking very quickly sometimes. I try not to, but if I do, raise your hand and ask me, because we want to make sure you leave the room knowing what happened. I don't like—this is my first year to put them in groups of four like this and I like it a lot. Mainly I like it because I can get to around the room and I can get to everybody. I like that a lot. What I don't like is that they feel like they should ask their neighbor how to work something. So now they're not listening to me and their neighbor is not listening to me either. So I tell them don't ask other people, ask me. Because if I don't know what you're having trouble with then I can't help you. And if other people are having that same question I can address it. But if you're just asking your neighbor what it is I can't help you. And I do tell them the fifth time I've explained something and you still don't get it, you need to come in for tutorial. Cuz I cannot explain it again and we just need to sit down one on one. But I really am looking for where I really try to pull that out. I want them to know that I've noticed that they're lost.

So it begins with the decision you're making about this blank look that something didn't—

Something didn't connect. Yes. You just need to tell me what it was. Or if I notice multiple blank looks, I'll say ok let's stop for a second and let's just go through what I just did, and I'll go through the problem and I'll ask them questions and I'll ask why did I do this step? And why did I do this step? And I tend to ask global questions so anybody can answer back, but if I'm worried about a particular person I may ask that person in particular. But "let's walk through what just happened" and usually if there's a lot of blank stares, that usually takes care of it. I just needed to reword it. Something I said wasn't quite right. Half the kids got it. And they understood what I was trying to get to and maybe I said something incorrectly "why is that a 3?" "oh, it's supposed to be a 2. Sorry." That happens. I try to get the kids involved. I try to start asking them questions about it so that they can find it.

It gives them permission to ask questions. You have that atmosphere where questions are ok and they're encouraged, and it helps more people.

I had this one student I'm thinking about the other day. I said "ok. Tell me what I did here." And I was talking to one particular student. "That's what I don't understand." And they were able to talk to me about it but when I started walking them through it, they said "that's what I needed to know." And they were able to verbalize it. Which I can understand. A lot of times I don't know enough to ask a question because I don't know what my question is. So I can completely understand peoples' concerns. So that's why I try to walk them through it so they can process it a little bit better.

Which helps build their understanding as well, it really does. So at the very beginning of the school year—and you have these kids for a whole year, which is great. What are the things that you do to start everyone off in the same direction? Are there any routines that you do that become part of the time kids are in here? Is there anything that you routinely do every year?

Not really—I don't think. I've been lucky that a good third of the students that I have in algebra II I had in algebra 1 so they already knew my teaching style was and what my expectations were and students can tell the others "don't to that. She gets mad." Laughs. So I've been very lucky that I had already had established those things with them over the course of a year. And I had them as freshman. So as juniors I can be a little more laid back with them and they are like "you were never like this when I was a freshman" and you can't be like that with freshmen! So it's really been nice that I'm able to do that. So I really don't have to establish too many things. Basically I'll respect you, but I expect it in return. We respect each other, we respect our classmates, we don't say anything inappropriate. But we can be a little more free with each other. It's very—there's no foul language. A very professional type of situation where it's fun, we can have fun, until we're not learning anymore and then we can't do that. We can't dissolve so much that we're not learning anything. So what happens is that I kind of set that standard that this is how I will act, and this is my expectations of the way you will act as well. I teach kind of at an upper average level usually so that kids that struggle can reach it and kids that are already pretty good at it can be challenged a little bit. I feel that if they need pre-AP, they should be in a pre-AP class. I like teaching on level kids. Those are the ones that struggle and those are the ones that need the extra help. If they say, "this is boring!" You should be in a pre-AP class. And I tell them that at the beginning of the school year in my algebra II classes. This is an on level academic level class. If you need to be in a pre-AP class you need to talk to your counselor. Because this is an on-level class and will be taught as an on-level class and the kids that are on-level are very happy to hear that. Of course last year I had some sophomores that said, " I need to get into the regular class." And I say, "this is the regular class." And they say, "This is hard!" Well I'm sorry, but this is the regular class—perhaps you should come for tutorials! But I have those types of

expectations. I want a comfortable room where they feel comfortable with math, and with not understanding and comfortable enough to be able to approach me. I want to be approachable. Still with that distance, you know. I've seen teachers that are too approachable. And I do know the math. Every once in awhile you have a student who wants to challenge you on that. No, I do know the math. I have a degree in mathematics. And you're in high school. (Laughs). I do know more math than you. Here's what it is, here's what's happening this is where it's going, and if I don't know I'll tell them. I don't remember, I just don't. The on-level kids appreciate that. Pre-AP kids expect you to know a massive amount more than they do. And it's been years since I taught pre-cal, years! I've never taught calculus. I've taken calculus, but it's been years since I taught it. I know where it's going, but I can't tell you specifically what's going to happen. So I like regular kids. Pre-AP kids are a little snarky sometimes.

But is seems like with the on-level kids, sometimes that spark that connection happens, it changes their whole life because they don't think of themselves as math failures anymore. They realize that they can get it.

And I think that's a very important person to be is the person who can give them that. I think it's even more important for me than a pre-AP kid. Pre-AP kids, those are the kids who are gonna go on and do mathematics, and I know that. But these kids have to still have to take math to get through college.

That may be the social worker, teacher or—

There's a huge number of things they can do. I just want you to be able to get through this. I had a student come in at lunch this week, and she said, "you know, I just took a math class." "Fantastic, how'd you do?" And she said, "great! And he taught just like you." I said, "really?"

And she said, "yes. I've never had someone else that taught like you and I'm so excited and I wanted to come by and say thank you and for all the stuff that you had done." Very sweet.

Probably the best reward of all the whole thing! I think I've covered everything—how do you foster buy-in? I think you talked about that a little. How do you foster that with kids who are just here because they have to be? Because they are. By now they'll follow you anywhere.

They've had different math experiences. I think it's the personal relationship I have with them, I really and truly do. Lots of people can teach math. Lots of people can get the information across. But I like the personal aspect of it and I like them to have a personal relationship with the math. Which sounds crazy, but I want them to see where this is going, and I'll tell them jus stick with me and we will get there. And so I kind of go around it, and we come back and they say that's what you were doing! That's where you were going with this! But then they are able to see it. I like looking at it holistically and then figure out what the particulars are. Let's look at what we're doing. Just stick with me for a minute. Just look at what we're doing. And then let's go in and figure out how to get there. I've said put your pencils down. Just write this part down. And put your pencils down and just watch me do this. I'm gonna talk about it, I want you to pay attention to that and not try to write down everything I say. I'll give you a chance to write it down. Then I can have a discussion with them about it without them having to frantically write down everything I say. I know some people give students notes. I don't like doing that, because I feel there's something that—two reasons: on is when you get to college you need to know what to write down about notes. And also because watching it hearing it seeing it writing it I think that writing it is an important part of that, too. And if you're just watching someone writing it you think "yeah, I can do that!" But you didn't do that. So I think that's important. I also probably—this may answer a lot of your questions—I have been told that I am an extremely right-brained

person. Which I find interesting that I'm right-brained because I love mathematics so much. But I know when I taught jr high for a few years, we took a test (Colors) they put us in order, here's the people what were both and left-brains over here and right-brains over here. And on the left-brain side, you have our math Department Chair, science-y people. And I was third from the end of the right-brained people. And the principal forever called me her right-brained math teacher. And I think that it's just the way I approach things. I like approaching it: where am I going with this, and how do I get there. I'm told I cycle around things and maybe that's why I do the sprinkling thing because let's see a little bit I don't want you to have to do everything at once. Now let's pull it together so you can have that experience of understanding. You can get excited about math. I'm looking more of the interpersonal I think. Maybe that's the right brain in me coming out? I don't know But I like having fun with them, joking with them, hearing their little jokes. You get a class of 33 like my fifth hour at the end of the day, and you just say sorry guys I just can't do it. Y'all can't do it because I just don't trust you, I can't do it cuz I'm tired, you know still get the—I could ask anyone in that class to follow me and they would follow me. I think it's they know that I care. And one of the things they've always told me, and I find this probably the most I don't know if rewarding is the word I want to use—that I'm fair. That I have a rule, and it's that same rule for everybody. It's not this rule for someone and this rule for someone else. It's the rule. And it may be harsh and you may not like it, but it's the same rule for everyone. So you raised that expectation and that's the expectation for everybody. But then I care. I want to know. And so I'd like to know what they're doing. But sometimes we're not able to but they know I care about them. When I had my student teacher—there was a student who was drawing when the student teacher was teaching. And tore it out of her book and told her I was going to send this to your mom. And she just put her head down and started crying so after

class I said something to her, I was really very angry, and she said "My mom's dead!" And I said "I did not know that. I am sorry. Do you want to go to the counselor?" And she said "I don't want to go to the counselor. Nothing helps!" And I said, "let's go down to the counselor. You can't go to class. Come on. I'll walk you down to the counselor." I walked her down to the counselor. I had no idea her mother had passed away last year. She passed away last year and I said "well, why didn't y'all let us know?" "We figured it was fine now." It's not fine. I was very angry at a lot of people about that. So that day they emailed out: don't forget her mother passed away. Well, I didn't know her mother passed away! The next day, the student teacher was here the student went out. She said could you check on her for me? We sat on the porch [of the portable] for 40 minutes and we talked. I said I was sorry for her loss and I hugged her, and she hugged me for like five minutes and cried. I and I said cry all you need to. And she said people tell me to stop crying. And I said then people are stupid. She said it's been a year. And I said people are stupid. Cry as much as you need to. It's just that kind of thing—they're kids! You have to be there for them. When I taught 8th grade we took them on a field trip. There was this group and I was the youngest and I got the jerks in my group "We don't want to give these to the parents" so they gave them to me. All right. Whatever. So we're going around, and they're the ones who had just been jerks to me all year long. We're walking around, and I love elephants, and they knew that. One of these girls who was just—on the road to being a little gangbanger. She says Ms. Harlow come here. I said, "no, we're going this way." She said, "no, you have to come here." I said all right. And all of the kids are standing there staring at me. And it was this huge mural of this elephant. And I had seen it before but I said Ohhhhh so cool! Thank you for showing me that." I gave her a hug, I said this is fantastic, and all the kids start laughing! They were mine for the rest of the year. As we were leaving I thought, as much as I get angry with

them, they're just kids! All they want is for someone to care. And that was like my second year teaching. And I think that developed everything else I've ever done. I always in the back of my mind I think they're just kids!

It's a process, too. The kid who comes in tomorrow is not the kid who comes in the next day.

That's the truth! That little group—one day I'd given a quiz and they were talking about ecology. And I was using an overhead back when we used overheads. And he said why don't you turn that off? And I said you won't be able to see the problems—and he said no, there are only three problems, write them on the board, turn that off, then you can save some energy! You are right that is fantastic I will do that. And (quietly) quietly he said, *welcome.* He was mine after that. Oh something I do at the beginning of the year: I make them Yay each other when they do something good. They start this in freshman year and they *look* at me, and I say "you better yay them!" If you do something good we're gonna yay you too. After four weeks they say, "we didn't yay that person." So we clap and yay that person. So when I have them in Algebra II, we start yaying and the ones that had me, yay, and the other ones go, "what?" and I say: you better yay! And the students say, "You have to yay people. This is her rule." So if you've said something that was good, that has to be acknowledged. I've observed different teachers and different classrooms and this one teacher, we're very good friends. And she would say, "mmm. Good." And she would move on! And I was like no! That was a really good jump in understanding. There needs to be some kind of acknowledgement of that. And that's when I started making people yay people. When I taught middle school we had this one girl I had an observation one time. And I had this one girl who was learning challenged. And she sat in the very front, and very slow but she was mainstreamed. And she was like looking at me and she was on for me and I said I think you have the answer and she said I do. And she gave me the

answer. And I think that was the first time I yayed anybody I said that is so great! That is exactly the right answer! Let's everybody yay! so and so. I remember my observation (principal) said this is a student that no one thinks can do anything, who is very slow, but you should have seen her beam when everybody did that. And again they just want to be acknowledged that this was something good. They had the answer. And in a regular class that's what they are looking for. They need that kind of support to help them over that hump to see that they can do it. And I tell them, I know you're not gonna major in math, but you might~ you never know! But I want you to leave this room and not be scared of math. That's my ultimate goal. That's it!

That's great, and it works, obviously.

Yes, and we've got great kids here, we really do. But they would do the same thing for me in middle school too. I think it's—I took those tests in college that said what should you do? [for a profession] no—me—nobody in my family is a teacher, in fact my dad's the only person in his generation who went to college, and I'm the only one in my generation who went to college. And I thought I'm not gonna be a teacher! There's nobody in my family that's a teacher! And I took these tests and they kept saying be a teacher. Well. When I decided my major was math, you could exchange advanced cal 1 and 2 which I was terrified of, if you would do student teaching. You had to take a couple classes and do a student teaching stint. I thought ok. That's a good trade-off for me, because I was scared of this advanced cal 1 & 2. And my second week student teaching, I went, I like this! I do! Maybe they were right about this. So I thought, I'm gonna teach for three years. Three years, if I don't like it I don't have to do it, and I was probably six weeks into my first teaching job, which everybody—and I thought this is what I'm supposed to do with the rest of my life. They were right, I was wrong! I can't imagine not doing it. And I've

385 thought about trying to get out of the classroom and doing other things, and I've applied for other
386 jobs, and it never quite fit, and I think it's because this is what I'm supposed to be doing! I love it.
387 I do.

APPENDIX J

PARTICIPANT 5 INTERVIEW TRANSCRIPT

Just a few clerical questions so that I know—do you have to turn in lesson plans or anything like that?

They ask us to turn in lesson plans, I give more of a monthly calendar, is what I use.

So they have a blue print for where you're going.

Right, my students do. I can give you a copy if you want.

Sure! That'd be great.

Since we're finishing up the topics that we're doing for precalculus, then it's TBA in terms of review and things like that.

So the kids get this every month.

Correct—well, actually every six weeks. So, six weeks starting April 7, all the way down to the end.

As a student I think this would be really helpful.

It's nice to know what to expect. I mean that's important.

Right. Do do you take attendance at a certain time of day, I know at some schools you have to have it in by a certain time.

Sure, we have ADA attendance, that pink slip up there, I'm supposed to have it in by 9:40 and I try to. Sometimes we start the class and things are going, and I may do it at a later date, but it's important to do it then.

I agree. Some people wait until the end of the class and do it by who was there, visually—.

Yes--.

So, walk me through how you prepare for a lesson. Let's say you're thinking about it from two perspectives. First of all, your thoughts about how you get started in the year, and then also maybe a particular lesson, so it's kind of two different things—you're getting ready for the overall year, but then, maybe you're preparing a lesson. Were there some specific pitfalls kids had, and, knowing that you did something different, or whatever.

Sure. The overall picture, one idea that we've done that I like a lot that Jeff Schroder the department chair, is we print out large calendars and we put every lesson that we want to teach on a sticky, a separate sticky, so we've got this huge calendar like this, and then we can say ok here I want to put this, this, this, this, and see how it all flows, and then maybe there's not enough space, maybe we want to stick something in, so we can easily move the stickies around to get a big picture of what we want. And then I'll make all of the six weeks calendars in the beginning of the year, and of course they can be tweaked as time goes on but I have the big picture in my mind of what I want for the whole year. And then, individually I use a note-taking guide from Stu Schwartz for pre-calculus, calculus, and cal 3. So I already have the notes ready and copied, but I also have my extra notes to go along with it. So I'll have in the margins "stress this particular point," or "bring this up," because it's not in the notes. I mean, no textbook is complete whatever you are using, so you have the things you add in, keeping track of it. And then also as I'm teaching things then I reflect on it at the end of the end of the day and I think ok, what went well, what didn't go well, and make those notes for the next time. So those are the types of those things that I use.

That's what I want to know. That's great.

Good. I can show you, too—like here are some of the precalc notes. This is an introductory set activity, Tower of Hanoi, and actually I am excited that Planet of the Apes part 3 is coming out

because in part 2 they had tower of Hanoi in it. And then this is another activity having to do with 4 4's, a story that I've read. Because we're about to get into logs so there's a relationship with all that. But this is the beginning of the notes. And here are things on the sides, extra things that I want to comment on. And since the note–taking guide, all the things in boxes are things the students don't have.

Oh, ok—

So as we're going through it, we're keeping track and they're writing extra comments in and working the problems. So it just makes it easier time-wise they're not writing down every single note, and they will need to be used to that to some degree in college, but this allows us to do a lot of material, and so you know, just extra little notes along the way. And then, this is a separate activity, I have them do dinosaur comics at some point in the year. This is a blank template that is – it's online, there's a guy who keeps up with comics and sometimes they're math-related sometimes they're appropriate for school, sometimes they're not but I give them a blank one and have them comment on a certain topic. Here the dinosuars are talking about logrithms. Just to make it light, or at least something separate and then again all of this and talking about Euler, and Euler's equation

And it's kind of conversational tone

Definitely. So that's what I use.

Important not to make a difficult subject harder than it already is!

Sure! Kids have enough trouble. So we try to mix it up a little bit but at the same time there's a lot of structure and the kids know what to expect.

That helps too, I think.

Yes.

So what's the hardest part to you about delivering a lesson, let's say?

Keeping the students motivated, inside class and outside class, I try to find things that I think will be interesting for them, real world applications, but it's still hard to always make them interested in what we're doing.

So how do you foster buy-in from your students?

I don't know, um—

I think, looking at what you're doing that's part of what it is, that you have things that are not "talk at you, you take notes, we do a test" its not—there's a little bit more spice to it that just straight up—

So definitely I use that, and then other things that we'll do, or I try to go to at least have a relationship with the students, teacher-student relationship, in that I'll try to go to one of their activities, all of the sports we have, or fine arts, or whatever it happens to be, and try to make a connection with students that way. We do things in class, we'll do group work at different times—we have a nice schedule here at West Side. Monday-Tuesday-Friday is traditional 1-7, Wednesday Thursday is alternating block, so we have an hour and a half with students on alternating block days, so that lends itself to doing more lab type of things or activities so we'll do group work on the longer days, we also try to fit in a video called the story of maths, which is about math history from England, but it talks about the world math history, starting in the Middle East in Egypt and that area and some of the influences that mathematicians have had and kind of going out from there. So different things to connect them, and have them feel like they're connected to this class and what we're doing.

It would seem—I'm a history major, but I would feel like I knew a little bit more about how this subject fit into the bigger picture that's really kinda cool.

Yeah.

This is kind of an odd question, but when you're standing up in front of students and you're telling them about something, what do you think in terms of where you are as a teacher, how do you know what to say in the moment? When you stand up there, and you're telling them something, whatever it is—new concept—how do you know what to say? What influences what you say? Without leading you—I mean just imagine you're standing up there and you're doing this what do you think is going on in your—you're talking to them, but you're also trying to—

Trying to get feedback—get a feel for their understanding. I guess mostly just calling on individual students and I get a class response too but that's usually students that are less shy for whatever reason because also I think they've been successful in their responses and they don't mind responding again, so these are the kids that are probably going to get the answer right, but that's not every kid. So calling on different kids and trying to get a feel for their understanding and what needs to talked about again, but I'll definitely repeatedly ask are there any questions about this part or it's also in the wording. I've gotten a few ideas from other people in terms of "what's a question that you have?" Or asking in a way where it implied there is a question. Or when student are working at the board or working a problem out, what is your guess? Making it light where it's just a guess, could be wrong, but it's just a guess. So try to keep the pressure or the stress low because I think everybody feels pressure or stressful when they're in front of other people and answering a question of any type—even asking a question can be stressful. So trying to keep it on a light level where they feel comfortable around their peers asking those questions or answering those questions and letting me know their understanding.

Can you and if you can, when, if you're watching students work, how do you tell a specific student right away what to focus on? It might be in a tutorial situation, but how do you suss out what it is they're having a problem with, or watching a student struggle—

One thing that I do I guess, is—another idea definitely all ideas are from other teachers that I have—think pair share—so I may talk about a topic, kinda like in the note-taking guide, I may ask some kind of general questions, but then it's specific, working some practice problems—I'll say ok, we're going to work this individually, think on your own, and then I'll be walking around and taking a look at what they're doing, and then I may make a comment here or there, "you may want to look at this part again" that type of thing. That's another way of getting feed back somewhat quickly how many of the students are doing, not all students, I can't see it all, but walking around and looking for quick things that then maybe I might want to comment too in general and say these are some things I'm noticing from a few students, you're missing this part, or you're making this assumption that isn't correct.

When students get off-topic or are not paying attention, how do you deal with that?

In different ways—sometimes I've been told given the advice to stand close to a student, proximity kind of reminds them that they should be on task. I'll call the student out, "Johnny, you need to work on what we're doing" or I'll call on them to answer a question and that gets them back into it. If it gets repeated, and sometimes I may move the student or I'll ask them to step outside and I'll talk to them individually.

How do you anticipate what will help solidify the concepts that you're trying to teach? The anticipation is what I'm interested in.

I guess practice—with mathematics I think that helps a lot practicing the topic. That's the idea of homework and things like that. And kind of summarizing at the end and saying ok, we're done

with this lesson, this is the big idea I want you to get out of this, and make sure that it all wraps around and makes sense to them.

When we're talking about each individual student, how do you keep their record in mind, in other words maybe this kid has a certain hole in their learning and you'll have to come back to it throughout the year to make sure it gets sufficiently filled in, how do you do that? With all the students that you have all day?

It's hard to keep track of particular holes for particular students at least for me it is. To some degree I put that responsibility on them. That they're responsible for working on those holes, but at the same time I try to help then and guide them with that, but one example of that would be a review sheet that I use, an idea that I got from a calculus teacher called Stuff You Must Know Cold. And these are things that I think they should know—basic ideas from Algebra I. It was originally calculus, but I liked it so much that I decided to make ones for Algebra I, Geometry, Algebra II and pre-calculus. And we have weekly quizzes over them. And I think the idea that they know they will be quizzed over something like this is important and so they will hopefully review those topics, and again that's where a lot of the holes are, and it doesn't mean they'll all review them as much as I think they should, but they have that opportunity and they're really encouraged to. I'll also bring it up in class, constantly "ok this is the rule we should be thinking about, that you should know from Stuff You Must Know Cold Geometry." Or I'll reference back to Stuff You Must Know Cold in some way, hopefully that will trigger too with them "oh yeah that's something I should know" or "I don't know that and let me remind myself" I'll tell them if you don't know this make a note to yourself or go to your Stuff You Must Know Cold sheet, and circle that and put a smiley face or something to remind yourself "I need to back and study this." I'll get you a copy of it. So I think of it like multiplication tables that students would learn in

elementary school. These are the basics of something that they need to know, these are the basics I think they should know from Algebra I, Geometry, and so on. And of course like in a precal class I'll give them a blank one at the beginning of the year with the assumption that they don't know any of these things yet. And they may know some of the things but I'm not going to quiz them on anything until we've talked about it. But as we're talking about it I'll say now, this is something that we can quiz over that you are expected to know and you want to go back to that sheet and circle it or put some note there that now you're responsible for that.

So in a way, you're really assuming nothing, because you're making sure that this is called out specifically, rather than just say well you might want to study these five things, you're actually saying this is what you need to—

Right I want to be specific as I can and at the same time at least I'm assuming they know nothing in terms of pre-calculus or calculus whatever that class is, but I'm assuming the reverse about everything beforehand. I'm assuming that you should know all these things. Do they? Not necessarily. I'm making that I guess expectation and trying to have them live up to that expectation.

Do you use the library here?

I've never taken students to the library, I encourage them to go, for many reasons and one of them would be to use the computers there. Because I also use a web site called Edmodo, where I communicate with students and they're expected to check it daily. Most of them have a phone and most of them get email notifications from me or from their peers through Edmodo. There are a few students that don't and so in that sense I would at least want them to check at home and if they don't have a computer at home check in the library for any recent notifications of any type.

So the texts that you use are the note-taking guides?

It is, Stu Schwartz We do have a different text, Sullivan and Sullivan for precalculus and Smith for Calculus. The students check them out at the beginning of the year and they keep them at home. I may reference it a little bit, to be honest I would like to reference it a little bit more, because I do think they need experience reading scientific texts, so that's something I wan to work on personally. To use that more. I may say ok your journal for this week is to read this section in the book and summarize it, but I don't do that very often or other things that we could use the textbook for, because the note taking guide has the majority of the notes that I want them to have and it has homework assignments to go with it. So it's a nice set up, but again scientific text is good for them to have experience with.

A little bit different form of reading.

It is.

When you—kids are going work in class, they were doing yesterday, test corrections—how do you know when the talk is math talk and not just chatting?

I don't always know. I try to keep my ears open and walk around the room frequently and remind them if I need to, to stay on task also if I feel like that's not working then I'll just say we're going to spend some time working on your own, so if you have questions make notes in the margin, when I open it back up for everybody to work together, you can ask those questions. But for right now you're going to work on your own.

How do you know what to say when a student comes up maybe with a problem, to help the topic become clear to that student?

Usually I'll say ok, how did you start the problem, have them restart the problem and we'll kind of look at their work I'll say ok this looks good up to here, and at this point I may try to lead them, or I'll say exactly what the problem is, but I may say you know you might want to look at

the exponent, what's going on there? What's happening from here to here? Oh It was a negative exponent I should have taken the reciprocal or whatever it happens to be. It's usually a small thing. But sometimes it's a big thing. They're like I don't even know how to start the problem. So I'll say ok let's look at the problem. And let's start it together. Ok they're taught the problem itself is saying there's exponential growth going on here. Well, what does that mean to you, "exponential growth"? What type of the equation might we be talking about? Trying to lead them through it as much as I can. So if they have no idea starting from the beginning or if they do have an idea trying to find the little mistake they may be making. Because I think it means a lot more to them and you'll hear the response with them oh, yeah that makes sense now. If you just start doing the problem for them, they're not going to make that connection as easily.

In what sense—you mentioned something about reflection earlier—in what sense do you think that habit or practice informs your practice?

I think it's one of the most important things we can do as teachers. Otherwise we're going to do the same thing we did the first time. And everything can use improvement. So I don't always have the time that I want to reflect on things, but I definitely try to do it regularly. I remember when I first started teaching I had a voice recorder that I would keep on me and I would listen to every morning and write down those notes I had made to myself from the following day and even in the evening. You have so many ideas it's like "ok well I could have done it this way, I could have done that"—you're in your house and you're doing this or that—I think trying to make time for it is a good idea but you never know, ideas just come, no matter what you're doing as a teacher or as a parent or anything, and trying to keep track of them is a good idea and make notes when you can because there's plenty of times too where I had a good idea and I lost it, I see whatever activity it is or lesson I want to teach and it's like "I know there was something that

was going to make this better" or after the fact it's like oh yeah I was going to do that it would have been a lot better type of thing. I do have some binders too that I keep track of in terms of ideas for next year or beginning of the year ideas or end of the year ideas or of course the lessons themselves so I want to make notes constantly and update things. Reflection I think is huge. Huge huge huge. Being a teacher or anything that's how you get better at anything.

Seems to be the case.

It is for me.

In the reading I've been doing supports that as well.

APPENDIX K

PARTICIPANT 6 INTERVIEW TRANSCRIPT

First of all, I noticed your lesson plans. Do the kids get those too?

Yes.

So they get a copy of what's going to happen.

Yes.

When do you set that up? When do you start formulating that?

I started quite early. Since I teach all AP courses, I teach three different AP courses. Calculus AB, Calculus BC, and AP statistics. These are three different AP courses, and the AP exam is in the month of May, I start my planning right in the month of August, is when I have to start. Because there's a lot of material and scope and sequence to be covered at a much more challenging level for the AP courses. Time is very limited. And then on top of it, you know the school system a lot of things happen without any notice. It's like suddenly I get an email from other teachers, "I'm taking them for a field trip." And there are like arts, social studies people, everybody different subject they have their own needs, and they don't have time, so there are good things that they want to do with their students, and their subject are such that they want to take the students out of the classroom and going away and coming back and all that takes time. But that disturbs my schedule I don't know about it, these are like sudden things that come in my planning, and the courses that I teach are especially for struggling students if they miss a lecture, it's very difficult. Next time when they come in they have no clue what I'm talking about. It's all linked subjects. I learned my lesson after teaching for one or two years, that these days I take up some number of days, one at least per cycle, then I realize one is not enough sometimes it goes to two. So I will take care of all those days out of my teaching plan, and the remaining days are to be distributed

so that I finish everything on time. But it's a very tricky thing to do, and unless you are a good planner, that will not work. You are asking about what should I tell the new teachers? The first thing is how to be an extremely good planner to make your life easier, otherwise it's a stress every day. Just now, some time back, before you came in here, I had a new teacher last year. She just graduated from University of Houston, and she was from our school. She had graduated five years back, and went for education, did math degree, there was a vacancy here so we hired her and we were happy. We got a new good energetic brand-new teacher. Just today before you came, she came to me and told me "I'm sorry I have bad news for you." I said "what is it? (laughing)." She said, "I'm not going to be here next year. I've decided not to continue in the profession."

How many years has she been here?

Just one year. And this is supposed to be one of the best schools. People die to get here (laughs). But she's very young and just had a test of teaching. And she said, "I like the profession, but it is to much of work beyond classroom time, and I want to shape my life in a different way I still want to help people and do good things. She wants to become a nurse. So she's going for a nursing career, and one year was she said, in spite of having a good school like this, where the turnout time should be less, because this is a good school, people are not unhappy here to leave from here. But she was tired of so much of work and the planning that goes and all that.

That's the hardest year! She's put in work that will come back to her, next year. That's unfortunate.

That is what happens. Anyway, but the schedule I think I start quite early. In spite of so many years of experience and all that, every year you keep getting different levels of students. Each class is different, and you have a thousand things in your mind, and your intentions are good

about going for this many things at this time, and what all, and when they come in and the whole world changes. Every second your plan is collapsing because you are looking at them and ok I'm supposed to be teaching this and it's new material, but there's a prerequisite thing for that, students, you know they have forgot a lot of prerequisite things, so you turn to teaching prerequisites because otherwise they will not understand the main thing (laughing). Your planning every single instant you look at the clock and you tweak around, it's a circus, to go with it. Eventually you learn it. You put some time and effort into it and you learn it. Every year your experience grows what mistakes you did this year, you are not going to—but then there are new mistakes (laughs) that you have to take care of! But I think it's once you are in that spirit, you know, it helps you out. And finally I am—I think I'm beginning—the success that this school has seen is quite good. Because ultimately we don't give up! Just keep fighting for it. And it works.

How many years have you been teaching at this school?

This year is my twelfth year. And next year will be my thirteenth year. Before that I was a chemical engineer, so I worked as engineer for 15, 16 years, and when we moved to this country I decided to change my career, and luckily I got this school, which is very good, and I was happy, so kept doing it.

Chemical engineering isn't easy either!

No (laughs).

Do you have to turn in these lesson plans to administration?

Yes. We have three cycles each semester, each cycle is six weeks, and we are supposed to turn in—you know there are district policies and rules and all that—each teacher is supposed to give at leas two weeks of lesson plans, minimum two weeks. We have set the standards differently a because especially for AP classes I can't just go with 2 weeks of planning, I have to have whole

year planning at least one cycle planning six weeks. This particular department we started it as an initiative, and we had a talk with other teachers saying, “look here. There are policies, there are guidelines that administration cannot expect you to give more than two weeks of lesson plans, but for our own practicality is it really useful?” What is useful is plan for a long term. And Initially there was no buy-in, but slowly teachers started realizing it. When we started it, students really appreciated it, because they get the whole six weeks plan, every day what is going to happen is written there, there is no surprise, on this day there will be a quiz what will it cover, on this day there will be a test, what will it cover, because they don’t have just this course, there are seven other courses to take and they have to plan their life. This helps them a lot. And when I started doing it, students were talking to other classes and teachers, and saying it helps us a lot this is very good, why don’t you do this? It will be good for us! And ultimately word spread around, and first the whole department started, then collaborations with other departments, when there are meetings we share good ideas with each other I shared this idea that this is what we started as an initiative in our department, it’s working very well, we have very good feedback from our students, it is useful. A lot of teachers bought into it, and ultimately now it is become a norm without a policy. Very few teachers are still insisting they don’t need to do more than two weeks. But most of them do. It’s a requirement here. The guideline is two weeks, but all teachers give at least for one cycle.

I would think they would have that anyway.

It’s good for running your classes well, planning everything. For students it is the most useful thing. What I have found is they like it a lot. On the first day of each cycle they are waiting for it. They come in, they expect me to give it in their hand so they can see. Especially for studies, for example sometimes there are four tests in a row for one day. This planning helped us a lot in that

direction also. So one thing leads to another and another leads to another, which is better. When we started sharing we came to know that oh my goodness physics, chemistry, biology, math, social studies, all these exams are coming together. Especially at the end of the cycle we give a major exam. And all departments have to give it because it's a part of the grade and it has to be done, but then we sat down together and said can we do something to help them? Can we stagger our exams? It is not necessary that we do this without talking together. So why don't we talk? And the departmental meeting, what we decided was instead of four exams on one day, let's stagger it. Last week of a cycle, we have alternate AB block schedule. First two days are math and English. So we decided math and science are generally hard-core subjects. So math and English are balancing, next two days are science and social studies. So the four core courses are staggered like this. And then some non-core courses like health science, art, they decided to do it the week before. So that helped in reducing the stress load of the students. And the idea was six week lesson plans, when that paper went out this thing surfaced out when this thing came out we came together to handle it. And when people understand each other and share ideas, something in the students' interest comes up. And I think it's working well now.

Are you using texts in your classroom?

Textbooks. Ok now in these courses for calculus and stats especially, unfortunately there is not a single textbook which is geared towards the AP sequence and the concept that not a single book. New books are coming, but still there are issues. A lot of new ideas, the AP people are wanting to test and all that. I have at least ten books of calculus, but as you teach more and more you get used to it. There is a textbook that students are having, but that is not exactly geared toward what AP expects, but we want our student to have a reading habit of textbooks, so when I am teaching it I give reference to certain topics from the textbook that they are supposed to read. But we have

developed our own materials. Which are geared more towards AP. We have for example this workbook which we have developed as a department. So all the concepts that are important, some of them are written by our own teachers, some are from my own network of teachers, because I go for AP grading and I know a lot of teachers so they give good ideas, so for each topic we have developed a book like this. And we follow this and the textbook is supplemental.

Is that something kids get to keep?

Yes. Next year will be the fourth year we have used this, and it's very useful. So instead of carrying this thick book every day, they just bring this. Homework assignments are from the textbook so they can do this at home they don't have to carry the whole thing. But if the child has a problem and they want to ask me a question from the textbook, they can bring it. We assign reading from the textbook at home. Doing some problems. But most of our work is in here. And now there are so many resources on the Internet also. As a supplement you can give a lot of things. Many, many resources. We just get overwhelmed with all those things. And sometimes it comes to a point where students find it too much with extra materials, they don't understand what you're doing. So it should be minimum, and normally they rely more on teachers. Even if they miss a lecture I have a lot of backup. For example UH has very good video lectures of calculus. Every single topic is available. You go and search for a topic you get that thing. But still, that's the problem it's not exactly what I covered in class. Broadly it will there. But students want exactly what I did, what are my expectations about that topic. It is not necessarily the way UH presented it, or the way they must have talked about it but I must have done something in addition to that based on my own experience, and the types of problems chosen by me would be different and that's the limitation. But smart students, those who are already good, they definitely make good use of it. The problem is for medium and low-level students. They rely too much on

their teacher. They need somebody to watch, somebody to look at it when the problem is solved they need to see each and every step done by the teacher. They just don't learn from watching a video. That's a problem with math.

One of the things I'm wondering too—this goes more towards the actual classroom experience. How do you anticipate when you're thinking about the particular topic you're about to teach, the things you can say or examples you can show that will help solidify what you're about to teach?

Again, this is from the number of years of experience. I can tell you the first two years the topic that used to take two or three weeks to get a good handle on for my students—now I can do it in two days. The same amount of mastery they can get in two days because of my delivery. The way I'm showing it to them. And that all came because of my experience and because of the calculus grading that I do. Of course I'm grading my own students' papers all the time, but when I go for grading AP calculus exams nationwide, like all over the nation 850 calculus teachers come together and we grade like 350,000 papers or something like that. So when we grade so many examples we see what misconceptions are there in students' minds. What are they writing, what are they communicating to us for a particular concept? And it is amazing to see those things that doesn't even come to our mind that somebody will be thinking it like this. So when I see it I can have an open window to their minds, you know? Previously I did not have it! If you don't have that experience, what do you do? You read a textbook. You understand the concept well and then you say how am I going to deliver it? How am I going to say it? Is there any simpler way of explaining it? It's too complex. Can I break it down into small pieces? What are some interesting examples that can be tied up because it the topic is dry they get bored, and they tend to give up easily, so all these things you have to integrate, if the topic is very difficult you have to make sure that it is brought down into small chunks to begin with, and slowly like climbing a

big hill but slowly you go so you don't realize you are on the top of the mountain. If you just think the top of the mountain and then want to jump in one step—not going to happen. But I think I learned a lot from those experiences. And it changed my whole teaching strategy.

It's interesting because it would almost be like you're having years of experience just by seeing those tests over and over again.

When you work with different types of students, smart students, mediocre, medium level, low level, there is a lot of interaction here. Right from 7:00 in the morning to 4:30. During lunchtime also I'm working with them. So when they come and after teaching when a student comes and talks to you about difficulties when they talk to you about this, I always ask them: tell me what you understand. I'm not going to give you the solution unless you speak out. I want to know what is your problem. What exactly you don't understand. So I make them talk about what their problem is. And that way learning is more effective. Because they don't just come to me without having them to know that I'm expecting to communicate what they're not understanding. If there is a problem, what did you do? Where exactly you are stuck? Why? And then I can help you. So when I see that, when they start talking, sometimes I realize that I've never thought about that this person will probably take it like this and can understand it like this which is not right, and how to fix it. So that link, communication with students especially helps you to become a good teacher, because you know what misconceptions are there in their mind. So when you are teaching you take care of them already. So then the problems are less. Of course, new problems surface out every time you learn! But the number is less. That's the key, basically. That makes the job harder, you know? But a hardcore teacher will always like it. Otherwise if there is no change, suppose I am teaching the same thing every year, it's pretty boring to me. I don't think I will be able to continue teaching like that. And when I came here there were certain models

where some teachers were having the same transparencies, same assessments, nice little binders, topic on this topic, here is the transparency, let's take it out, put it there, and talk like every year that's a cookie-cutting approach. And I hated it because I don't like it. I never want to keep a problem the way I presented this time, next time I will do it slightly different. Some people take it as a stress, because they don't like that impromptu challenge that comes up. They're scared about what they're talking, what they're teaching, they don't want to go a little tangentially because they are afraid of making mistakes. If you are not confident, the mastery's not there, for the teacher, this internally they're worried. That worry reflects in their teaching. They play it very safe. They don't go too deep, because if you go too deep, questions are going to come from that end, and then you don't answer them in a proper manner, then it's a cycle. They (students) lose faith in you and they don't look at you in a proper way and some people don't want to go into that, they just say this is it, I'm just going to stick to it. I've seen some teachers who would solve a problem three times before they talk to the students because there are a lot of steps in it, and in each step there is a reason behind why we do this, why not like this and all that, they just practice, practice, practice. And they get stressed out in that process. So if the teacher is competent in the subject the stress is less, but variation in teaching abilities will be there some people are very strong background and for them it is natural to do things. For example I come from an engineering background which is too high for a teaching job here, but I can very well integrate all physics, chemistry, math, concepts together because I have that background. And students get the benefit of it. But I do it flawlessly because I am used to it. And I present this to the other department members they are not so comfortable because it's a difference. I have that experience so I can do it very fluently without stressing myself. That same thing I cannot expect from the other people. In the beginning I was trying to do it. "It's good! Why are you not doing

it? Try it!" But then I realized what their problem was, you know? Some of them finally told me I'm sorry, I'm a little worried about it because I'm not good like you in that aspect of integrating it, but given some time maybe I'll do it. They would come watch me doing it and slowly, slowly, little bit little bit. I said ok fine, even if you don't do a one hour lecture, ten minutes is not bad, and I think that helps.

I think it's interesting too, and maybe that's my background, I think it's interesting to know sometimes where these concepts—calculus was a tool to solve a problem, so what problem this time? Why this concept? I feel like I'm in the know or have a little insider information if I have that, and makes it seem a little less unapproachable. Do you when you're teaching your students, do you know where each individual is weak, or let's say in a specific class are you able to do that?

There are levels to this. The levels are some of the students I've taught before. I teach three different courses. Some of the students take in ninth grade summer I teach algebra II pre AP. Which goes into fast track. This is called accelerated track. So these students can take calculus BC when they're in 11^{th} or 12^{th} grade. So I have them in ninth grade, they go to precal with some other teacher and then they come back to me for calculus. So I have started them at one time. So their level and ability is known to me before. But in most of the cases I don't know their ability before because I haven't taught them before. I just teach seniors. Except for this Algebra II pre-AP summer course. And the stats course in the morning I taught before school, 7:00-7:50. Because otherwise their schedule doesn't fit in and the students want more extra AP courses to take and there you can take it from 10^{th} grade, 11^{th} grade, or 12^{th} grade. So I will make sure of trueness in that class. So somebody's in 10^{th} grade taking stats. I know that student. And the same student comes back to me in either 11^{th} or 12^{th} grade to take calculus. There I know the

ability. So I'm kind of ready for that student. But most of the students I don't. They just come to me when they go to 12th grade. Other teachers have handled them before. But I judge them, I take my own time, it takes only two or three weeks to get the initial pulse of them, after doing their homework, check the first quiz, second quiz, the way they respond in the classroom, the Q & A thing, they don't respond I ask them questions and then I try my best and typically it takes about 3 or 4 weeks to know their names good, their faces good, the closeness between the student and the teacher, they're scared in the beginning to talk openly to you, and it takes about one-2 months for bonding sometimes. Once I know, then I can tweak. And that experience takes about 1-2 months roughly. During that process when you grade their papers especially then you see inside of it. So particularly when I see low level students in the beginning and I haven't called upon them in the classroom discussion I start doing that. So what do you think? So what can you do? Why do you think like that? Can you tell us? I involve them more, try to do that. And that also depending on how they respond. Some student s are very—if they don't know and you keep calling on them again and again, they don't like it. Because it's a little embarrassment. So it has to be tweaked very carefully. If you see a good response from them they are not minding it. Some of them like it! Ok, he's calling on me at least whether I know or don't know is not a question. He's calling on me and letting me speak in the class, that is a big thing for them, so they're not worried about "I'm wrong" or what. It depends upon the personality. But there are some kids who are afraid of speaking because their foundation is not strong, but then you're to judge it. You're to sense it quickly. And if you sense it, you have to handle them differently. Because you don't want to go into the personal area and destroy the bonding. So in that case I talk to them in person. Lunchtime or some time go very close to them and make them comfortable first. What is it that it's doing to them when I'm calling on them how comfortable or

uncomfortable they are. And to make them comfortable you are to assure them that this is not bad. It's going to be good for you to understand. Once you talk to them one-on-one, sometimes they open up. So that you can take as an inspirational thing for them, motivational thing for them, encouragement you call it. The more you do it, the more successful and better you will be. Because if they don't like you, you have lost the whole thing. You may be a master of so many things, but if they don't like you it's a gone thing. They are very smart to figure out if you are putting a ruse on it. They can judge you very well. I think that's very important, to know your students well. And some teachers find it very difficult because it's time-consuming. And you can't do this with every student all the time, but as many as you can, it's good, And once you do that later on, it becomes easy instead of not doing it.

Do you ever use the library?

Ok in my classes I hardly use the library because this course is designed for making their prerequisite skill stronger and all the time that is there to finish the whole requirements and it's not going to the library like reading or watching a video or something that English teacher or social studies where that kind of learning can happen. In calculus I show them videos from MIT. How is the topic taught at MIT. And I have all the resources in my room. So I can open Internet and have online courseware and there's a video right there and they can see. So I don't think I have taken them to the library any time. Because what I want them to learn other than my own teaching, those resource s are available to me in my classroom. And most of the time the math courses are such that they work on problems, so you teach, give some example where there is interaction while teaching also you don't solve the problem yourself you involve the class. And then once you are done with one problem you increase the level a little bit more, increase the level step by step and let them go with one more problem on their own, so that kind of thing

more happens in math. When will the library think of me? You are done with your things and there is spare time for you to go to the library and maybe do some extra things that you cannot do in the classroom. That is very uncommon in math. In fact, none of the math teachers are taking students to the library because that's not how the math courses are designed. Some of them are maybe doing it but maybe in their spare time. It's very unlikely for a math teacher to have spare time!

The courses that you're teaching they're pretty much wire to wire.

Very true.

When you have students in the class and they start to veer off does that ever happen first of all, does it happen where maybe a kid has some sideline story and it's getting every body going in a different direction does that happen at all?

Very rarely. Very rarely. But you are right. There could be cases like that. And the reason for that is very rarely it has happened to me. But the problem there is: if the child is not engaged in the class, they're finding it difficult what you are doing, they're not understanding it, so they don't know how to pass their time, they are sitting there it's like a punishment to them. And if the child is more active they want attention from other people, somehow in your discussion if something comes up they will try to take you tangentially to what they want, they'll make a comment to make the whole class laugh or something and then there will be some more interaction somebody will say something, some other student will say something. For the sake of humor it's not bad. Because everything should not be very stressful, you know? It's like difficult things—sometimes small breaks are required to ease the tension. But you are to use your judgment about what extent is it going? Is it healthy, or is it turning into a distraction from what you are doing here. If it's going too tangential, then you are to bring them back. Sorry, I would

like to laugh for more than half an hour like this, but I don't have the liberty, let's come back to the real world, and keep proceeding (Laughing). A couple of times it has happened to me and I take it like a break in between. It's not bad if it's not done with bad intentions. And they get relief somebody heard me, somebody listened to me. And they'll get back on track.

How do you view when you're teaching and there is a group out here, and you get going on your thing, and you think you're really doing well and you realize, how do you monitor the level of on-task-ness in the classroom while you're working—how do you monitor what is going on?

Actually I try my best to keep and eye on them because I'm standing here, first of all I never have my back to the students. Always I'm facing them. So I can read everybody's face. And the pace at which I'm going what I'm trying to say I keep eye contact with everybody. I try to gauge it. Is the pace at which I'm going, is it all right? Or the way I'm talking is it all right? The complexity that I'm trying to develop—their eyes speak to me. And if somebody's not finding it, I can read it, and I can see it. I can quickly figure out that level at which I am talking is probably higher that's why a couple of faces are not looking the way they should be, and I quickly change my style of going to the lower level simply find-- and bring an example, and if I find somebody too lost, I call that person by name and try to involve them in the discussion. What do you think? Do you agree with me what I did just now? And if they don't understand they will speak out. No, I'm sorry, can you go back to the step before the last step. And then I say ok, yes, no problem, I'll go. But before going there if I can find a simple easy thing, I'll always do a simple easy thing on the side. Let's do this first. Then we will go here. So that takes care of students getting lost because of their inadequate preparedness. Some are not really ready for (with) the prerequisite knowledge. Some step from previous Algebra I, Geometry, and all that. And if they have lost it and you try to go ahead they will feel lost. That's the one thing that I do normally. Sometimes

two or three people together, they are sitting and if one person does not understand they look at the other person, they are a friend of each other, in group work normally try to sit with that person. If that person does not understand, he or she will look at the next person whom she relies on, and at that time, if that person also looks at her, both eyes kind of—are you understanding what he's talking about? And the same look the other person gives and you're watching from here, you judge it quickly that too many people are losing it. You have to change your style. You have to stop doing what you're doing because it's not going there. Too many people are having issues. And you have to stop. And you say what's the problem? And you ask those two people do you need my help? What can I do so that you are understanding it? And then they will talk, and then I take a seat back, and say can somebody help? I try to bring other people into the discussion. Sometimes the students do a better job than you [can]. Because they understand their language better than you, and they get engaged in it, and the lack of concentration eases out. But that you have to do very very smartly. You don't want to lose too much time doing this. You'll lag behind too much. But that knack has to be there within the teacher. If you don't have it, then you're just completing your formality. You cover the material but they don't understand anything. That's not what we want to do. That's not teaching. That's a tricky part, it's hard. I understand, it's not easy.

How do you get buy-in from students?

Buy-in. That is first day, I introduce myself. I tell them who I am, why I have chosen teaching as my career, what I have done for the department, for the school, and for the students, and what is in general my views about how I should be doing. I give assurance to them first, that I'm there to help you, I'm there to fix all your problems that you had before. It doesn't matter, I'm not going to talk to any teacher about your prerequisites. Somebody else has taught you I'm not going to

ask that teacher how is this student? What is his or her level? I'm going to judge you on what feedback you give me. I'm not going to ask anybody else. I don't want it. Because I don't want biased opinions about some other people that oh, that person is very bad, there's going to be a problem. We totally don't respect that here. In the department there is a norm. We don't share this kind of thing, we don't want other people to get influenced. You judge them, you can form your own opinion. And I tell them if you have difficulties don't feel embarrassed about asking questions, because I'm going to try my best to help you out as much as possible. I don't care what questions you have. I will not go ahead unless I satisfy your answers, what your desires are, what you want. Unless you give that confidence in you will not have buy-in. Luckily in my case I don't have to do it too much because there is a reputation they already know me. Their friends have spoken about me to them, and they come with certain feelings about me already. But when they hear it from me, that endorses it further. Here is a person who really cares, here is a person who will really help me. And then I follow through I make sure they have their confidence in me. So when they come in, I never say no to them. Very few teachers are doing lunch tutorials now. So they are saying I need to have some breathing time. I know, I understand you and I feel sometimes that it is too much. But some students cannot come after school. They have transportation issues. But they want help. And they are very sincere. As soon as the bell rings they also have an option to go and sit with their friends. But they don't do it. They are waiting outside your room, and they want to come in and have a talk with you. I don't mind doing that. I tell them, I have my sack lunch I don't go to cafeteria for a single day. You can bring your sack lunch, sit here and while eating I can answer your questions. So they know that. And they have full confidence that if they come to me their questions will be answered with respect. It won't be like oh, you don't know even this much? What kind of—that doesn't happen. That doesn't

happen. The buy-in is to make sure that you follow the word you say. If you assure, if you promise them you're going to be with them through all their struggle, and you turn around on one day lunchtime they come to you and you say sorry I'm eating my lunch can you just wait, I'll do it afterwards. That doesn't work with them. The main keys to assure them—make sure that they have your assurance, and once they have the assurance they are willing to take risks. And they want to work. Even if they don't they get more diverted. And it all depends on the teacher. What kind of inspiration and motivation you want to set in. It's hard work for you, but it's the cost of what you pay for making them learn.

One other question I had, you were talking about how you start in August how you set up your whole year. In what ways do you use reflection, either reflection before you teach, or after you're done with the lesson, or even in the moment of teaching. How do you use that?

This goes on. It's an ongoing process. You have ideas about teaching, you start based on your previous experience what you learned this year new, when you go for grading you have some friends that talk to you about different ideas, and so when you come up with the new year every year you are charged with new ideas. So the same lesson gets taught in a different way. While teaching sometimes you know impromptu things happen. You never know what kind of communication your students are going to have with you, what kind of questions they're going to throw you. It's interesting. And you should be able to handle it well and with your experience I think you can do it. Many times I have two classes which I teach the same calculus BCb1 andb2. Two classes of the same subject. But my presentation is different for the first class the way I teach is not exactly the same to the second class. Because in between that 1 ½ hours, things change. My mind changes, you know I think maybe I should be doing this based on the feedback of the first class was it too fast? Was it too heavy? Was it too slow? Whatever. Was some more

groundwork required before hitting the difficult thing? That experience comes through the b1 period, and then b2 comes in and then you start differently. First of all it's to entertain you because you don't wan to get bored yourself, the same thing again like that. So it depends on the dynamics of the class also. The b1 is a very strong class. Somehow the smart students are all in that one class. So the energy and inquisitiveness is at a quite high level. So you are charged up with that. And then the next class comes in, not so smart students are there, they're all struggling. Your energy goes down, I was right at the top for the first period, let's go in the same spirit here, that doesn't work! Their demand is different. Their expectations are different. And you're right in the air on top, and they're pulling you down all the time! (Laughs) It's a tussle. To what level you compromise it just depends on your interaction with students and how stressed you are to cover the material to make sure that you get it. It's a tweaking that you keep doing all the time. All the time. The benefit that you get out of the first intellectual discussion with smart kids, you want to transfer that to the next batch. That's your goal, that's what you want. Sometimes expectations are too much. The reality is different. You go with good intentions, but the intentions may not be good for them. Suddenly you need to come down to a level where they will understand it, and then the whole thing about first period where the level was quite high changes drastically, your mood changes, you have to go with a much simpler approach, much simpler things to engage them. It's class to class it changes. And that's—it's also depends on the time of the class, First class in the morning I've seen most people are pretty energetic. They've had breakfast and 8:00-9:30 is a full-energy. No problem. Second class before lunch is fine. But you have a lunch time in between. And then when they come after lunchtime, same students but energy, participation level, most of them are sleepy. After lunch, if you start playing with your lecture without any interest or without any humor, or without making them stand up and talk and

all that, you always see people doing this (shows falling asleep) Quite often in the third period it's the most struggle thing that I've seen. Keep them alive! In this course you can't keep saying keep a lot of humor and all that. You are to do working problems and all that, but in the third period more interaction is required, to make sure they're not sleeping. And the requirement changes so the pace goes down. You have more interaction, more moving around the room. And when you're moving, they don't sleep. Because if you stand here, keep talking, there's a kind of dozing. But if you keep tapping and asking, sometimes after 50 minutes I'll stop the whole class because too many people are not—first of all the level is low, they're not very smart students, some of them are not getting what I'm trying to do, it's a frustration. But you can't give up like that. You just stop I just say ok, get up. You can stretch, stand up stretch your body, if you want a sip of water go down, one minute you should be back in and unconventional things you are to do. Wasting 2-3 minutes we feel that, it helps, charges them back. And when you come back, look here we've wasted 2-3 minutes, can you focus? Let's focus now. Sometimes all they need is a break. A break in your long kind of—and then last period. Last half hour. To make it productive is always a challenge. Because 3:25 the bell is going to ring, half the minds are already on their "when I'm going to get out, what I'm going to eat, what I'm going to do" starts. So typically at the last period my activities are different. I'll stop at least ten or fifteen minutes and I won't give them a chance to keep thinking. They will be in a group, and there will be some type of challenge they will do on the board, this board, that board, or my computer or anywhere and I let them go loose a little bit and keep moving. So they're still engaged doing some things, but not in a conventional lecture and this kind of thing. So you are to change. From class to class your strategy changes to make sure they are getting what you want.

So true. The kids you get in the morning aren't the same kids in the afternoon.

And the same level the complexity, some topics are so difficult. It is very easy for me to teach them in the morning when they're fresh. Their concentration is good, they want to learn, their energy is good, so I can get through the message quickly. And they understand it better. But the third period I struggle to communicate the same thing, same ideas, but it takes a lot of effort to make them understand. Totally different dynamics. Fourth period, last half hour is again a challenge. So your requirements change every single class. Totality is fine the overall you are to maintain the pace and all that, but still reflection when you go back home and you start thinking about how did I do in the first period? Wow excellent I am happy. How did I do in the second period? Not so well, third period was even worse, 4th period it is what else can I do next time? How can I tweak it? That is continuous reflection, not only at home, period –to-period reflections go on all the time.

Yes and when you can anticipate that it's going to be that way, then you can address it head on, heads-up kind of thing.

The thing that we do well here is team spirit. So we are very open to each other. And very challenging. The level of teachers that we have here are very competent, very respectful, so if I have problems with teaching a certain concept at a level we want and the students aren't getting it, maybe my delivery is different, maybe I'm doing something that is not teaching them. So there are other friends who I can go and talk to, I did this topic today and this was my reaction. They were not getting it! Is there anything you do differently? How do you teach it? What other—give me some pointers here. And that happened quite often. So during lunchtime or off periods we sit down and talk. And the new teachers and there are many new teachers who come to me all the time, asking. This is what I'm going to teach, what do you think? These are my

plans, can you give some more insight about what exactly we should be doing? That's very good here. It helps to develop teaching.

And then too, it's almost like a petri dish because everybody's working on it together and you find what works and everyone's doing that instead of struggling alone. I think that's a hard part of teaching, too, is that you're in here by yourself without anyone watching or giving you hints. That's about all I have for you.

Thank you.

I really appreciate your time!

APPENDIX L

PARTICIPANT 1 REPERTORY GRID

Topic: Expert Teaching

Teacher: P1

Construct	Reflection and feedback for following year	Withitness	Lesson planning searching for new materials/ideas	Professional development—Conferences, NCTM	Efficiency/organization	Revamped lessons	Constant learning	Enrich/try new things for greater effect	Never satisfied	Share responsibility with students/ownership	Contrast
Process	1	3	1	1	2	2	3	2	5	3	Feeling/innate
Task you do in order to better your practice	3	3	2	2	5	2	3	3	5	4	Key trait to being a successful teacher
Make instruction better	2	4	1	1	3	1	2	3	3	5	[Teacher initiated] Climate/interaction
Teacher traits	1	1	5	4	2	5	3	3	1	1	Outcome/task you do
Key component of instruction	3	5	1	1	4	2	2	3	3	5	Approach you take in the classroom
Traits of an educator	2	1	5	5	2	5	2	3	1	4	The outcome of the traits
Outside classroom	2	5	1	1	3	2	2	2	3	4	During instruction

APPENDIX M

PARTICIPANT 2 REPERTORY GRID

Topic: Expert Teaching Teacher: P2

Construct	Reflection	Organization	Planning	Creativity	Rapport	Relationships	Safe Risk-taking for students	Rigor	Constant feedback via formative assessments	Being able to change directions mid-stream	Contrast
Objectives driven, lesson-oriented	1	1	1	1	5	5	3	2	2	2	People-oriented affective part of classroom
Content is the focus	5	1	1	1	4	5	4	2	3	4	(Emotional) Connection to students is the focus
Before instruction	1	1	1	1	3	3	5	2	4	5	During instruction
Take the temperature of the room (Checking for comfort level)	2	3	3	3	1	1	1	5	1	1	Try to push them beyond where they are comfortable, non-routine problems, out of the box thinking
How students are made to feel safe in class	3	4	3	3	1	1	1	2	5	5	Help students understand the content in whatever way necessary
Instructional	1	1	1	1	5	5	5	2	1	1	Relational
Accommodations when needed to support relationship	4	3	3	5	1	1	2	4	1	1	Finding unique way to present lesson (pre-lesson)
Planning stage	1	1	1	2	5	5	5	1	2	3	People-centered
What they know/don't know informs practice	2	1	1	2	5	5	5	3	1	2	People-oriented
What worked/what didn't, reflect on past	1	1	1	2	3	3	4	2	5	5	Lesson in progress, reorient student thinking
Processes activities pace	1	1	1	1	5	5	5	2	3	4	Environment/kids ok making mistakes

APPENDIX N

PARTICIPANT 3 REPERTORY GRID

Topic: Expert Teaching Teacher: P3

Construct	Reflection	Knowledge	Flexibility	Willingness to meet students where they are in terms of problem solving	Consistent	Understanding of where the kids are coming from	Creative	Up-to-date on new technologies and strategies	Organized	Comfortable with presenting-being the authority	Contrast
Indication of change occurring	1	5	1	2	5	4	1	2	5	5	Not changing
Student-centered	5	5	2	1	4	1	3	5	5	5	Teacher-centered
Be a better teacher for the particular students	1	1	2	2	5	2	5	4	5	5	Better teacher in general
Seek out knowledge/understanding	5	1	4	4	5	4	5	1	5	2	Innate allow to come out
Classroom procedures	5	5	5	5	1	5	4	4	1	2	Approach to instruction
Something for self and students	1	3	3	5	1	5	1	1	1	1	For student benefit
Student needs	1	1	1	1	5	1	1	3	5	5	Classroom culture
Professional development	5	1	4	4	4	4	1	1	1	1	Personal development
Student performance	1	5	1	1	4	2	4	5	5	4	Teacher performance
Not obvious skill	1	5	1	1	1	2	1	1	1	5	Commonly understood skill
Student-centered	5	5	1	1	5	1	2	5	5	5	Teacher-centered
Things you have to do	1	5	1	1	5	2	1	1	1	5	Personality-related traits

APPENDIX O

PARTICIPANT 4 REPERTORY GRID

Topic: Expert Teaching Teacher: P4

Construct	Reflection	Clear understanding of content	Concern for students' understanding	Feedback for students	Positive Relationship with students	Student engagement	Students on task in class	Passion for your material	Unafraid to try new things freshness	Discovery for students—their thrill	Contrast
How I interact with students	5	5	1	3	1	3	2	5	4	4	Informs my Teaching
My depth of understanding	2	1	5	2	5	5	5	3	4	3	Creating environment
Create the lesson (pre)	5	1	3	3	x	3	3	2	2	1	Adjust the lesson (post)
Interaction and classroom environment	3	3	1	3	1	2	5	2	3	1	Adjustments in student conduct
Personal mathematics scholarship (teacher)	4	2	5	5	4	4	4	1	1	3	What students need additionally
Determine if lesson was effective (post)	1	3	1	4	4	5	5	2	2	1	What's happening in class (during)
The exciting stuff	2	1	2	3	2	1	5	2	1	1	Classroom management
The way I prepare a lesson (pre)	5	1	4	4	4	4	4	1	2	3	Did it work? What could I have done better? (post)
Do what takes to bring the content to a place that's more easy to understand	1	2	1	2	5	3	4	2	1	2	Classroom environment
Classroom environment	4	5	4	5	2	1	1	4	3	3	Being able to teach on the fly
Share joy with the material	3	1	5	5	4	4	4	1	1	2	Meeting student needs
The ability to set up the learning (pre)	3	1	2	3	5	5	5	3	1	1	What happens in the classroom (during)

APPENDIX P

PARTICIPANT 5 REPERTORY GRID

Topic: Expert teaching Teacher: P5

Construct	Reflection	Classroom management	Structure	Planning	Understanding content	Applications of the topic	Connecting with students	Contrast
Lesson design	5	3	1	4	1	2	4	Assessment of success of lesson
Planning the lesson, part of that is application	3	5	3	1	1	1	4	Background component
Connect with students to have classroom mgt—better chance of them doing what you want them to do	5	1	3	4	4	3	1	Drives understanding about practice
Reflect and refine to those students are interested in	1	5	4	2	2	1	2	Classroom management
How to present material	3	2	1	2	1	3	5	Relationship to students
Easier to have classroom management when connected with students	2	1	2	2	3	5	1	Interest/future uses of content

APPENDIX Q

PARTICIPANT 6 REPERTORY GRID

Topic: Expert teaching Teacher: P6

Construct	Reflection	Pace	Content	Curiosity to know how to do it better	Lesson design for prerequisites	Time management for lesson design	Accountability to students	Make arrangements to take care of their academic needs	Professional development	Encouragement and motivation for students	Contrast
Teaching knowledge	5	2	1	4	1	5	3	2	1	4	Intrinsic to teaching practice
Efficiency	2	1	3	5	1	1	2	3	5	4	Curiosity
Support students	1	5	5	2	4	5	2	3	5	1	How to achieve your goal
Teaching proficiency	5	1	1	5	2	1	4	5	1	4	Professional improvement
The structure of teaching	5	1	2	4	1	1	3	5	2	5	Student needs
Constant improvement of practice	1	5	1	1	5	2	5	4	2	2	Standard by which you judge if you are doing your job
Student-centered	1	3	4	2	1	5	5	1	3	1	Do my job effectively
Constantly improve lesson design	1	1	2	2	1	2	2	2	3	5	Develop whole student

REFERENCES

Alliance for Excellent Education (2014, July). *On the path to equity: Improving the effectiveness of beginning teachers.* Retrieved from http://all4ed.org.

Anderson, J. R. (1981). *Cognitive skills and their acquisition*. Hillsdale, NJ: Erlbaum.

Atkinson, A., Coffey, A., Delamont, S., Lofland, J., & Lofland, L. (2001) *Handbook of ethnography.* London: Sage.

Atkinson, B. M. (2012). Rethinking reflection: Teachers' critiques. *The teacher educator 47*(3), 175-194. DOI: 10.1080/08878730.2012.685796

Baxter, P., & Jack, S. (2008). Qualitative case study methodology: Study design and implementation for novice researchers. *Qualitative Report 13*(4) 544-559.

Bednall, J. (2006). Epoche and bracketing within the phenomenological paradigm. *Issues In Educational Research*, 16(2), 123-138. http://www.iier.org.au/iier16/bednall.html

Berliner, D. C. (1993). Expertise: The Wonder of Exemplary Performances. In J. N. Mangieri & C. C. Block, (Eds.) *Creating Powerful Thinking in Teachers and Students: Diverse Perspectives* 161-194. Fort Worth, TX: Harcourt Brace College Publishers.

Berliner, D. C. (2004). Describing the behavior and documenting the accomplishments of expert teachers. *Bulletin of Science, Technology & Society*, *24*(3), 200-212.

Bloom, B. S. (1953). Thought processes in lectures and discussion. *Journal of General Education 7*, 160-169.

Borg, S. (2003). Teacher cognition in language and teaching: A review of research of what language teachers think, know, believe, and do. *Language Teaching, 36*, 81-109.

DOI: 10.1017/S0261444803001903

Borko, F.L., & Livingston, C. (1989). Cognition and improvisation: Differences in mathematics instruction by expert and novice teachers. *American Educational Research Journal 26*, 473-498.

Bransford, J. D., Brown, A. L., & Cocking, R. R. (1999). *How people learn: Brain, mind, experience and school.* Washington, DC: National Academy Press.

Bransford, J. D., Brown, A. L., Cocking, R. R., Donovan, M. S., & Pellegrino, J. (2000). How people learn: Brain, mind, experience, and school. *Committee on developments in the science of learning and committee on learning research and educational practice, commission on behavioral and social sciences and education, national research council*.

Brown, J. S., & Duguid, P. (1991) Organizational learning and communities-of-practice: Toward a unified view of working, learning, and innovation. *Organization science 2*(1), 40-57.

Bryan, W. L., & Harter, N. (1899). Studies on the telegraphic language: The acquisition of a hierarchy of habits. *Psychological Review, 6*, 345–375.

Bruner, J. (1991). The narrative construction of reality. *Critical Inquiry 18*(1), 1-21.

Carter, K., Cushing, K., Sabers, D., & Berliner, D. (1988). Expert-novice differences in perceiving classroom information. *Journal of teacher education 39*(5). 25-31. DOI: 10.1177/002248718803900306

Charmaz, K. (2006). *Constructing Grounded Theory.* Thousand Oaks, CA: Sage.

Christensen, T.M., & Brumfield, K.A. (2010). Phenomenological designs: The philosophy of phenomenological research. In C.J Sheperis, J.S Young, & M.H. Daniels (Eds.), *Counseling research: Quantitative, qualitative, and mixed methods*. Upper Saddle River, NJ: Pearson Education, Inc.

Clark, C. M. (1988). Asking the right questions about teacher preparation: Contributions of research on teacher thinking. *American Educational Research Association 17*(2), 5-12.

Chi, M. T. H., Feltovich, P. J., & Glaser, R. (1981). Categorization and representation of physics problems by experts and novices. *Cognitive Science 5*(2), 121-152.

Chi, M. T. H., Glaser, R., & Farr, M. J. (1988). *The nature of expertise*. Hillsdale, NJ: Lawrence Erlbaum Associates.

Chi, M. T. H., & Van Lehn, K. A. (2012). Seeing deep structure from the interaction of surface features. *Educational psychologist 47*(3), 177-188. DOI: 10.1080/00461520.2012.695709

Choi, I., & Lee, K. (2009). Designing and implementing a case-based learning environment for enhancing ill-structured problem solving: classroom management problems for prospective teachers. *Education Technology Research & Development 57,* 99-129.

Cochran-Smith, M., & Lytle, S. L., (2009). Teacher research as stance. In S. E. Noffke & B. Somekh (eds.). *SAGE handbook of educational action research.* London: SAGE.

Connors, R. D. (1978). *An analysis of teacher thought processes, beliefs, and principles during instruction*. (Unpublished doctoral dissertation). University of Alberta, Edmonton, AL.

Cornelius-White, J. (2007). Learner-centered teacher-student relationships are effective: A meta-analysis. *Review of Educational Research*, *77*(1), 113-143.

Creswell, J. (2002). *Educational Research: Planning, Conducting, and Evaluating Quantitative and Qualitative Research*. Saddle River, NJ: Prentice Hall.

Creswell, J. W., Hanson, W. E., Clark, V. L., & Morales A. (2007). Qualitative Research Designs: Selection and Implementation. *The Counseling Psychologist 35,* 236-264.

Cross, N. (2006). *Designerly Ways of Knowing.* London: Springer.

Cross, N. (2011). *Design Thinking.* New York, NY: Berg

Crotty, M. (2003). *Foundations of Social Research: Meaning and perspective in the research process.* Thousand Oaks, CA: Sage.

Dahlgren, M., & Chiriac, E. (2009). Learning for professional life: Student teachers' and graduated teachers' views of learning, responsibility and collaboration. *Teaching and Teacher Education 25,* 991-999. DOI:10.1016/j.tate.2009.03.019

Darling-Hammond, L., Amrein-Beardsley, A., Haertel, E., & Rothstein, J. (2012). Evaluating teacher evaluation. *Phi Delta Kappan. 93*(6), 8-15.

Davis, E. A. (2006). Characterizing Productive Reflection among Preservice Teachers: Seeing what matters. *Teaching and Teacher Education 22* 281-301. DOI:10.1016/j.tate.2005.11.005

Del Schalock, H., Schalock, M. D., Cowart, B., & Myton, D. (1993). Extending teacher assessment beyond knowledge and skills: An emerging focus on teacher accomplishments. *Journal of Personnel Evaluation in Education*, *7*(2), 105-133.

DeAngelis, K. J. & Presley, J. B. (2011). Toward a More Nuanced Understanding of New Teacher Attrition. *Education and Urban Society* 2011 43: 598-627 DOI: 10.1177/0013124510380724

deGroot, A. (1965). *Thought and Choice in Chess.* The Hague: Mouton.

Dewey, J. (1910). *How We Think.* Lexington, MA: D. C. Heath & Co.

Dreyfus, H. & Dreyfus, S. (1986). *Mind over Machine: The power of human intuition and expertise in the age of the computer*. Oxford: Basil Blackwell.

Duffy, G. G. (1993). How teachers think of themselves: A key to creating powerful thinkers. In J. N. Mangieri & C. C. Block, (Eds.) *Creating Powerful Thinking in Teachers and Students: Diverse Perspectives* 161-194. Fort Worth, TX: Harcourt Brace College Publishers.

Elliot, J., Stemler, S., Sternberg, R., Grigorenko, E., & Hoffman, N. (2011). The socially skilled teacher and the development of tacit knowledge. *British Educational Research Journal 37*(1), 83-103. DOI: 10.1080/01411920903420016

Ericsson, K. A. (2006). The Influence of Experience and Deliberate Practice on the Development of Superior Performance. In In K. A. Ericsson, N. Charness, P. J. Feltovich, & R. R. Hoffman, *The Cambridge Handbook of Expertise and Expert Performance (Cambridge Handbooks in Psychology)*, 685-707. Cambridge, United Kingdom: Cambridge University Press.

Ericsson, K. A., & Staszewski, J. (1989). Skilled memory and expertise: Mechanisms of exceptional performance. In D. Klahr& K. Kotovsky (Eds.), *Complex information processing: The impact of Herbert A. Simon* (pp. 235-267). Hillsdale, NJ: Erlbaum.

expertise. (n.d.). *The American Heritage® Dictionary of the English Language, Fourth Edition*. Retrieved May 08, 2013, from Dictionary.com website: http://dictionary.reference.com/browse/expertise

Feiman-Nemser, S. (2003). What new teachers need to learn. *Educational Leadership 60*(8), 25-29. Retrieved February 5, 2012, from http://www.ocmboces.org/tfiles/folder907/What%20New%20teachers%20Need%20to%20Learn.pdf.

Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H., & Wenderoth, M. P. (2014). Active learning increases student performance in science, engineering, and mathematics. *Proceedings of the National Academy of Sciences*, 201319030.

Fromm, M. (2004). *Introduction to the Repertory Grid Interview.* Muenster, Germany:

Waxmann Verlag GmbH.

Gawande, A. (2010). *The Checklist Manifesto: How to get things right.* New York: Metropolitan Books.

Genzuk, M. (1999). Tapping into community funds of knowledge. *In: Effective strategies for English language composition: A curriculum guide for teachers grades Kindergarten through Eight.* Los Angeles: Annenburg Metropolitan Project/ARCO Foundation.

Gholami, K. & Husu, J. (2010). How do teachers reason about their practice? Representing the epistemic nature of teachers' practical knowledge. *Teaching and Teacher Education 26,* 1520-29. DOI:10.1016/j.tate.2010.06.001

Glaser, B. & Strauss, A. (1967). *The discovery of grounded theory: Strategies for qualitative research.* Chicago: Aldine Publishing Company.

Gu, Q., & Day, C. (2006). Teachers' resilience: A necessary condition for effectiveness. *Teaching and teacher Education 23*(6), 1302-1316. DOI:10.1016/j.tate.2006.06.006

Houston Education Research Consortium (2013). *Student data codebook.* Retrieved from http://kinder.rice.edu/uploadedFiles/Kinder_Institute_for_Urban_Research/Programs/HERC/Student%20Data%20Codebook.pdf.

Housner, L., & Griffey, D. (1983). Teacher cognition: Differences in planning and interactive decision making between experienced and inexperienced teachers. *Paper presented at the annual meeting of the American Educational Research Association, Montreal.*

Ingersoll, Merrill, L., & Stuckey, D. (2014, April). *Seven trends: The transformation of the teaching force.* Retrieved from http://www.cpre.org/7trends

Ingersoll, R., & Smith, T. (2003). The wrong solution to the teacher shortage. *Educational*

Leadership, 60(8), 30–33.

Jankowicz, D. (2004). *The easy guide to repertory grids.* Chichester, England: Wiley.

Jozefiak, D. (2011, December 31). Personal interview.

Jung, J. (2012). The focus, role, and meaning of experienced teachers' reflection in physical education. *Physical education and sports pedagogy 17*(2), 157-175. DOI: 10.1080/17408989.2011.565471

Kane, T. J., Staiger, D. O., & Geppert, J. (2002, Spring). Randomly accountable. *Education Next, 9*(3). Retrieved from http://educationnext.org/

Keen K. (1992). Competence: What is it and how can it be developed? In J. Lowyck, P. de Potter, & J. Elen (Eds.), *Instructional design: Implementation issues* (pp. 111-122). Brussels, Belgium: IBM Education Center.

Kelly, George, A. (1955), *The Psychology of Personal Constructs. Volume l*, New York: Norton.

Kennedy, M. (2004). Reform ideals and teachers' practical intentions. *Education Policy Analysis Archives, 12*(13). Retrieved January 30, 2012, from http://epaa.asu.edu/epaa/v12n13/.

Klem, A. M., & Connell, J. P. (2004). Relationships matter: Linking teacher support to student engagement and achievement. *Journal of school health*, *74*(7), 262-273.

Kolodner, J. L. (1984). Towards an understanding of the role of experience in the evolution from novice to expert. In M. J. Coombs (Eds.), *Developments in expert systems* (pp. 95-116). London: Academic Press.

Korthagen, F. A. J. (2004). In search of the essence of a good teacher: Towards a more holistic approach in teacher education. *Teaching and Teacher Education (20),* 77-97.

Korthagen, F. A. J. (2010). Situated learning theory and the pedagogy of teacher education:

Towards an integrative view of teacher behavior and teacher learning. *Teaching and teacher education 26,* 98-106. DOI:10.1016/j.tate.2009.05.001

Krainer, K. (2005). What is good mathematics teaching, and how can research inform practice and policy? *Journal of Mathematics Teacher Education 8*(2). DOI: 10.1007/s10857-005-4766-0.

Larkin, J., McDermott, J., Simon, D. P., & Simon, H. A. (1980a). Expert and novice performance in solving physics problems. *Science*, *208*(4450), 1335-1342.

Larkin, J. H., McDermott, J., Simon, D. P., & Simon, H. A. (1980b). Models of Competence in Solving Physics Problems. *Cognitive science*, *4*(4), 317-345.

Leinhardt, G., & Greeno, J. G. (1986). The cognitive skill of teaching. *Journal of Educational Psychology 78*, 75-95.

Luehmann, A. L. (2007). Identity Development as a Lens to Science Teacher Preparation. *Science Teacher 91*(5), 822-839.

Mirabile, R. (1997). Everything you wanted to know about competency modeling. *Training and Development. August.* 73-77.

Morine-Dershimer, G. (1977, April). What's in a Plan? Stated and unstated plans for lessons. *Paper presented at the Annual Meeting of the American Educational Research Association, New York, NY.*

Morine-Dershimer, G. (1983). Tapping teacher thinking through triangulation of data sets. *R & D Report No. 8014.* Austin, TX: Research and Development Center for Teacher Education.

Muller, C. (2001). The role of caring in the teacher-student relationship for at-risk students. *Sociological inquiry*, *71*(2), 241-255.

Ohly, S., Sonnentag, S., & Pluntke, F. (2006). Routinization, work characteristics and their relationships with creative and proactive behaviors. *Journal of organizational behavior*, *27*(3), 257-279.

Ovens, A., & Tinning, R. (2009). Reflection as situated practice: A memory-work study of lived experience in teacher education. *Teaching and teacher education 25*, 1125-1131. DOI:10.1016/j.tate.2009.03.013

No Child Left Behind (NCLB) Act of 2001, Pub. L. No. 107-110, § 115, Stat. 1425 (2002).

Parry, S. B. (1996). The quest for competences: Competency studies can help you make HR decision, but the results are only as good as the study. *Training 33,* 48-56.

Pendlebury, S. (1990). Practical arguments and situational appreciation in teaching. *Educational Theory 40*(2), 171-179.

Pendlebury, S. (1993). Practical arguments, rationalization, and imagination in teachers' practical reasoning: A critical discussion. *Journal of Curriculum Studies 25*(2), 145-51.

Powell, M. (1978). Research on Teaching. *The Educational Forum 43* (1).

Rudestam, K., & Newton, R. (2007). *Surviving Your Dissertation.* Thousand Oaks, CA: Sage.

Russell, T., & Loughran, J. (2007). *Enacting a pedagogy of teacher education: Values, relationships and practices*. London: Routledge.

Salganik, L. H., Rychen, D. S., Moser, U., & Konstant, J.W. (1999). *Projects on competences in the OECD context: Analysis of theoretical and conceptual foundations*. Neuchâtel: Swiss Federal Statistical Office.

Sandberg, J. (2000). Human competence at work: An interpretive approach. *Academy of Management Journal 43*(1).

Sanders, W., & Horne, S. (1998). Research Findings from the Tennessee Value-Added

Assessment System (TVAAS) Database: Implications for Educational Evaluation and Research. *Journal of Personnel Evaluation in Education 12*(3), 247-256.

Schoenfeld, A. H. (1998). Toward a theory of teaching-in-context. *Issues in Education*, *4*(1), 1–94.

Schoenfeld, A. H. (2011). *How we think: A theory of goal-oriented decision making and its educational applications*. New York: Routledge.

Schön, D. A. (1983). *The reflective practitioner: How professionals think in action*. New York: Basic Books.

Schön, D.A. (1995). Knowing-in-action: The new scholarship requires a new epistemology. *Change, November/December,* 27-34.

Shanteau, J. (1992). Competence in experts: The role of task characteristics. *Organizational Behavior and Human Decision Processes 53*, 252-266.

Staiger, O., & Rockoff, J. (2010). Searching for effective teachers with imperfect information. *Journal of Economic Perspectives 24*(3), 97-118.

Sternberg, R. (1998). Abilities are forms of developing expertise. *Educational Researcher 27,* 11-20.

Sternberg, R. (2006). *Cognitive psychology 4th edition.* Belmont, CA: Thomson Higher Education.

Stoof, A., Martens, R., van Merriënboer, J., & Bastiaens, T. (2002). The boundary approach of competence: A constructivist aid for understanding and using the concept of competence. *Human Resource Development Review (1)*345. DOI: 10.1177/1534484302013005

Stough, L. M. (2001, April). Using stimulated recall in classroom observation and professional development. *Paper presented at the annual meeting of the American Educational Research Association, Seattle, WA.*

Stronge, J. H., Ward, T. J., & Grant, L. W. (2011). What makes good teachers good? A cross-case analysis of the connection between teacher effectiveness and student achievement. *Journal of Teacher Education*, *62*(4), 339-355.

Sweller, J., Mawer, R. F., & Ward, M. R. (1983). Development of expertise in mathematical problem solving. *Journal of Experimental Psychology: General*, *112*(4), 639.

Taylor, F. (1911). *The principles of scientific management*. New York: Harper Bros.

Torff, B. (1999). Tacit knowledge of teaching: Folk pedagogy and teacher education. In Sternberg, R., (Ed.), *Tacit Knowledge in Professional Practice* (pp195-213). Mahwah, NJ: Lawrence Erlbaum.

Tracey, M. W., & Hutchinson, A. (2013). Developing Designer Identity through Reflection. *Educational Technology*, *53*(3), 28-32.

Tracey, M. W., Hutchinson, A., & Grzebyk, T. Q. (2014). Instructional designers as reflective practitioners: developing professional identity through reflection. *Educational Technology Research and Development*, *62*(3), 315-334.

Turner, D. (2010). Qualitative interview design: A practical guide for novice investigators. *Qualitative Report 15*(3) 754-760.

Tsui, A. (2003). *Understanding expertise in teaching: Case studies of second language teachers.* New York, NY: Cambridge

Tsui, A. (2009). Distinctive qualities of expert teachers. *Teachers and Teaching, Theory, and Practice 15*(4), 421-439.

University of Minnesota Center for Teaching and Learning (2013). *Peer review instrument.* Retrieved from http://www1.umn.edu/ohr/teachlearn/resources/peer/instruments/.

United States Census Bureau (2012) *State and county quick facts.* Retrieved from http://quickfacts.census.gov/qfd/states/48/4835000.html

Vollmeyer, R., Burns, B., & Holyoak, K. (1996). The impact of goal specificity on strategy use and the acquisition of problem structure. *Cognitive Science 20*, 75-100.

Vygotsky, L. S. (1960). *The development of higher psychological functions*. (M. Cole, trans.). Moscow: Acad Ped Nauk.

Westerman, D. A. (1991). Expert and novice decision making. *Journal of Teacher Education 42,* 292-307.

Wray, D., Medwell, J., Fox, R., & Poulson, L. (2000). The teaching practices of effective teachers of literacy. *Educational Review 52*(1), 75-84.

Yinger, J. (1986). Examining thought in action: A theoretical and methodological critique of research on interactive teaching. *Teaching and Teacher Education 2*(3), 263-282.

Yukl, G. (1994). *Management in organizations.* Englewood Cliffs, NJ: Prentice-Hall.

ABSTRACT

THE ROLE OF REFLECTION IN EXPERT TEACHER INSTRUCTION

by

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Degree: Doctor of Philosophy

Teachers in K-12 education have a difficult and sometimes chaotic work life. However, the experts in the field make difference in the lives of the students they teach. These effects are seen even years after the course has ended. Quality teaching has been shown to affect employability and even wage attainment for students. The purpose of this qualitative research study was to find ways to view the role reflection plays in the practice of expert teachers and to enter the world of an expert teacher through their description and narrative of how they go about their practice. High School mathematics teachers in a Title I school system in the southwest United States participated in this study. Participants were both male and female math teachers, and had from twelve to twenty-eight years of classroom teaching experience. Class schedules included both block and traditional periods. Observation and interview were used to gain understanding of teachers' worldview. Repertory grid elicitations were used to record the constructs these teachers held regarding practice. It was found that the use of active learning, especially group work and tutoring, helped the students retain content at greater levels for superior performance on the Advanced Placement and other standardized tests. In addition, these exemplars exhibited a great degree of collegiality with others on the staffs in their schools and in

professional conferences and other activities. They used routine and structure to build a safe place for students to learn. Their respect and warm regard for students was evident throughout the study. Teacher-student relationships were important and shown to be nurtured. The teachers studied were shown to believe that their practice was a partnership in learning with their students. They were always available for tutoring and to help the students in their efforts to comprehend the material and achieve high marks on standardized tests. The performance of these students reaches some of the highest levels in the nation. The aim is to better understand how expert teachers think about their practice, and how they use reflection to achieve superior performance in the classroom.

AUTOBIOGRAPHICAL STATEMENT

Elizabeth A. Gross is a former library director of a nonprofit organization geared toward social justice. She guided this library and collection through a retrospective conversion and it now uses Koha, an open source library catalog and database. She is a former high school media specialist. She has worked with learners from pre-k through adult, and has learned much from them all. In addition, her interest in research of all types has led to a successful stint in medical research. As well as finding prior art for patent claims. She and her husband Ken reside in Houston, TX and have raised three daughters: a medical doctor, and attorney, and an entrepreneur. A former All-American swimmer, she now enjoys running and yoga.